Educational Research and Development Journal
Fall 2025, Vol. 28, No. 2, pp. 24–40

Teaching Strategies Employed in a Second Grade One-Way Chinese-English Dual Language Immersion Math Class

Ko-Yin Sung

Utah State University

Abstract

The purpose of this study is to understand current math teaching practices in dual language immersion (DLI) education by investigating a second–grade Chinese-English DLI teacher's use of instructional strategies in a math class taught in Mandarin Chinese. The students in the class were all native English speakers. This study examined the teacher's math instructional strategy use through classroom observation. The teacher was observed over a six-week period, during which three units were taught, resulting in a total of 1,680 minutes of math instructional data. Oxford's (1990) Taxonomy of Strategies was used as the framework to capture the teacher participant's strategy use in the classroom. The findings indicate that *evaluating* and *paying attention* were the most frequently used. The strategy use identified in this study differs from that reported in other DLI research. Explanations for and implications of these distinctive findings are discussed.

Introduction

Gaining math concepts at elementary school level is not only a predictive factor of students' reading and math achievement, but also of their overall academic success later in life (Lewis et al., 2020). Lewis et al. (2020) explained that it is because early math ability represents various skills (e.g., reasoning, critical thinking, problem–solving, and conceptual understanding) needed in multiple academic subjects. Mathematical practices can be defined as utilizing language and other symbols to process thinking, speaking, and participating towards the goals of education (Moschkovich, 2015). Hence, to be proficient in math, a student's language knowledge plays an important role. Oliveira et al. (2015) elaborated that language used in mathematics requires students' understanding of a specialized and context-specific variety of language rarely used in real life; hence, good knowledge of the specific language and efficient communication through it are fundamental for achieving mathematical proficiency. As the language of math often involves complex concepts and diverse words and expressions, for students who receive math instruction in a second language, their limited second language proficiency level could sometimes hinder their level of math understanding. Ernst-Slavit and Mason (2011) gave a simple example of how the math term, "mean", containing multiple meanings, often created confusion for English language learners in mathematics classrooms. Gottlieb and Ernst-Slavit (2013) thus claimed the critical role of language in math as different aspects of mathematical skills greatly depend on language and are challenging for second language learners. However, studies have reported that teachers who offer math instruction in students' second language (e.g., English as a second language learners, bilingual learners in various types of dual language programs) often struggle to provide effective math instruction. For example, a couple of studies (Celedón-Pattichis, 2010; Ross, 2014) found that the teachers had a difficult time deciding the type of instructional approach to use to improve their students' math performance. Other studies (Gottlieb & Ernst-Slavit, 2013; Krause & Barko-Alva, 2019) reported that the teachers were not capable of implementing math tasks that were challenging enough for students as such tasks usually have high language demand. As a result, bilingual learners' math performance suffered.

Although the current literature has identified math instruction offered in the students' second language as challenging, few studies have examined math instruction in one-way dual language immersion (DLI) programs, a type of bilingual program in which all or the majority of students learn academic subjects in two languages – their first language (e.g., English) and a target language (e.g., Chinese). As one-way DLI programs gain popularity and expand rapidly across the United States (Sung & Tsai, 2019), particularly with Mandarin Chinese now being the second most commonly implemented program language in the United States (American Council for the Teaching of Foreign Languages, 2021), research such as the present study is needed to better understand current math teaching practices in these programs. Such work can help improve the quality of DLI education and better serve the growing student population these programs support. With this in mind, this study investigated the teaching strategies used by a second grade Chinese-English one-way DLI teacher in a mathematics class in Utah, a pioneer state in implementing one-way DLI programs.

Many studies (Sorto et al., 2014; Tavares, 2015; Yeh, 2017) on L2-medium math teaching, which refers to teaching mathematics in a learner's second language rather than their first language, have found that the strategies instructors use to teach math in students' second language resemble those employed by second language teachers in language instruction. Given the essential role of language in math instruction and the common finding that language strategies are often employed in L2-medium math teaching, it is appropriate for this study to adopt Oxford's (1990) Taxonomy of Language Learning Strategies as the framework for capturing and interpreting the teacher participant's math teaching practices. Specifically, Oxford's (1990) framework was used to analyze the categories, frequencies, and effectiveness of math teaching strategies employed in the observed classroom. The study's findings help identify instructional strengths and weaknesses, thereby informing future teacher training, instructional practices, and potential program policy changes.

Theoretical Framework

Oxford (1990) claims that the use of language strategies greatly facilitates second language learners' communication in listening, speaking, reading, and writing in the target language, which is integral to mathematical learning (Gottlieb & Ernst-Slavit, 2013). Oxford (1990) proposed six categories of strategies grouped in two different types. One type of strategy is named direct strategies including memory, cognitive, and compensation strategies that demand a learner to mentally process and use the target language. In applying Oxford's (1990) framework in a DLI math classroom, for example, teachers can use repetition or chants to teach key math terms in the target language (memory strategy), model step-by-step problem solving (cognitive strategy), and use drawings or manipulatives when explaining math concepts (compensation strategy).

The other type of strategy is called indirect strategies, which consists of metacognitive, social, and affective strategies, utilized to plan for communication tasks and evaluate language performance. In a DLI math classroom, teachers may guide their students to reflect on which strategies help them solve math problems (metacognitive strategy), use positive reinforcement to build confidence in solving math problems in the target language (affective strategy), and create group problem-solving activities to encourage the use of math discourse in the target language (social strategy).

In sum, the two types of strategies work collaboratively to assist learners' communication in a second language when learning math. Direct strategies provide learners with the linguistic and cognitive tools necessary for math language use, while indirect strategies offer the regulatory and supportive mechanisms that enable learners to apply these tools effectively in communicative contexts. Empirical research (Bessai, 2018; Mohammadi & Alizadeh, 2014; Zou & Lertlit, 2022) using Oxford's (1990) framework to analyze strategy use has consistently shown that it is a reliable and valid tool. The framework captures the multidimensional nature of language learning strategies across different teaching contexts, and findings from these studies provide valuable pedagogical insights for supporting diverse learners. Applying Oxford's (1990) classification of strategies in the analysis of DLI math instruction in this study offers a systematic lens for identifying how teachers support both mathematical understanding and target-language development.

Empirical Literature Review

By using keywords such as "dual language immersion", "DLI", "math instruction", "Mandarin Chinese", and "teaching strategies", relevant studies were identified through a systematic search of relevant databases. The inclusion criteria emphasized empirical works that investigate mathematics instruction in DLI context, specifically addressing teaching strategies, their effectiveness, or classroom methodologies. Both qualitative and quantitative studies published within the past 20 years were considered. Titles, abstracts, and full texts were screened to ensure the review included a representative and pertinent set of studies.

Types of Math Teaching Strategies

Previous studies on bilingual teachers' math instructional practices have identified a few teaching strategies. Several studies centered on the use of particular strategies. For example, Somerville and Faltis (2019) investigated the effect of the translanguaging strategy on math instruction in a fourth grade two-way Spanish-English dual language program. Through video recordings of math lessons, participant observation, and interviews, the study found several positive effects of translanguaging. For the teachers, translanguaging enabled them to respond to the diverse linguistic repertoires of their students and facilitated meaningful teaching of the math content. For the students, translanguaging served as a way for them to express complex math ideas which required extended language use. Translanguaging aligns well with Oxford's (1990) strategy framework, which emphasizes using all available linguistic resources to support comprehension (cognitive strategies), reduce anxiety, and enhance learners' sense of identity (affective strategies). Based on the findings, the researchers argued that translanguaging, an effective strategy for developing bilingualism, should not be seen as a threat that takes away space for target language use in the classroom. Instead, the authors suggested that it was time to move away from the dual language instructional model, in which languages were taught separately by subject matter and time of day, to move toward a model which supports translanguaging practices.

Similar to Somerville and Faltis' (2019) study, Patthoff et al. (2021) also focused on investigating teachers' use of a particular strategy, the use of technology, in their study. The researchers investigated three Spanish-English two-way elementary DLI teachers' use of technology as a strategy to facilitate mathematics learning. Through lesson observations, interviews, and workshop discussions, the researchers found that the teacher participants' use of technology strategies was able to move away from engaging learners at a surface level (e.g., being attentive and doing math drills) and move toward deep learning (e.g., linking concepts with language, directing attention to specific content and grammatical feature of mathematics discourse). Viewed through Oxford's (1990) strategy framework, these uses of technology supported modeling and math concept connections (cognitive strategies), directed attention and monitored comprehension level (metacognitive strategies), facilitated mathematical communication (social strategies), and increased the visibility of students' work (affective strategies).

While the aforementioned studies identified effective teaching strategy use, Krause and Barko-Alva's (2019) classroom observation-based case study with a focus on a fourth grade Spanish-English two-way DLI teacher's math questioning strategies found that, although the teacher tried to use questioning to help develop students' conceptual understanding of math and create opportunities for mathematical understanding and cross-linguistic connections, the language used in questioning was simplified. In the context of Oxford's (1990) strategy framework, this suggests a limitation in the teacher's use of cognitive strategies (e.g., supporting deeper processing) and social strategies (e.g., facilitating rich discourse), as the simplified language reduced opportunities for students to engage in more complex mathematical and linguistic practices. The researchers caution that math questioning strategies used in bilingual classrooms need to be more strategically formulated than what were observed in the case study. For instance, the authors suggested that bilingual teachers should not simplify the language while asking math questions in order to foster an active bilingual math learning environment.

Frequently Used Math Teaching Strategies

Other studies on bilingual teachers' math instructional practices expanded their investigations to look into teachers' use of multiple strategies. For instance, Li et al. (2022) investigated the effects of three math instructional strategies they observed in the teacher participants' classrooms, namely, explicit teaching (cognitive strategy), guided practice (metacognitive strategy), and peer interaction (social strategy), on more than 300 third to fifth grade Spanish-English DLI learners' reading comprehension and math performance. The study results suggested that the three strategies positively influenced the students' reading comprehension, which is tightly correlated with their math performance as math involves not only symbols and numbers, but also word problems (Fuchs et al., 2015). Kasule and Mapolelo (2005) conducted a questionnaire and interview study regarding primary school teachers' mathematics teaching strategies in a second language in Botswana. The teacher participants proposed a few categories of strategies, such as linguistic strategies, games, and organizational strategies, which, after the researchers analyzed the details of how they were carried out in the classrooms, were determined to be inefficient to the diverse students' needs. For instance, the researchers mentioned that one of the linguistic strategies, classroom discussions (social strategy), were initiated by the teacher participants who controlled the topics to be discussed, and decided which student to respond and when to end the discussion. According to the researchers, this type of classroom discussion, which follows a predictable sequence called initiate-response-feedback, can potentially diminish learners' active participation and productivity. The suggestion made based on the result of Yeh's (2017) study was aligned with Kasule and Mapolelo's (2005) finding. Yeh (2017) conducted a three-year longitudinal study on two Spanish-English DLI teachers' mathematics teaching. The study found that the two teacher participants utilized similar teaching strategies such as supporting their students through scaffolding and practice (cognitive strategies) to acquire math skills. However, the author pointed out that one of the teacher participants misused the teaching strategy by teaching math terms independently of their applications. The author further explained that a more balanced model of learning should consist of not only acquiring math skills, but participating through meaningful interactions. An example highlighted by the author was the use of classroom discussions to build individual and collective understandings.

In sum, some of the previous studies on bilingual teachers' math instructional practices named a few strategies (e.g., translanguaging and use of technology) that are especially effective in the bilingual learning context while the other studies found that the ways the teachers employed certain strategies were not effective (e.g., class discussions and scaffolding). Even though these studies offer valuable insights into commonly used strategies in DLI math classrooms and their levels of effectiveness, their findings may not be fully generalizable to other types of DLI programs or target languages (e.g., Mandarin Chinese one-way programs), as nearly all were conducted in Spanish-English two-way DLI settings in the United States. In addition, many of the studies only researched the use of a single strategy. More information is needed on bilingual teachers' comprehensive use of strategies in carrying out math instruction in the classroom. Considering the limitations identified in the previous studies, the present study investigated a second-grade Mandarin Chinese-English one-way DLI teacher's math instructional strategies in the classroom.

Methodology

DLI Math Instruction in the Utah Context

The state of Utah passed Utah Senate Bill 41 in 2008, which enabled funding for the implementation of K–12 one-way DLI programs in various languages including Mandarin Chinese. According to the state, the benefits of the DLI program are being highly proficient in a critical language, performing well on standardized tests, being culturally competent, developing higher cognitive and problem-solving skills, and being well-prepared for the global job market (Utah Dual Language Immersion, 2022). The majority of the students in the program are English-speaking monolingual white students. When the current study was conducted, there were 38 one-way Mandarin Chinese programs in 12 different school districts in eight different counties (Asia Society, 2019). The Utah one-way program adopts the 50:50 model, in which students receive instruction for half of their school day in English taught by an English-speaking teacher and the other half in the target language taught by a target language-speaking teacher. With respect to the medium of instruction of specific subjects, if a subject is taught in one language, it is reinforced in the other language. For example, the Utah Instructional Model (2022) illustrates that social studies and math are taught in the target languages and reinforced in English from Grades 1 to 3. From Grades 4 to 6, social studies and science are taught in the target languages and reinforced in English while math is taught in English and reinforced in the target languages. Take the Chinese program as an example, from grades 1 to 3, 20% of total instructional time is expected to be math in Chinese. Only 15% of total instructional time is used in English to reinforce the contents of social studies, math, and science originally taught in Chinese. The heavy emphasis of math instruction through the instructional medium of Chinese from Grades 1 to 3 means that the Chinese-speaking teachers in these grades take on most of the responsibility to ensure that students understand abstract math concepts in the target language well enough for them to transfer the knowledge to English for the yearly standard assessments in English.

A recent Utah DLI research study (Watzinger-Tharp et al., 2018) conducted by the Utah State Office of Education reported that in the subject of math, Utah DLI students did not surpass their non-DLI peers until the majority of the math instruction switched from the target languages to English in 4th grade. The research finding seems to suggest that math instruction in the target languages may not be sufficiently effective in the Utah DLI program. The Chinese DLI literature also showed that Utah DLI teachers often encounter difficulties explaining abstract math concepts clearly in Chinese (Sung & Tsai, 2019). Therefore, this study intended to understand more about the current math teaching practices in the Utah Mandarin Chinese DLI program in hope to offer insightful information for teaching implications and suggestions for future research.

The Teacher Participant and the Math Class

The teacher participant in this study was a native English speaker in his late twenties, who spoke Chinese as a second language. The teacher learned Chinese when he served a two-year religious mission in a Chinese speaking country. After he completed his mission, he returned to the U.S. and earned a bachelor's degree in International Studies in which he took a few Chinese language classes. During the time of this study, he was working on a graduate degree in second language teaching. With respect to his language teaching experience, the teacher had been teaching in a Chinese one-way DLI classroom setting for three years, although the first year was in a part time context. Prior to this, he tutored Chinese to college students for two years and had three years of experience tutoring English to non-native speakers in Taiwan.

When the study was conducted, it was the second semester the teacher participant worked as the Chinese-speaking teacher in the second-grade Mandarin Chinese DLI class, which had 25 students, all of whom were native English speakers. The Utah DLI program adopted the strict no-English policy, meaning that when the designated medium of instruction was Chinese, no English should be spoken for any reason by the teacher or the students. The results of the classroom observation illustrate that the teacher participant followed the policy closely. During the time of observation, the teacher taught three math units: two-digit subtraction, three-digit addition and subtraction involving regrouping, and money and time (e.g., telling time to the hour, half hour, and five minutes; recognizing dimes, nickels, pennies, and quarters). In terms of the math textbook used in class, the teacher participant explained that the school district he worked for used Go Math for the elementary math curriculum; however, Go Math was not available in Chinese so the state organization in charge of the DLI program provided Chinese DLI teachers with enVision (Chinese edition) to aid the teaching in math using Chinese. The teacher participant found a couple of issues with enVision. According to the teacher, enVision was not written for his students' age and proficiency, and it taught math concepts in a very different order and with different processes than Go Math, which caused students to be confused. Since a previous second-grade Chinese DLI teacher created Chinese worksheets based off of the Go Math textbook and noticed that students had done well using them in class, the teacher participant decided to use Go Math for his classes and adopted the Chinese worksheets from the previous teacher.

Data Collection and Analysis

This study examined the teacher's math instructional strategy use through the data collection method of classroom observation. A research assistant (RA) who was trained on the knowledge and classroom applications of Oxford's (1990) strategy framework was sent to observe the teacher participant's math instruction, which was offered approximately 60–75 minutes per day in Mandarin Chinese four times a week. The RA observed the teaching of a total of three math units during a six-week period. The math sessions were audio-recorded to allow the researcher to review and confirm that all strategy use was captured accurately. Thus, both the RA's observation notes and audio recordings served as data collection tools to enhance reliability. Over the six-week study, a total of 24 observation sessions were conducted, resulting in approximately 1,680 minutes of audio-recorded data.

To answer the first research question, What types of math teaching strategies did the Chinese DLI math teacher use?, the RA used Oxford's (1990) Taxonomy of Strategies as the guidelines to capture the teacher participant's strategy use in the class. There are a total of 62 strategies categorized in six strategy groups: memory, cognitive, compensation, social, metacognitive, and affective. During observations, the RA added three more strategies, scaffolding (cognitive strategy), modeling (cognitive strategy), and encouragement through competitions (affective strategy) that the teacher used but were not indicated in the strategy guidelines.

To answer the second research question, What were the frequency and effectiveness of the various strategies observed?, when the RA observed a strategy employed by the teacher, or a strategy the teacher directed the students to use, she recorded in real-time the use of the strategy and the details of how it was used on the sheet of guidelines. The RA tallied all strategy incidents and assessed their quality for appropriateness, clarity, and effectiveness in supporting student understanding according to Oxford's (1990) framework. Strategies used in more than 10% of the incidents were considered most frequently used. Strategies used between 8% and 10% of the incidents were considered moderately used, while those used between 2% and 7% were considered less frequently used. Strategies used in less than 2% of the incidents were considered only occasionally used. Triangulation was conducted by comparing the RA's observation notes, the audio recordings, and the tallied incidents; any discrepancies were discussed and resolved by the researcher and RA to ensure accurate capture of both frequency and quality. Inter-rater reliability between the researcher and RA was 97%.

Results

Research Question 1: Types of Math Teaching Strategies Used

To answer the first research question regarding the types of math teaching strategies observed, the results from the classroom observations illustrated that a total of 2215 incidents of teaching strategies were identified, which comprised 20 strategies. Of those 20 strategies, eight were metacognitive, four were memory, four were cognitive, two were social, one was affective, and one was compensation. It is evident that the teacher participant used the metacognitive strategies more frequently than other types. The detailed frequency and effectiveness of each strategy observed in the classroom is discussed in Research Question 2 below.

Research Question 2: Frequency and Effectiveness of Strategy Use

To address Research Question 2, which concerns the frequency and effectiveness of strategy use, the findings are presented by first describing examples of the most frequently observed math teaching strategies, followed by strategies used moderately, less frequently, and occasionally. For each example, the effectiveness of the strategy is discussed and interpreted using Oxford's (1990) strategy framework as a guiding lens.

Most frequently used strategies. Among the strategies identified, the top two most frequently used strategies, *evaluating* and *paying attention*, were used far more often (23.4% and 21.5% respectively) than any other strategies (see Table 1).

Table 1

Teaching Strategies Used in the Second-Grade Classroom

Frequency Ranking	Strategy	Strategy Type	# (%) of Strategy Incidences
#1	Evaluating (Assessing your own learning and progress.)	Metacognitive	519 (23.4%)
#2	Paying Attention (Focusing on key information and staying on task.)	Metacognitive	477 (21.5%)
#3	Making Positive Statements (Using encouragement or affirmations to boost confidence.)	Affective	214 (9.6%)
#4	Modeling (Demonstrating problem-solving behaviors for learning.)	Cognitive	194 (8.8%)
#5	Using Physical Response (Using actions or gestures to reinforce learning.)	Memory	152 (6.9%)
#6	Organizing (Structuring information logically for easier understanding)	Metacognitive	124 (5.6%)
#7	Seeking Practice Opportunities (Looking for opportunities to practice actively.)	Metacognitive	106 (4.8%)
#8	Scaffolding (Breaking tasks into manageable steps or providing support.)	Cognitive	103 (4.7%)
#9	Repeating (Practicing language forms multiple times to reinforce learning.)	Cognitive	78 (3.5%)
#10	Setting Goals and Objectives (Planning specific goals for learning outcomes.)	Metacognitive	59 (2.7%)
#11	Using Mechanical Techniques (Memorizing through drills, lists, or patterns.)	Memory	33 (1.5%)
#12	Using Imagery (Visualizing concepts and ideas to aid memory.)	Memory	32 (1.4%)
#13	Highlighting (Emphasizing key points or information for attention.)	Cognitive	29 (1.3%)
#14	Structured Review (Systematically reviewing previously learned material.)	Memory	27 (1.2%)
#15	Encouragement through Competitions (Motivating learning via games or challenges.)	Social	17 (0.7%)
#16	Monitoring (Tracking comprehension and performance during tasks.)	Metacognitive	14 (0.6%)
#17	Cooperating with Peers (Working with others to learn or solve problems.)	Social	14 (0.6%)
#18	Planning for a Language Task (Preparing steps or strategies before starting a task.)	Metacognitive	9 (0.4%)
#19	Using Mime or Gesture (Communicating or reinforcing meaning nonverbally.)	Compensation	7 (0.3%)
#20	Determining the Level of Difficulty of a Language Task (Assessing how challenging a task is before attempting it.)	Metacognitive	7 (0.3%)

The metacognitive strategy of *evaluating* (23.4%) was the most frequently used teaching strategy. The strategy was often used to check if the students understood the information given by the teacher in Mandarin Chinese, which sometimes was not necessarily related to the math content. Excerpt 1 illustrates such an incident.

Excerpt 1

Teacher: 你們等一下會有一個數學考試。如果你知道我在說什麼, 請給我一個讚。

[You will have a math test in a minute. If you know what I am saying, please give me a thumbs up.]

Students showed their thumbs up.

Teacher: 如果有問題請舉手。

[If you have a question, please raise your hand.]

Even though the content of the class was math, the fact that the instruction was given in the students' second language possibly prompted the teacher to evaluate often whether the students understood important information said in the classroom including announcements such as the one in Excerpt 1. Other than announcements, the teacher also frequently evaluated the students' math learning progress and level of understanding. Excerpt 2 shows such an incident.

Excerpt 2

Teacher: 寫好了嗎? 寫完的人請舉手。

[Did you finish writing? People who are finished please raise your hands.]

Teacher: 如果你寫完請舉手

[If you are finished, please raise your hands.]

After a few minutes

Teacher: 誰知道這個是幾點? 三、二、一 說。

[Who knows what time this one is? Three, two, one, say it.]

Students: 八點。

[Eight o'clock.]

Teacher: 八點, 對不對?

[Eight o'clock. Is it correct?]

Students: 對!

[Correct!]

Oxford (1990) stated that metacognitive strategies, such as *evaluating*, provides a way for learners to understand their learning progress. In the case of the teacher use of *evaluating* in this study, the strategy offered him the information about the learning progress of the class as a whole, which helped him better adjust his teaching pace to fit his students' needs.

The metacognitive strategy of *paying attention* (21.5%) was the second most frequently used strategy in the classroom. The results of the classroom observations showed that the teacher frequently used this strategy when he tried to get students' attention for the next task. Excerpt 3 is a typical example of how *paying attention* was employed.

Excerpt 3

Teacher: 手放好，脚放好，眼睛看我。
[Keep hands and feet to yourself and eyes to me.]

Teacher: 給我看你們準備好學習
[Show me that you are ready to learn.]

Teacher: 三、二、一、零 (counting down to get students' attention)
[Three, two, one, zero.]

Teacher: 坐
[Sit…]

Students: 好!
[well!]

In the excerpt above, the teacher illustrated how he usually used short phrases to get his students' attention. The observation notes documented that there were days when the class was less focused than usual due to various reasons (e.g., content being difficult, school events occurring near math instructional time). To combat the students' inattention, the teacher frequently utilized the *paying attention* strategy to ensure that the students were ready for their tasks. According to Oxford (1990), language learners are often overwhelmed by new materials (e.g., new terms, new grammar, a different writing system) introduced in a second language. Using the metacognitive strategy of *paying attention* helps learners regain their focus.

Moderately used strategies. Followed by the two most frequently used metacognitive strategies are the affective strategy of *making positive statements* and the cognitive strategy of *modeling*, which were moderately used by the teacher (9.6% and 8.8% respectively).

The use of affective strategies, such as *making positive statements*, influences the level of success of language learning. It positively affects a learner's emotions, attitudes, motivations, and values, which make language learning more enjoyable and effective (Oxford, 1990). The teacher was observed making positive statements when the students were attentive or when they solved math problems correctly. Excerpt 4 shows such incidences.

Excerpt 4

Teacher: 把筆放下。很多人的鉛筆放下了，很好。
[Put down your pencils. Many of you have put down your pencils, very good.]

The teacher circled around to check on the students' answers and went back to the front of the class.

Teacher: 很好，我覺得你們寫得很好。
[Excellent, I feel that you wrote very well.]

The other moderately used strategy is the cognitive strategy of *modeling*. The teacher often used modeling to demonstrate to his students how to interpret and solve math problems step by step. Excerpt 5 is an example of the teacher's use of the *modeling* strategy.

Excerpt 5

Teacher: 樹上一共有三十四隻鳥，十六隻鳥飛走了。
[There were a total of 34 birds on the tree, but 16 of them flew away.]

Teacher: 好，所以，你們看。有三十四隻鳥， 十六隻鳥飛走了。
[OK, so, look. There were 34 birds, and 16 of them few away.]

The teacher was writing numbers on the board while repeating the math problem.

Teacher: 樹上還有幾隻鳥？ “還有” 是減還是加的意思？
[How many birds are still on the tree? "still are" means minus or plus?]

Students used hands to signal the "minus" sign.

Teacher: 好, 什麼減什麼? 好, 我們看。這是大的數字。這是小的數字。小可不可以減大？
[Good, what minus what? OK, let's see. This is the big number (*pointing to 34*). This is the small number (*pointing to 16*). Can the small number minus the big number?]

Students: 不可以。
[No.]

Teacher: 大可不可以減小？
[Can the big number minus the small number?]

Students： 可以！
[Yes!]

Teacher： 所以是什麼減什麼？
[So it is what minus what?]

Students： 三十四減十六。
[34 minus 16.]

The teacher continued to model how to solve the expression 34–16.

Teacher modeling is a great strategy to demonstrate to learners how to solve math problems. When the teacher modeled how to solve a problem, the teacher not only provided the solution, but also laid out the steps and the think-aloud process in each step, greatly reducing the learners' cognitive load. Rosenshine (2012) stated that *modeling* is an effective teaching strategy in mathematics, science, writing, and reading that provides learners with cognitive support.

Less frequently used strategies. Followed by the moderately used strategies are six less frequently used strategies (one memory, three metacognitive, and two cognitive strategies). With respect to the memory strategy, the teacher was observed to sometimes use the strategy of *using physical response* (6.9%) to illustrate a math concept (e.g., asking students to use their fingers to make a circle to represent an hour), to remember a key Chinese character used in the math problem (e.g., asking students to write the character "大" [big] in the air), and to remind the students to pay attention to the instruction (e.g., telling students to "show me your hands on your ear to show me that you're listening."). Memory strategies such as *using physical response* are useful in helping learners use the connection between motion and verbal material to remember the large amount of math concepts and key terms in the target language (Oxford, 1990).

The three metacognitive strategies less frequently used are *organizing* (5.6%), *seeking practice opportunities* (4.8%), and *setting goals and objectives* (2.7%), all of which are strategies to help learners arrange and plan their learning effectively (Oxford, 1990). In the class, the teacher was observed to sometimes promote the strategy of *organizing* when he told the students to put away their individual white boards and markers when they finished doing math problems and were ready to move on to the next task. He also advocated the strategy of *seeking practice opportunities* when he from time to time gave extra handouts with math problems to students who completed their tasks early to create more practice opportunities for them. Sometimes in the beginning of the class, the teacher used the strategy of *setting goals and objectives* to give a summary of the objectives he expected the class to accomplish in class. The use of multiple metacognitive strategies at times assisted the teacher to optimize his students' learning conditions and avoid chaos that can sometimes occur if the learners lose focus.

The two cognitive strategies that were less frequently used are *scaffolding* (4.7%) and *repeating* (3.5%). Scaffolding is related to the concept of zone of proximal development (ZPD), which is defined as the difference between what a learner can do on their own versus what they can do with guidance from a more experienced individual (e.g., teacher) (Vygotsky, 1978). In the math class, the teacher was observed to occasionally walk around the classroom while the students were solving math problems individually. The teacher would stop by the desk of a student who struggled with the problems and use *scaffolding* to help the student learn how to solve the math problems. *Repeating,* the other cognitive strategy less frequently used, was promoted by the teacher when he wanted the students to remember new math terms in Chinese (e.g., nickel, dime, quarter, minutes, single digit, double digits). *Repeating* is one of the commonly used language learning strategies to help learners practice using the target language (Oxford, 1990). Considering that there is a large number of math terms to remember in Chinese, it is not surprising to see the teacher using *repeating* to help his students remember them.

Occasionally used strategies. There were ten strategies that were occasionally used. They were three memory, three metacognitive, two social, one cognitive, and one compensation strategies. The teacher occasionally used the memory strategies of *using mechanical techniques* (1.5%), *using imagery* (1.4%), and *structured review* (1.2%), in the classroom. The teacher was observed using imagery (e.g., drawing lines or a clock) to teach math concepts such as subtraction, addition, and time. For each math unit taught, the teacher did a *structured review* and occasionally used *mechanical techniques* (e.g., moving Styrofoam cups) to concretely demonstrate addition and subtraction math problems. Oxford (1990) stated that these memory strategies assist learners by making new concepts and language more meaningful to the learners.

The cognitive strategy of *highlighting* (1.3%) was occasionally used when the teacher went over word problems. On the board, the teacher would underline key phrases and numbers (e.g., highlighting "compared to" and "a total of") that are essential for his students to understand before they can solve the problems. Finally, the rest of the strategy use, which are three metacognitive: *monitoring* (0.6%), *planning for a language task* (0.4%), *and determining the level of difficulty of a language task* (0.3%), two social: *encouragement through competitions* (0.7%), *and cooperating with peers* (0.6%), and one compensation: *using mime or gesture* (0.3%), were used minimally in the classroom.

Discussion

This study reported the various math teaching strategies used by a second-grade Chinese-English DLI teacher in Utah's one-way immersion program model and examined their effectiveness using Oxford's (1990) strategy framework. Although informative, the study is not without limitations. First, it was a small-scale case study involving only one teacher participant. Second, it relied on a single data collection method, classroom observation. Finally, only three math units were observed. Despite these limitations, the findings offer valuable insights into a Chinese DLI teacher's enactment of mathematics teaching strategies and provide a useful foundation upon which future research can build. The following paragraphs summarize the key findings of this study.

To answer the first research question, *What types of math teaching strategies did the Chinese DLI math teacher use?*, the present study found that the teacher participant utilized 20 strategies, nearly half of which were metacognitive. This finding is not aligned with the previous studies (Somerville & Faltis, 2019; Kasule & Mapolelo, 2005; Krause & Barko-Alva, 2019; Li et al., 2022; Patthoff et al., 2021) which highlighted direct strategies, such as cognitive strategies that require mental processing of both the math content and the target language, as well as indirect strategies, such as social strategies involving class discussion and peer interaction. This suggests that compared to the previous studies, the teacher participant in this study placed greater emphasis on helping students monitor and regulate their learning processes. The observation analysis in this study further showed that the teacher participant frequently felt the need to check students' comprehension of his instruction in Chinese and to ensure that they were attending to the lesson rather than engaging in unrelated tasks. The summary of strategy frequency and effectiveness presented in the next paragraph provides additional insights and explanations for these differences.

To answer the second research question, *What were the frequency and effectiveness of the various strategies observed?*, among the total of 2215 incidents of math teaching strategies observed, almost half of them (996 incidents, 45% of all strategy use) represented the use of two particular metacognitive strategies, *evaluating* and *paying attention*. These two strategies are indirect strategies that emphasize centering students' learning and checking their learning progress (Oxford, 1990). The 519 (23.4%) incidents of the strategy use of *evaluating* observed in this study were used to check if the students understood the information given by the teacher in Mandarin Chinese, while the 477 (21.5%) incidents of the strategy *paying attention* observed was to ensure that the students were attentive before they started their math learning or during the transition from one math task to another.

The teacher participant's heavy use of these two strategies can be explained by the specific teaching context he was in. In the previous studies, the learning context was Spanish-English two-way programs, which include two language groups – Spanish heritage-speaking and English-speaking students in a class, so that each group of students can be experts in one language and help the other group learn their language. In the Utah one-way Chinese-English program context, however, almost all the students in the program were monolingual English-speaking students. In the case of the second graders in this study, they had only begun learning Chinese in first grade. The novice Chinese level of the students likely prompted the teacher in this study to feel the need to constantly check whether the students paid attention to his instruction and if they understood him in Chinese. This was evident when the teacher expressed his concern to the researcher after class that students who had a low Chinese level understood less of the lesson and their learning was negatively impacted.

However, as the teacher in this study spent significant time making sure that students were attentive and understood his instruction, less time could be spent on using other strategies to make content more comprehensible. This was evident in the substantial frequency gap observed when this study found that a few strategies were used more than 20% of the time, whereas the remaining strategies ranged from 0.3% to 10%. For example, this study found that cognitive strategies such as *modeling* (8.8%), *scaffolding* (4.7%), and *repeating* (3.5%), which directly enhance learners' understanding of content and the target language, were only moderately or less frequently used. Also, a very useful social strategy*, cooperating with peers* (e.g., group discussion) (0.6%) to improve understanding of math concepts frequently used in other studies was seldom used in this study. A close look at the strategy use of *cooperating with peers* in this study showed that the students did not have conversations in Chinese to discuss how to solve math problems, but instead, the study results showed that the teacher asked students to work in pairs to do drills such as counting down numbers or to ask their partners sitting next to them what their answer was for a particular math problem. The limited social strategy use of *cooperating with peers* in this study seems to suggest that the teacher did not believe that the students' Chinese level was sufficient for them to discuss math problems in groups. If there were a group of Chinese heritage students in class who could possibly produce a little more language output in Chinese to help bring up the Chinese level of the monolingual English-speaking group, the strategy of *cooperating with peers* may be used more efficiently.

Finally, another strategy that other studies reported as a positive strategy use, but was not used at all in this study is the translanguaging strategy. The absence of the strategy use was most likely due to the strict Chinese-only policy in the Utah program, which prevents teachers and students from using a combination of English and Chinese in the Chinese-speaking classroom.

In sum, this study found that even though the strategies the teacher participant utilized were effective, there appeared to be an imbalanced use of various strategy types in the instruction. In other words, the teacher's heavy reliance on metacognitive strategies successfully helped the students stay on task; however, the limited use of direct strategies (e.g., cognitive and memory) or other types of indirect strategies (e.g., social and affective) may have constrained students' opportunities to deepen conceptual understanding and engage more actively in the learning process. According to Oxford (1990), teachers should employ a variety of strategies that work collaboratively to assist learners' learning in a second language. The lack of a diverse range of strategies observed in this study echoes issues identified in previous research, which found that teachers providing math instruction in students' second language often struggle to deliver instruction that effectively improves students' math performance.

Based on the discussion of the study limitations and findings, several directions for future research are suggested. First, future studies need to include more participants with diverse teaching backgrounds and experiences before any generalizations on the findings can be made. Second, future studies should adopt diversified data collection methods to capture DLI teachers' math teaching strategy use and develop a more comprehensive understanding of the math teaching strategy phenomena. Third, a wider variety of math topics should be examined to determine whether topic type influences teachers' strategy use. Fourth, studies aimed at identifying a balanced and effective combination of math teaching strategies are needed to assist DLI teachers in overcoming the challenges of teaching math in students' second language. Finally, this study calls for additional research on DLI teaching strategies within the one-way model, as existing scholarship remains limited, and further evidence is needed to understand how program structure shapes teachers' instructional decision-making.

Conclusion and Implications

This study reported several important findings. First, due to the one-way program learning context (e.g., all learners were at the novice level in Chinese in lower grades), math teaching strategy use in this study heavily relied on two metacognitive strategies, which are indirect strategies. These two strategies allowed the teacher to monitor whether learners were on track with their learning. However, other types of strategies, particularly direct strategies (e.g., cognitive, memory, and compensation), which could directly support learners in comprehending both the content and the target language, were comparatively less frequently or rarely used. Moreover, indirect strategies other than metacognitive strategies (e.g., affective and social strategies) were also observed only sparsely.

In conclusion, the heavy emphasis on a particular type of strategy found in this study is likely insufficient to support all aspects of math learning in a target language. These findings may be attributed to the design of the Utah one-way DLI program. The program primarily enrolls monolingual English-speaking students, which appears to limit teachers' ability to effectively implement social strategies in lower grades, as most students are still at a novice level in the target language. Additionally, the target language-only policy practiced in the program prevents the use of translanguaging strategies, which are gaining recognition in educational research (García et al., 2017). This suggests that state education administrators should reconsider the design and language policies of the Utah DLI model and base decisions on the most current research in Chinese DLI programs to enhance program effectiveness. Questions such as whether strictly separating the use of the target language from English and whether the lack of recruitment efforts for heritage language students (Valdez et al., 2016), who could contribute knowledge of the target language and culture, are beneficial for the state program, should be thoroughly discussed.

Furthermore, DLI teacher training programs that focus on implementing a wider range of effective math teaching strategies, beyond simply checking students' language comprehension, are urgently needed. Such training would provide valuable guidance for enhancing DLI teachers' effectiveness in teaching mathematics.

References

American Council for the Teaching of Foreign Languages. (2021). *World readiness standards for learning languages*. https://www.americancouncils.org/news/announcements-featured-content/arc-completes-national-canvass-dual-language-immersion-programs

Asia Society. (2019). *Utah Chinese dual language immersion program*. https://asiasociety.org/chinalearning-initiatives/Utah-chinese-dual-language-immersion-program

Bessai, N. A. (2018). Using Oxford's Strategy Inventory of Language Learning (SILL) to assess the strategy use of a group of first and third year EFL Algerian university students. *American Scientific Research Journal for Engineering, Technology, and Sciences, 42*(1), 166–187.

Celedón–Pattichis, S. (2010). Implementing reform curriculum. *Middle Grades Research Journal*, *5*(4), 185–198.

Ernst–Slavit, G., & Mason, M. R. (2011). "Words that hold us up:" Teacher talk and academic language in five upper elementary classrooms. *Linguistics and Education*, *22*(4), 430–440.

Fuchs, L. S., Fuchs, D., Compton, D. L., Hamlett, C. L., & Wang, A. Y. (2015). Is word-problem solving a form of text comprehension?. *Scientific Studies of Reading*, *19*(3), 204–223.

García, O., Johnson, S. I., Seltzer, K., & Valdés, G. (2017). *The translanguaging classroom: Leveraging student bilingualism for learning*. Caslon.

Gottlieb, M., & Ernst-Slavit, G. (2013). *Academic language in diverse classrooms: English language arts, grades K–2: Promoting content and language learning*. Corwin Press.

Kasule, D., & Mapolelo, D. (2005). Teachers' strategies of teaching primary school mathematics in a second language: A case of Botswana. *International Journal of Educational Development*, *25*(6), 602–617.

Krause, G., & Barko-Alva, K. (2019). Language and Mathematics: Questioning Strategies in a Dual Language Bilingual Education Classroom. *Proceedings of the 41st Annual Meeting of PME-NA*, (pp. 1687–1691).

Lewis, B., King, M. S., & Schiess, J. O. N. (2020). *Language counts: Supporting early math development for dual language learners*. https://bellwethereducation.org/publication/language-counts-supporting-early-math-development-dual-language-learners

Li, J. T., Arizmendi, G. D., & Swanson, H. L. (2022). The influence of teachers' math instructional practices on English learners' reading comprehension and math problem–solving performance in Spanish and English. *International Journal of Bilingual Education and Bilingualism, 25*(10), 3614–3630. https://doi.org/10.1080/13670050.2022.2068346

Mohammadi, H., & Alizadeh, K. (2014). An investigation of reliability and validity of the Strategy Inventory for Language Learning among Iranian university students. *International Journal of English Language Teaching, 1*(2), 53–63. https://doi.org/10.5430/ijelt.v1n2p53

Moschkovich, J. N. (2015). Scaffolding student participation in mathematical practices. *ZDM*, *47*(7), 1067–1078.

Oliveira, A. W., Meskill, C., Judson, D., Gregory, K., Rogers, P., Imperial, C. J., & Casler–Failing, S. (2015). Language repair strategies in bilingual tutoring of mathematics word problems. *Canadian Journal of Science, Mathematics and Technology Education*, *15*(1), 102–115.

Oxford, R.L. (1990). *Language learning strategies*. Newbury House.

Patthoff, A., Castillo, J., & Treviño, A. (2021). Dual-Language Teachers' Use of Technology to Facilitate Mathematical Discourse. *Computers in the Schools*, *38*(3), 161–188.

Rosenshine, B. (2012). Principles of instruction: Research-based strategies that all teachers should know. *American Educator*, *36*(1), 12–39.

Ross, K. E. (2014). Professional development for practicing mathematics teachers: A critical connection to English language learner students in mainstream USA classrooms. *Journal of Mathematics Teacher Education*, *17*(1), 85–100.

Somerville, J., & Faltis, C. (2019). Dual languaging as strategy and translanguaging as tactic in two-way dual language programs. *Theory Into Practice*, *58*(2), 164–175.

Sorto, M. A., Colindres, C. A. M., & Wilson, A. T. (2014). Informing Practice: Uncovering and Eliciting Perceptions in Linguistically Diverse Classrooms: research matters for teachers. *Mathematics Teaching in the Middle School*, *20*(2), 72–77.

Sung, K. Y., & Tsai, H. M. (2019). *Mandarin Chinese dual language immersion programs*. Multilingual Matters.

Tavares, N. J. (2015). How strategic use of L1 in an L2–medium mathematics classroom facilitates L2 interaction and comprehension. *International Journal of Bilingual Education and Bilingualism, 18*(3), 319–335. https://doi.org/10.1080/13670050.2013.837367

Utah Instructional Model (2022). http://www.utahdli.org/instructional–model/

Utah Dual Language Immersion (2022). *Why immersion?* http://www.utahdli.org/why-immersion/

Valdez, V. E., Delavan, G., & Freire, J. A. (2016). The marketing of dual language education policy in Utah print media. *Educational Policy, 30*(6), 849–883. https://doi.org/10.1177/0895904815614647

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Watzinger-Tharp, J., Swenson, K., & Mayne, Z. (2018). Academic achievement of students in dual language immersion. *International Journal of Bilingual Education and Bilingualism*, *21*(8), 913–928.

Yeh, C. (2017). Math is more than numbers: Beginning bilingual teachers' mathematics teaching practices and their opportunities to learn. *Journal of Urban Mathematics Education, 10*(2), 106–139.

Zou, B. & Lertlit, S. (2022). Oxford's Strategy Inventory for Language Learning: English learning of Chinese students in a Thai university. *LEARN Journal: Language Education and Acquisition Research Network, 15*(2), 705–723.