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Functions and Strategies of Teachers' Discursive Scaffolding in English-medium Content-based Instruction

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ABSTRACT

Although decades of research have documented scaffolding in second language learning, providing scaffolding in content-based instruction (CBI) has remained under-explored. This qualitative study investigated teachers' discursive scaffolding strategies and functions and L2 students' reciprocity to teachers' scaffolding in science CBI. Four teachers and 30 bilingual students were selected through convenience sampling from an international school. The audiotaped recordings of 24 hours of classroom instruction were transcribed and analyzed based on discursive scaffolding strategies (Walqui, 2006) and scaffolding functions (Wood, Bruner, & Ross, 1976). The deductive content analysis of data demonstrated that the most frequent scaffolding strategies were bridging and schema building while contextualizing and developing metacognition were barely observed. Furthermore, the findings revealed that scaffolding functions were mostly aimed at providing the idealized version, recruiting pursuit of a goal, and controlling frustration, whereas marking critical discrepancy was rarely employed. It can be concluded that scaffolding strategies and functions mostly pertain to enhancing students' comprehension rather than developing metacognition. These findings have implications for the applicability of types of scaffolding strategies and functions in CBI classrooms.

Keywords: scaffolding functions; scaffolding strategies; content-based instruction; international students

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Introduction

Content-based instruction (CBI) refers to the integrated learning of a second/foreign language and a subject matter. It suggests that language is the object of the study in itself and a medium for learning a particular subject matter (Cummins & Early, 2015; Mahan, 2020). In CBI, students may face a great challenge to learn both the content and language, simultaneously; therefore, teachers have a twofold function: assisting students in the learning of both the second or foreign language and the content of the subject matters (Troyan, Cammarata, & Martel, 2017). To open spaces for productive and qualified CBI instruction, scaffolding tailored to the demands of instructional challenges, supportive learning environments, and eventually students' success is expected on the part of the teachers (Gibbons, 2015; Mahan, 2020; Rassaei, 2014). The concept of scaffolding has gained mounting attention from teachers, researchers, and professionals holding a sociocultural perspective (Harraqi, 2017; Smagorinsky, 2018), and it has been proposed as a means for studying teacher-learner classroom interaction (Daniels, 2016; Koole & Elber, 2014).

While recent years have shown a drastic increase in studies discussing the potentialities of scaffolding in educational contexts (Cammarata, Tedick, & Osborn, 2016; Coyle, Hood, & Marsh, 2010; Echevarría, Vogt, & Short, 2017; Gibbons, 2015; Koole & Elbers 2014; Nikula, Dafouz, Moore, & Smit, 2016; Reynolds, 2017; Wette, 2014), research on scaffolding in English-medium content-based instruction is disparate and limited. The issues of teachers' pedagogical skills, qualified language teachers or content teachers in CBI contexts, lack of appropriate materials, the imbalanced development of students' content and language knowledge, distinct features of each subject, and difficulty in pinning down the actual zone of proximal development (ZPD) of CBI students on both content and language knowledge make CBI classes more problematic (Awan & Sipra, 2018; Stoller & Fitzsimmons-Doolan, 2017). On the other hand, scaffolding poses some ambiguities as there are different conceptualizations of scaffolding in diverse physical contexts (Li & Zhang, 2020; Mahan, 2020), which needs more systematic and empirical research (Mahan, 2020; Meyer, Coyle, Halbach, Shuck, & Ting, 2015; van Kampen, Admiraal, & Berry, 2018). Given the dearth of studies on scaffolding in CBI, the classroom discourse analysis approach was applied in this study to explore the discursive scaffolding strategies and functions in an English-mediated CBI. The current study aimed to explore scaff olding by building on prior theoretical knowledge and frameworks in order to heighten understanding of scaff olding in CBI classes.

Review of the Literature

Scaffolding

The notion of scaff olding, rooted in sociocultural theory, was introduced by Bruner in the 1970s and is used to describe the work done within Vygotsky's zone of proximal development in teacher-learner interaction (Smagorinsky, 2018). Scaffolding is used as instructional strategies to assist less skilled peers in the learning process (Lin, Hsu, Lin, Changlai, Yang, & Lai, 2012; Van de Pol, 2012). Besides, Walsh (2011) defined scaffolding as feeding in of essential tips at the point of students' need to mediate and facilitate learning through contingency, intersubjectivity, and transfer of responsibility (Lin et al., 2012; Van de Pol, 2012; Van de Pol, Volman, & Beishuizen, 2010; Wood et al., 1976). The main body of research on scaffolding is qualitative and descriptive based on naturally occurring teaching data (Echevarría et al., 2017; Gibbons, 2015; Lin et al., 2012; Nikula, Dalton-Puffer, & García, 2013; Ruiz de Zarobe & Cenoz, 2015; Ruiz de Zarobe & Zenotz, 2017).

Scaffolding Strategies

Walqui (2006) proposed six scaffolding strategies for effective teaching: modeling, bridging, contextualizing, schema building, representing text, and developing metacognition. The first scaffolding strategy, i.e. modeling, refers to visual, oral, or written appropriate samples of those things students are expected to do. So, modeling is used as a strategy to afford students' involvement with good examples of the final product (Emilia, 2010; Sari & Munir, 2018; Tajeddin & Kamali, 2020; Walqui, 2006). Additionally, modeling demonstrates unambiguous examples and an imitation of an early state in learning. Modeling, as an integral part of science classes, can engage students in the learning process, encourage an open-inquiry learning process, and develop students' cognitive and metacognitive competence in science (Louca & Zacharia, 2012; Valk & Jong, 2009). Furthermore, it provides explicit rules and principles for learners' practice through didactic methods (Harraqi, 2017). As to science subjects, this strategy can make students more interested in open inquiry to learn more about scientific concepts through autonomous investigation (Valk & Jong, 2009). The second scaffolding strategy is bridging, which refers to new knowledge that is built on a previous understanding. Thus, it is an anticipatory guide that can assist students to predict or retell the concepts which contribute to a better understanding.

Among other scaffolding strategies found in this study, bridging to previous knowledge can also help assess students' prior knowledge and apply relevant real-world samples (Harraqi, 2017; Tomlinson & Moon, 2013; Walqui & van Lier, 2010). The teacher can apply bridging at the beginning of the learning process through narrative pedagogy or oral questions in order to make a more conducive atmosphere (Kamil, 2017; Sari & Munir, 2018). Research conducted by Mahan (2020) investigated teachers' scaffolding in CLIL classes, and the results showed that science teachers tap into prior knowledge and elaborate on how the world works. Contextualizing, i.e. the third scaffolding strategy, points to the essence of embedding concepts or tasks in a rich context and makes it situation-dependent through pictures, two-minute videos, and other objects or sources of information to construct meaning. According to Walqui and van Lier (2010), contextualizing is not used to simplify the teaching process but further enriching the instruction through macro-scaffolding. As decontextualized concepts are unlike everyday routines, students will face great challenges. The challenges can be eliminated through contextualizing, which is context-dependent and entails means such as pictures, music, film, and 3D objects. Besides, some teachers apply this strategy by asking students for imagination as it does not require a lot of preparation for the teachers (Tajeddin & Kamali, 2020). According to Grossman (2015) and Mahan (2020), academic subjects are acquired with difficulty as they need inferring meaning from context. It was found that teaching science can become effective through supportive materials such as visual aids, graphic organizers, and film clips, which is in line with Mahan, Brevik, and Ødegaard (2018). Furthermore, this strategy can be crucial in that it makes complicated concepts closer to the students' world experience to reduce cognitive demand (Harraqi, 2017).

Schema building, the fourth scaffolding strategy, is the process of storing and retrieving knowledge and experience, organizing students' knowledge and understanding and attracting their attention to important points, topics, and information by focusing on heads and subheads, pictures and their captions, class agendas, and titles of charts (Boche & Henning, 2015; Harraqi, 2017; Mahan et al., 2018). In this way, a student can build her/his knowledge with a general overview. According to Harraqi (2017), this scaffolding strategy helps students make a conceptual map for processing information top-down and distinguish between central and marginal data. When learners are asked to transform one genre into another genre, they are engaged in representing, which is the fifth scaffolding strategy (Barr, Eslami, & Joshi, 2012). It is applied to construct a deeper sense of meaning in the process of learning and to improve students' language knowledge (Ajayi, 2014). This scaffolding strategy aims at helping students have opportunities for assessing their language mastery, which can be applied in various forms such as paraphrasing, online word search strategies, and word analysis. Besides, this strategy can develop students' metacognitive abilities in case it is provided through inquiry-based teaching (Louca & Zacharia, 2012; Valk & Jong, 2009).

Metacognition, the last type of scaffolding strategy, means "learning to learn" (Coyle et al., 2010, p. 29). This scaffolding strategy focuses on how teachers support students in the ways that students can manage their thinking process while doing tasks or learning something (Grossman, 2015; Ruiz de Zarobe & Cenoz, 2015; Ruiz de Zarobe & Zenotz, 2017). Furthermore, it can assist students in monitoring their current level of understanding and deciding whether it is adequate or not (Gritter, Beers, & Knaus, 2013; Van de Pol et al., 2010). Teachers' scaffolding for developing students' metacognition would affect their competence in different aspects: (a) deliberately applying learned strategies; (b) knowledge of strategic options and the ability to choose the most effective strategic option in diverse situations; (c) monitoring, evaluating, and adjusting performance during activity; and (d) planning for future performance based on an evaluation of past performance. According to Grossman (2015) and Mahan (2020), this scaffolding strategy was included in 72% of scaffolding frameworks. Successful instruction fosters meta-awareness and, along with it, student independency through explicit teaching of strategies of modeling, doing tasks, and conducting the discussion. Developing metacognition has been investigated in CLIL classes, and the results of the studies indicate that metacognition is a crucial tool for the students in the CLIL classroom (Mahan, 2020; Ruiz de Zarobe & Cenoz, 2015; Ruiz de Zarobe & Zenotz, 2017).

Scaffolding Functions

Regarding the scaffolding functions, the very first framework was proposed by Wood et al. (1976), who described different scaffolding functions through teacher-learner interaction. Each of the categories, namely, recruiting interest, reducing degrees of freedom, maintaining pursuit of the goal, marking critical features, controlling the frustration, and demonstrating an idealized version of the act are discussed in turn. By recruitment of interest, the teachers' first task is attracting students' attention to the required steps which can be employed for pedagogical, contextual, or managerial purposes (Buenner, 2013). Wood et al. delineate recruitment as "luring a novice into task either by demonstrating it or providing tempting material" (p. 95). Research by Belland, Kim, and Hannafin (2013) suggests that recruitment is one of the seminal scaffolding functions classified as motivational, not cognitive support, which demonstrates the teachers' attempts to cope with the students' moment-by-moment interaction (Buenner, 2013). More specifically, recruitment can take place at the beginning of each session as the warm-up to orient students toward the topics, or in the middle of instruction to make students involve and reduce their distraction. Hence, to apply recruitment, various techniques can be applied to fit in various contexts as games, visual supplement, teachers' intonation as reading aloud, asking questions, and repetition. Studies by Walsh, Morton, and O'Keeffe (2011) and Heron and Webster (2018) were well documented and acknowledged that students' empathic talking about their personal lives and interest not only establishes rapport but also recruits interest.

The reduction of degrees of freedom refers to reducing the number of available acts required to reach the result or eliminating the alternatives the learner is faced with to reach the endpoint of the task (Wood et al., 1976). Importantly, it is pointed out that reducing freedom means simplifying to help students carry out tasks or learn a new concept. In particular, this type of scaffolding is triggered when students fail to learn or do tasks, and it can be provided through teachers' rephrasing, using explicit instruction and explanation, and providing visual clues and verbal hints. A number of studies have documented the effective features and examples of reducing degrees of freedom. For example, Heron and Webster (2018) concluded that simplifying the instruction process makes teaching responsive to learners' needs and can be provided in various forms like breaking items down into parts and producing more of the target words and forms until students produce them. However, as Gibbons (2015), Li and Zhang (2020), and van Lier (2004) pointed out, this scaffolding function generally renders students less autonomous in the learning process. In the study by Buenner (2013), it is underlined that simplifying is more influential when it is contingent on students' ZPD; for instance, by providing limited options, giving an example, or making a comparison.

Through direction maintenance, the teachers keep the students on track and try to prevent them from regressing to reach the task results. In other words, students should be scaffolded to understand the requirement of tasks in hand, the aims of subsequent matters, and the way to get to overall target goals. Accordingly, teachers maintain direction by keeping the students involved in overall learning goals and assess their online comprehension required for turning to the next task. Maintaining direction is used to promote and facilitate students' comprehension even through explicit clarification. Studies by Buenner (2013) and Heron and Webster (2018) documented that this scaffolding function is used to check students' comprehension, to provide guidelines of academic requirements, to clarify the overall view of the teaching/learning process, and to draw students' attention to previous and coming concepts, lessons, and evaluation. It should be noted that this scaffolding function was not taken into account in the studies in which participants were highly proficient such as the study by Li and Zhang (2020), where the teacher was a Ph.D. holder with 20 years of teaching experience.

The fourth scaffolding function, i.e. marking critical features, is to highlight the important and critical features, thereby making students more conscious of the discrepancies they may have and the ideal solutions to the task. Moreover, pointing out critical features of any tasks, rules, usages, or examples can facilitate students' learning by providing the reason for the matters and enhancing internalization and automatization of the learned knowledge (Buenner, 2013; Walsh, 2006). More specifically, as Heron and Webster (2018) pointed out, rising intonation was used to mark critical features, while it was rarely used for calling attention to students' errors. Frustration control is a face-saving activity on the part of the instructor and reminds learners that task performance under his/her guidance is not threatening. In response to students' frustration, teachers could provide explicit praise, make a joke, be playful, or use one-word expressions like "ok," "good," and "yes" (Heron & Webster, 2018). In addition, some practical strategies related to classroom management as transferring tasks to other students can be used to eliminate the negative effects of frustration. According to Heron and Webster (2018), this scaffolding function is provided in different ways due to students' characteristics, proficiency level, and the high-stakes nature of educational contexts. Interestingly, Li and Zhang (2020) excluded this scaffolding function in their study as the students were adults with active participation. The last scaffolding function is a demonstration of the idealized version which involves the ideal target structure or modeling of the task. Demonstration of the idealized version provides the most explicit details required to achieve the task goal. Importantly, when teachers cannot help students come up with the correct answer, the idealized version could be demonstrated as the last option concerning time limitation or the nature of the concept (Buenner, 2013). Also, the final type of scaffolding can be applied by teachers to benefit the whole class.

Content-Based Instruction

The term Content-based instruction (CBI) was adopted in the mid-1960s (Stoller & Fitzsimmons-Doolan, 2017). It refers to instructional approaches in which both language and content objectives are focused and a non-L1 is the medium of a teaching nonlanguage subject matter (Cammarata et al., 2016; Ruiz de Zarobe & Cenoz, 2015). In CBI, content is the main focus instead of grammar and vocabulary, and teachers try to present content besides trying to increase language proficiency and culturally and cognitively meaningful language (Airey, 2012; Cammarata et al., 2016; Vinke, Snippe, & Jochems, 2008). CBI is considered as an umbrella term for a number of approaches which are adopted in different educational contexts like immersion programs in Canada, Content and Language Integrated Learning (CLIL) in Europe, and English-medium education in Asia

(Juan-Garau & Salazar-Noguera, 2015; Lyster & Ballinger, 2011; Morton & Llinares, 2016; Ruiz de Zarobe & Cenoz, 2015). The results of studies have shown that CBI and CLIL have similarities regarding their essential properties (Cenoz, 2015; Coyle et al., 2010; Karim, 2016).

Previous studies have demonstrated the distinct characteristics of CBI/CLIL approaches and their effects on students' cognitive development, subject knowledge, language skills, and language use. For instance, many studies have been conducted to investigate the effect of content-based instruction on students' language use (e.g., Dalton-Puffer, Nikula, & Smit, 2010; Escobar, 2013; Nikula, 2010, 2015; Tavares, 2015). In a study by Li and Zhang (2020), CLIL is characterized as facilitating students' cognitive and social development along with language development. Some other studies on CLIL have documented the positive impacts of CLIL on different skills and sub-skills (Li & Zhang, 2020). For instance, it was found that content-based instruction has positive effects on improving students' reading comprehension (Li & Zhang, 2020). A number of authors have recognized the impact of teaching subject matter knowledge through a foreign/second language on learners' consciousness-raising and advanced meaning-making (Coyle, 2007; Dalton-Puffer, 2011; Gibbons, 2015), and on bringing different languages and cultures closer to each other (Awan & Sipra, 2018). In short, the literature shows that CBI/CLIL can provide students with mediation to help them be more competent and engaged in higher-order thinking and be autonomous in using language and critical meta-cognitive benefits (Coyle, 2007; Gibbons, 2015).

Apart from the above benefits of CBI, several challenges have been identified centered on the lack of appropriate materials in various educational contexts; the preference of language teachers or content teachers; the teachers' preference of content or language knowledge; and assessment system (Awan & Sipra, 2018; Cummins & Early, 2015; Snow, 2014; Stoller & Fitzsimmons-Doolan, 2017; Sun, 2017). In light of reported studies in English-medium content instruction, each content subject such as mathematics, science, and social studies has its own needs and traditions, which makes CBI/CLIL studies more problematic (Mahan et al., 2018; van Kampen et al., 2018). Delving into issues of content subjects, some researchers have addressed the nature of science, math, and social studies and the types of tasks in CBI/CLIL classes (Airey, 2015; Nikula et al., 2016; Ødegaard, Haug, Mork, & Sørvik, 2014; Shanahan & Shanahan, 2012; Tytler, Prain, Hubber, & Waldrop, 2013). For instance, it was pointed out that science is a complex and multifaceted knowledge relying on observation in a laboratory, experimental evidence, and rational arguments of natural phenomena for helping students have a conceptual understanding of the scientific knowledge (Lunetta, Hofstein, & Clough, 2007). In examining the nature of science, visual supplementary materials including models and pictures with analytical types of tasks are mostly provided to make science more comprehensible, whereas it was found that math teachers primarily focused on rules and procedures with lots of drilling and recall tasks (Airey, 2015; Mahan et al., 2018; Nikula et al., 2016; Ødegaard et al., 2014; Shanahan & Shanahan, 2012). Exploring teacher scaffolding in CBI classes of social science and geography revealed that social science teachers mostly concentrated on more student talk and classroom interaction but few strategies were provided (Mahan, 2020).

The studies discussed above have made important contributions to scaffolding in various contexts and unraveled the use of scaffolding. In short, the literature related to scaffolding functions by Wood et al. (1976) and scaffolding strategies by Walqui (2006) suggests that various types of activities, student-teacher interaction, and tasks were provided by the teachers based on the students' age and proficiency levels, type of subject knowledge, and contextual characteristics. There are a few studies conducted on scaffolding in CLIL classes which are mostly located in Europe and not focused on CBI classes, as it was reviewed above. The main focus of the previous studies differs from that of the present one. For example, Li and Zhang's (2020) study investigated the effect of teachers' scaffolding on intensive reading in CLIL classes, or Mahan (2020) aimed to characterize CLIL teaching in science, English, and mathematics in terms of content and language. However, the focus of the present study is on teachers' scaffolding functions and strategies in science classes in CBI.

As the preceding literature review shows, many aspects of scaffolding have been examined in SL/FL classrooms, but very few systematic, empirical studies have investigated the scaffolding provided by the teachers in English-medium content-based instruction (Mahan, 2020; Li & Zhang, 2020). A closer look at the literature reveals that the challenges, especially lack of appropriate materials, teachers' dual roles for content and language instruction, and students' difficulties in learning content through another language, can be mediated by scaffolded instructional techniques and strategies. To bridge these gaps, the current study was undertaken to investigate the types of discursive scaffolding strategies (Walqui, 2006) and scaffolding functions (Wood et al., 1976) provided by teachers in science CBI. Scaffolding function is studied to demonstrate the purposes of scaffolding and scaffolding strategies aim at demonstrating the action taken to achieve the purpose. Thus, this study aimed at answering the following questions:

1. What are the scaffolding strategies used by EFL teachers in science content-based instruction?
2. What are the functions of scaffolding used by EFL teachers in science content-based instruction?

Method

Participants

Participants of the current study constituted two groups whose participation was on a voluntary basis: 4 EFL teachers and 30 international students. This study was conducted in a medium-sized international school in Iran. International schools aim at promoting international education in an international environment like the Council of British International Schools, United Nations International Schools, International Baccalaureate Schools, and the Federation of British International Schools. In these schools, students can be transferred across international schools around the world through special rules, so there is non-selective student enrollment. These schools accept the students who are mostly non-native in that country, like the children of the staff of international organizations and foreign embassies. Besides, local students study at international schools to be qualified for higher education or employment in foreign countries. International schools provide a curriculum aimed at internationalism through the inquiry-based process to nurture students to be independent and cooperative. There are different international curricula, such as the International Baccalaureate, Edexcel, Cambridge Assessment International Education, and International Primary Curriculum, which are mostly different from the national curriculum. In Iran, there are a few international schools which hold International Baccalaureate (IB) accreditation. The IB program, one of the international education programs in Iran, has the right to monitor schools and grant sustainable development certification of educational establishments. In this system, teachers are required to have an advanced level of language and content knowledge and hold IB certification. Teachers are assisted by a handful of agencies and Online Curriculum Center (OCC) that specialize in recruiting international teachers.

In this study, the teachers were female, had 10-16 years of experience, and taught science in an international school in Iran. The teachers' educational degree ranged from B.A. to Ph.D. and their ages ranged from 31 to 52. Teacher selection was based on the instructed subject, i.e. science in this school. The students were bilingual girls (10 to 12 years old) who were studying at an international primary school in Tehran. The average class size was eight students in four classes.

The students studied English, Persian, and French from kindergarten onwards, that is, about four years in total. English was the medium of instruction and the science books were *Oxford International Primary Science* (Hudson, Haigh, Roberts, & Shaw, 2014). All students had taken the required science and English courses since starting kindergarten and their content knowledge was generally comparable to that of CBI students in international schools. Prior to collecting data, consent for this study was obtained from the school principal, teachers, and students' parents.

Instrumentation and Data Collection

In this study, classroom observations were carried out through audio-recording in line with the study's main purpose of explicating scaffolding functions and strategies. At first, four teachers were selected from the international school through convenient sampling. Then, four sessions of each science teacher were observed, resulting in a total of twenty-four hours of audio-recording. Each class lasted about an hour and a half. Data were collected in the span of three months during the academic year. After the audio recording of the whole sessions, the talks of both teachers and students were transcribed and analyzed to study the teachers' scaffolding strategies and functions. The third researcher's role in the classroom was as a non-participant observer but the impact that recording the conversation might have had on the students' behavior should not be overlooked.

Data Analysis

For the transcribed data, descriptive statistics were computed to analyze and interpret the data to identify teachers' scaffolding. Thus, the discourse analysis method was applied in this study to analyze the data as the focus of this study was student-teacher interaction in an educational context (Walsh, 2011). Data analysis was predominantly deductive content analysis, which is a subjective and analytical approach. Deductive content analysis was used when previous research findings, theories, or frameworks regarding the phenomenon of interest exist and the analysis is directed for testing concepts, categories, or hypothesis in new contexts (Armat, Assarroudi, Rad, Sharifi, & Heydari, 2018; Byram, 2012; Elo, Kääriäinen, Kanste, Pölkki, Utriainen, & Kyngäs, 2014; Schreier, 2014). To address the research questions concerning the teachers' scaffolding functions and strategies, deductive content analysis was conducted on the transcriptions based on Walqui's (2006) and Wood et al.'s (1976) frameworks. Scaffolding function aimed at illustrating the purpose of each scaffolding, but scaffolding strategies pointed to the action in which the ultimate purpose could be met. In analyzing the data, the present study draws on an earlier framework by Walqui (2006) to describe the teachers' scaffolding, which is categorized into six strategies: modeling, bridging, schema building, contextualizing, text representation, and metacognition. A detailed analysis of the transcripts was carried out using the categorization of scaffolding functions proposed by Wood et al. (1976), which consists of recruiting interest, reduction in degrees of freedom, the pursuit of a goal, critical discrepancies, controlling frustration, and demonstrating an idealized version. As with the coding of scaffolding functions and strategies, the data were coded through deductive content analysis. A well-informed intercoder, a TEFList, recoded all the data, with 87% cases of agreement. Later, based on the discussion of differences between the first coder's and the interceder's coding of the corpus, adaptations were made.

Results

To investigate the research questions, deductive content analysis of classroom interaction was done. Relevant to the purpose of the present study, the types of discursive scaffolding strategies (Walqui, 2006) and scaffolding functions (Wood et al., 1976) provided by teachers in science CBI are reported.

CBI Teachers' Scaffolding Strategies

The findings indicate that all six types of scaffolding strategies were employed by CBI teachers to various degrees. As Table 1 demonstrates, *bridging* was used the most by the teachers (*n* = 105, 30.7%). It is followed by *schema building* (*n* = 101, 29.53%) and *modeling* (*n* = 57, 16.66%). The descriptive statistics also show the least frequent scaffolding strategies included *contextualizing* (*n* = 8, 2.33%) and *developing metacognition* (*n* = 17, 4.97%).

Table 1
Frequency and Percentage of Scaffolding Strategies Used by Science Teachers in CBI Classes

	Frequency	**Percentage**
Modeling	57	16.66
Bridging	105	30.70
Schema building	101	29.53
Contextualizing	8	2.33
Representing text	54	15.78
Developing metacognition	17	4.97

In the process of learning, a number of students encounter difficulties in understanding concepts or language points which may be unknown to them. So, teachers prompt students to guess what the concept probably means. In science classes, teachers frequently try to provide scaffolding strategy through making a connection between previous knowledge and a new one in order to build new concepts in science (Harraqi, 2017). Making explicit linking to real-life or personal experience as observable, scientific phenomena would make students more engaged and involved in the process. Also, this type of scaffolding strategy can help assess students' previous knowledge. In Excerpt 1, the teacher uses *bridging* to aid the students in the learning process.

- *Excerpt 1*

Teacher 3: *One hundred centimeter is one meter. For measuring the force, use Newton. Instead of meter, centimeter, millimeter, we use Newton.*

Teacher 3 has taught forces, then she tries to focus on the way in which forces can be measured through gauges by modeling, but this concept was difficult for students. So, as the excerpt clearly shows, the science teacher tries to convey the Newton meaning by eliciting and referring to prior knowledge of weight and meters which they have covered earlier in class. It seems new knowledge makes students confused and Teacher 3 decides to activate their prior knowledge.

Through schema building, the science teacher focuses on representing scientific phenomena and providing clear examples to make concepts understandable for the students. This strategy allows teachers to make a conceptual map for processing information top-down and to distinguish between central and marginal data and provide some heads and subheads, pictures, charts, captions, and overview of lessons before getting into lessons (Harraqi, 2017). Excerpt 2 provides an instance of this strategy:

- *Excerpt 2*

Teacher 1*:* *No honey, these pyramids are so big. If you stand here, you're like this, it's that much big.*

Student: *I know, but the stones are.*

Teacher 1: *They look black, for example, a black is the same as our class. This much big.*

Student: *Two cars.*

Teacher 1: *Yeah, it said about 2 cars, as heavy as 2 cars.*

As evident in Excerpt 2, the teacher tries to orient students towards the concept by using pictures and to provide clear examples of analogies and explanations in terms of the cognitive complexity of that learning concept. In this way, typical illustration and explanation are used to provide the concept with senses of general overview in a top-down way. Apart from building schema, visual aids can be influential in attracting students' attention and make complicated concepts closer to their world as one of the students gives an example of it.

As a practical scaffolding strategy, modeling involves providing the samples of requested things through the experiment, the written sample, the movie, and the like. This scaffolding strategy can make classes more attractive and productive as it is inquiry-based. Besides, this scaffolding strategy can be a means to encourage students (Emilia, 2010; Walqui, 2006) and give a chance to accomplish a task by clarifying the process.

- *Excerpt 3*

Teacher 2*:* *What am I doing? Scrambling a piece of paper, what did I do? The form of paper is changed?* (Rising intonation)

Student: *Yes.*

In Excerpt 3, the teacher makes a model while the students watch. She is attempting to convey the conceptual meaning and elicit the answer needed to achieve the aim by adding some questions. Although teacher 2 provides scaffolding through modeling to mark critical features of the scientific concept, the students cannot follow her, so she provides scaffolding by gradually reducing the degrees of freedom and revealing more of the target word until they produce it.

Representing text is the next scaffolding strategy extracted through deductive content analysis. Through this strategy, students are asked to transform one genre into another or represent their understanding or interpretation into written or spoken words through scripts, skits, or enactments.

- *Excerpt 4*

Teacher 4: *It's said, it's about 2 cars, and first we read & then talk about it and this group draw its picture …. Aida and that group make its model by the use of these staffs.[stuffs]*

The above excerpt manifests the science teacher's attempt to represent the text in different ways to make it more comprehensible. In addition, paraphrasing could be used to check students' language and content knowledge. For students, paraphrasing and modeling would be interesting because the emphasis is placed on student-student interaction through inquiry-based learning activities. Besides, it is a strategy that may fulfill the needs for content and language practice.

Contextualizing is one of the most imperative and difficult scaffolding strategies due to the essence of embedding concepts or tasks in a rich context. This strategy could be provided with pictures, videos, and other objects or sources of information to construct meaning. This is evidenced in Excerpt 5.

- *Excerpt 5*

Teacher 2: *This is a giant rock, I want to pull it, is it possible? (The teacher played video then asked this question).*

Student: *No.*

Student: *Yes.*

Teacher 2 uses the picture to enrich the instruction and construct the meaning of pulling. The teacher tries to contextualize the science concept to make texts more comprehensible and eye-catching for students.

The last scaffolding strategy is developing metacognition, which refers to different ways in which students' thinking is managed by themselves (Harraqi, 2017). As it is a difficult process, it was rarely used by the teachers (4.97%). A sample is given in Excerpt 6.

- *Excerpt 6*

Student: *I can make website for it, can I?*

Teacher 2: *why not. How can we make website more comprehensible, practical, and eye-catching?*

In this case, the students are in grade 4 and want to demonstrate their projects, so one of them proposes to make a website for the school exhibition. From Excerpt 6, it can be concluded that the science teacher tries to develop students' metacognition by planning for future performance based on an evaluation of past performance.

Scaffolding Functions

The purpose of the second research question was to explore the scaffolding functions provided by science teachers. As given in Table 2, scaffolding functions consist of recruiting interest, reduction in degrees of freedom, the pursuit of a goal, critical discrepancies, controlling frustration, and idealized version, based on Wood et al.'s (1976) framework.

Table 2
Frequency and Percentage of Scaffolding Functions by Science Teachers in CBI Classes

	Frequency	Percentage
Recruiting interest	42	11.26
Reduction in degrees of freedom	42	11.26
The pursuit of goal	73	19.57
Critical discrepancies	26	6.97
Controlling frustration	65	17.42
Idealized version	125	33.51

The most frequent scaffolding functions by science teachers, in descending order, are as follows: Idealized version (n = 125, 33.51%), the pursuit of goal (n = 73, 19.57%), and controlling frustration (n = 65, 17.42%). As can be seen from Table 2, scaffolding functions like critical discrepancies, reduction in degrees of freedom, and recruiting interest were the least frequent ones, respectively. All in all, the results indicate that about one-third of science teachers' scaffoldings were done by providing an idealized version. The various functions of scaffolding provided by science teachers are illustrated below. While excerpts are offered to exemplify teachers' scaffolding, it should be noted that these are only short extracts from student-teacher interactions.

(a) Recruiting Interest

Recruiting interest serves to attract students' attention and involve them in the subject. This scaffolding function is used to recruit students into the previous or next tasks. In other words, teachers mostly use it to start instruction as a warm-up, in the middle of instruction, or as a post-task. Recruitment could take place through reading aloud, asking questions, or repetition. In the following excerpt, the science teacher teaches five senses and plays games with students. First, she asks students to wear something on the eyes and to find their friends through touching as one of the five senses.

- *Excerpt 7*

Teacher 3: *Come forward and find your friends…. anybody can talk. Who is she? How do you get it?*

Student: *She wears glasses.*

Teacher 3: *No question.*

In excerpt 7, Teacher 3 tries to bring the class to an end by playing games about senses. In addition, she tries to assess students by recruiting their interest in games. Due to the students' age, the teacher uses this function to encourage and entertain them to follow up on the concept of five senses.

(b) Reduction in Degrees of Freedom

Simplifying the task is another scaffolding function used by teachers when students cannot achieve the goal or do tasks alone. In other words, teachers' decision to simplify is based on their observation or students' production of the task, or lack of it, in particular. This function of scaffolding, explicitly or implicitly, serves to make lessons more comprehensible for students. Reduction in degrees of freedom can be applied by breaking tasks or concepts into a series of steps, providing an overview, limiting the scope of concepts, giving examples especially in science, acting, or rephrasing through visual clues or verbal tips. An example of the reduction in degrees of freedom in the science classes is as follows:

- *Excerpt 8*

Teacher 2: *You can draw an arrow to show that, this object is going forward*, so *we should push it.*

Teacher 2 tries to simplify the demanding concept of forces, in particular when students fail to learn pulling and pushing forces. Apparently, by giving explicit visual clues dependent on the nature of science, the teacher employs this function and draws arrows to describe differences between pulling and pushing.

(c) The Pursuit of the Goal

This scaffolding function is provided to assist in keeping students towards ultimate goals. To stay focused and motivated to reach goals, students should be engaged in the process of learning through clarification of the concept and tasks. This scaffolding function can be applied either explicitly or implicitly for language use or content knowledge. A sample of the pursuit of the goal is given in Excerpt 9:

- *Excerpt 9*

Teacher 4*: If you are pushing something an object is going forward, you can draw an arrow to show that, this object is going forward. Can you remember in the previous state, I told you draw arrow like this? What does it show? It shows that this train and this lug are going forward.*

In science classes, active participation, doing experiments, and modeling can clarify the concept and involve students in the process. In Excerpt 9, the science teacher tries to clarify pushing and pulling through samples and visual cues as she says "*It shows that this train and this lug are going forward.*" Besides, she tries to maintain direction by calling students' attention to the previous session.

(d) Critical Discrepancies

It is a scaffolding function that highlights the critical features of students' work and the ideal one that might be overlooked or be erroneous. Critical discrepancies can make students more reflective and critical thinkers. Teachers can mark critical characteristics through verbal cues and explanation of the reasons, asking critical questions, doing projects, and doing experiments. A sample of critical discrepancy is as follows:

- Excerpt 10

Student: *Teacher, these are not crystal.*

Teacher 2: Y*eah, I think that it's repeated at home, and the water was not boiling at that time, it should be boiling.*

Student: *But for Baran's is exactly crystal.*

Excerpt 10 is from the science class where the teachers and students go through an experiment on making crystal. Teacher 2 marks critical features of students' models by giving reasons for boiling which marks the nature of her error. As it was pointed out, the differences between students' experiment are highlighted to mark the critical features of crystal which were overlooked.

(e) Controlling Frustration

Controlling frustration, another function of scaffolding, would help students solve their problems in a less risky or demanding situation. Reducing students' frustration over the difficulty, teachers mostly try to elicit the problematic matters. An example of this scaffolding function is given below:

- *Excerpt 11*

Student: *I don't know… understand what quarter? Why we use quarter?*

Teacher 3: *We do not want to count all gardens, we want to count some places of that. For example, you want to know the number of insects in Nahjolbalege Park. Just count one-fourth.*

Immediately before this episode, the teacher and students have studied the types and the number of insects. At first, teacher 3 talks about the number and types of insects in different places. The excerpt reveals that this concept makes students frustrated either due to subject concept or language proficiency. Following a request for clarification, Teacher 3 uses examples from the real world as a basis for discussion. Implicit clarification from the real world could engage students in reflections, information sharing, and maximizing opportunities for problem-solving in science classes. However, as shown in Excerpt 11, students' questions or even silence indicate the demanding concepts. In response to students' frustration, teachers provide more clarification through samples, simplification, rephrasing, or retelling, either explicitly or implicitly.

(f) Idealized Version

Idealized version, the most explicit type of scaffolding function, involves providing ideal forms, modeling, or recasting of correct forms to improve students' comprehension. This scaffolding function is provided to facilitate the flow of the instruction, avoid distraction, or provide modeling. Apart from the above reasons, the teachers may also have no choice but to provide the most ideal structure or answer if no hint works. Demonstration of the ideal version may benefit all the students, but it could hinder the students' cognitive and metacognitive development and make students less autonomous in the learning process. Excerpt 12 displays this function.

- *Excerpt 12*

Student: *Miss, I have a question, that I gave you, is that good?*

Teacher 1: *If you used that amount of water, yeah.*

In Excerpt 12, Teacher 1 and the students are involved in an experiment in the laboratory. She provides the exact amount of each ingredient and does not allow the students to experiment with various amounts. However, it is important to note that they are doing an experiment and it is too difficult to experiment with various amounts due to the limitation of ingredient or its danger.

Discussion

This study sought to shed light on the way teachers scaffold their students by identifying the discursive scaffolding strategies and scaffolding functions. The findings indicate that CBI teachers mainly provide scaffolding strategies to contribute to the students' better understanding of scientific concepts based on the ongoing monitoring of students' learning needs and the conceptual complexities of the topics in science classes. The findings indicate that teachers are more preoccupied with the students' understanding of scientific concepts because the subjects are taught through L2 and students' language knowledge is a matter which should be taken into account (Mahan, 2020). Bridging, the most frequent type of scaffolding strategies, is realized through making a connection between previous knowledge and new knowledge, referring to real-life or students' personal experience, and making a conceptual map in the top-down process. The finding concurs with previous studies in that linking new information into existing ones or activating students' prior knowledge is one of the most important scaffolding strategies (e.g., Dalton-Puff er, 2007; Grossman, 2015; Mahan, 2020; Mahan et al., 2018; Tajeddin & Kamali, 2020). However, the findings stand in contrast with Pawan's (2008) study, which suggests that content instructors link information to previous knowledge less than the other types of scaffolding strategies. These contradictions may highlight the differences between the nature of the content subjects or the integration and applicability of science matters in real-life or personal experience.

We furthermore found that teachers used titles, subheadings, illustrations, captions, or titles of charts to build a schema. This result aligns well with previous studies wherein multiple visual representations were provided to make conceptual knowledge more comprehensible (Mahan et al., 2018; Nikula et al., 2016; Tytler et al., 2013). Unsurprisingly, some of the scaff olding pertains to modeling, in which the teachers provide the samples of requested things through the experiment as an internal part of the science syllabus (Louca & Zacharia, 2012; Valk & Jong, 2009). However, the purposes of teacher scaffolding either on content or language were not taken into account in this study. It could be argued that the aim of building schemata might be to contextualize scientific issues and make them closer to real life through a general overview in a top-down way. With regard to the nature of science and modeling in science classes, the findings point to the salient role of modeling as one of the most frequently used scaffolding strategies. Representing texts, one of the scaffolding strategies, helps reconstruct the texts and transform them into written or spoken words. In addition, representing text could be provided to assess students' language knowledge or content knowledge (Ajayi, 2014; Barr et al., 2012; Louca & Zacharia, 2012). Therefore, while the ultimate goal of representing texts was not highlighted in this study, teachers might use it mostly through spoken words. As the student books are picture-oriented and/or due to the experimental nature of science, students did not study various genres in grades 3 and 4.

As it was found in this study, there was little evidence of developing metacognition, although developing metacognition is considered as a powerful tool for creating autonomous and independent students in the learning process in CBI/CLIL classrooms (Li & Zhang, 2020). This may contribute to a more demanding process of developing metacognition when science and language knowledge tend to reoccur within CBI classes (Mahan, 2020; Ruiz de Zarobe & Cenoz 2015; Ruiz de Zarobe & Zenotz 2017). Although the strategy of developing metacognition was one of the least used strategies, the findings reveal that modeling could eventually develop students' reasoning and evaluation of past performance. The lack of teachers' focus on metacognition development might be greatly due to students' age as students were between 10 and 12 or due to the fact that it would be highly challenging to develop metacognition when content knowledge is taught through another language. Contextualizing was provided the least; however, in other studies, it was concluded that academic subjects and concepts should be situation-dependent and contextualized (Grossman, 2015; Mahan et al., 2018; Mahan, 2020). Therefore, the finding is incompatible with the importance assigned to contextualizing in previous studies. This might be the result of the types of science books that are picture-dominated or the inquiry process of the science classes in contextualizing scientific concepts.

The current study was also undertaken to investigate the teachers' scaffolding functions based on Wood et al.'s (1976) framework. The findings revealed that these scaffolding functions pursued by science teachers were mostly aimed at providing the idealized version, the pursuit of a goal, and controlling frustration. The teachers mostly used the idealized version of the act to scaffold students in science classes, so it might be argued that teachers preferred the most explicit type of scaffolding functions, as found in a previous study by Buenner (2013), due to time limitation, the nature of science concepts, or the last option, if no hint works. This type of scaffolding function would hinder metacognition development and student autonomy (Van de Pol et al., 2010). It is important to highlight the point that most of the scaffolding strategies like bridging, modeling, and schema building focused on science knowledge, so providing an idealized version might be attributable to language knowledge in order to avoid distraction in the teaching process. As was found in this study, the pursuit of a goal and controlling frustration were frequently used after the demonstration of an idealized version. These findings support those reported by Li and Zhang (2020) and Heron and Webster (2018), in that directing students towards ultimate goals could be varied or eliminated due to students' characteristics, proficiency level, and the types of subject knowledge. The finding would imply that the use of these two scaffolding functions might be due to students' age and dual difficulties of content and language in CBI classes.

Through simplifying or reducing the degree of freedom, the science teachers made lessons more comprehensible for students through breaking tasks or concepts into a series of steps, providing an overview, limiting the scope of concepts, giving examples, acting, rephrasing, and providing visual clues and verbal hints. Gibbons (2015), Li and Zhang (2020), and van Lier (2004) point out that this scaffolding function generally affords students' autonomy and cognitive development in the learning process but could facilitate language learning while it is contingent on students' ZPD (Li & Zhang, 2020). As to simplifying, there is also the question of teachers' aims on content knowledge or language knowledge but as it was found in the study by Li and Zhang (2020), even the highly proficient students were scaffolded by simplifying. The least frequently used scaffolding function was marking critical features in science classes although this type of scaffolding function could create spaces for developing students' metacognition (Harraqi, 2017; Li & Zhang, 2020). A similar finding reported by Heron and Webster (2018) showed that teachers mark and highlight the critical features the least. Regarding the nature of science and students' age in this study, it could be argued that applying various strategies such as modeling, bridging, or schema building in science classes would eliminate the necessity of highlighting the critical features.

Conclusion and Implications

This study contributes to a greater understanding of discursive scaffolding strategies and scaffolding functions in science content-based instruction (CBI). The results of this study demonstrate that science teachers provide scaffolding via teacher instruction, topical discussions, model making, laboratory experiments, and homework in pairs or individually. Apart from the types of scaffolding strategies and scaffolding functions, the frequency and types of teacher scaffolding strategies might vary in terms of diversity of purposes (functions) and the cognitive complexity of the scientific concept. For instance, in this study, modeling was provided for different functions of making the concept less demanding, controlling students' frustration, and referring to real-life experience to make the concept more comprehensible. However, in some situations, teachers used various strategies to achieve specific scaffolding functions. For example, the teachers used modeling to recruit the interest, control frustration, provide idealized versions, and link scientific concepts to real-life experience. It can be concluded that teacher scaffolding is contingent on affording essential tips based on students' needs, students' characteristics, teachers' pedagogical skills, types of subject knowledge, contextual characteristics, and purpose of that course. From the findings, it can be concluded that science teachers use a limited number of strategies to develop students' metacognition; therefore, scaffolding is rarely aimed at improving students' abilities for applying learned strategies or evaluating and adjusting their performance during activities. In general, by providing an idealized version and maintaining pursuit of a goal, CBI teachers mostly use the most explicit types of scaffolding in science classes. Therefore, there is a risk of creating too much dependency on teachers and having less autonomous and self-regulated students. In addition to providing an idealized version, over-controlling frustration could lead to students' fewer inquiries, while inquiry-based strategies are critical to the promotion of students' engagement in higher-order thinking.

The present study can be seen to have made a contribution to research on scaffolding and classroom interaction in CBI classes. The findings of the present study yield some implications for teachers and teacher educators as to scaffolding in CBI classes. This study unveiled important practical information for science teachers in CBI classes in terms of the intrinsic link between scaffolding both language and content knowledge. In addition, this study has demonstrated the ways in which science teachers' scaffolding complements and contextualizes scientific concepts to achieve the instructional objectives. Another implication for this study relates to a classroom discourse analysis approach which has provided insights on the underlying mechanisms of teachers' scaffolding in CBI classes. Thus, this study is of great value for CBI teachers who would like to improve their knowledge about scaffolding strategies and functions to enact more effective teaching. Furthermore, teacher educators could devise some teacher education courses and workshops to heighten teachers' awareness of scaffolding functions and discursive scaffolding strategies.

This study had its own limitations. As it provides insight into only science teachers in CBI classes, it is tenable to examine scaffolding functions and strategies for other subjects in instructional contexts. Further research could delve into examining the effect of scaffolding strategies on students' improvement. In future studies, both experienced and novice teachers can be considered to explore the role of teachers' experience on scaffolding strategies and scaffolding functions. Also, exploration of teacher scaffolding through stimulated recall interviews would demonstrate the teachers' purposes on scaffolding functions and strategies. Finally, findings can be enriched through the use of video-recording to study nonverbal teacher scaffolding.

This Special Issue

Zia Tajeddin & Minoo Alemi (Guest editors)

We are honored to introduce six papers included in this special issue on discourse in second language classrooms.

Classroom discourse is central to knowledge (co)construction in the classroom. The analysis of this discourse brings to light not only patterns of teacher-students interaction but also the process underpinning language teaching and learning. This special issue, titled "Discourse in Second Language Classrooms," is devoted to unpacking various aspects of language classroom discourse. The papers included in this special issue address types and functions of teacher scaffolding in content-based instruction (CBI), L2 teacher questions and student responses, classroom greetings, teachers' discursive construction of their identity, uses of L1 in language classrooms, and peer scaffolding.

The main purpose of the study reported by Joan Kelly Hall, Tiangang Wang, and Su Yin Khor was to explore the link between teacher questions and student responses. They found that L2 teacher questions contributed to both the linguistic quality of the classroom input provided to learners and the linguistic quality of learners' responses. In their paper, Lauren K. Shields-Lysiak, Maureen P. Boyd, John P. Iorio Jr., and Christopher R. Vasquez analyzed teacher greetings. The authors examined classroom greeting data, which unraveled how greetings were used as a marker of dialogic pedagogy to create spaces for building classroom community togetherness. The study conducted by Li Li aimed to explore the relationship between discourse and identity in teachers' discursive construction of their identity. Findings revealed that identity construction, as realized through teacher-students interaction, mainly helps develop practical knowledge and engage in language-related practices.

Serdar Tekin and Sue Garton's study investigated the use of L1 in English classrooms. The authors drew on both observational and interview data to examine how much, when, how, and why teachers use L1 in their English classrooms. The results indicated that the teachers used L1 for various purposes such as giving instruction, providing feedback, and asking questions. The study conducted by Sahar Zahed Alavi and Mahboubeh Saadat investigated variability in peer-peer scaffolding in L2 writing tasks. The microgenetic analysis of the pairs' interactions during scaffolding episodes showed that the pairs used suggesting, instructing, and translating to different degrees. The last paper in this special issue, authored by Andrew Jocuns et al., addressed the impact of the Covid-19 pandemic on language education. In a series of case studies, the authors used nexus analysis to study changes in classroom discourse from face-to-face to online teaching and the ways the initiation-response-evaluation (IRE) sequence emerged differently in online education.

We hope these papers will heighten the researchers' interest in conducting more research on classroom discourse and raise awareness about the significance of the discursive aspects of classroom ecology.

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