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Fostering English Reading Ability of Thai EFL Science Pre-service Teachers through the Instruction of Cognitive Discourse Functions and Collaborative Strategic Reading in Science Related Theme: A CLIL Approach

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Abstract

English reading comprehension is a core competence for pre-service science teachers because it enables access to scientific knowledge, supports learning from English-medium materials, and prepares future teachers for English-supported science instruction. This study examined whether integrating Collaborative Strategic Reading (CSR) with Cognitive Discourse Functions (CDFs) within a CLIL approach could enhance English science-text reading comprehension among Thai EFL preservice science teachers. An explanatory sequential mixed-methods design was embedded in a one-group pretest–post-test framework. The participants were 27 first-year pre-service science teachers in the Science Education program at a public university in Bangkok. The intervention employed CSR-CDF lesson plans built around science-related reading topics, integrating CSR routines with seven CDFs. Quantitative data were collected using a researcher-developed reading comprehension test. Qualitative data were gathered from weekly reflective journals and post-intervention focus-group interviews. The results showed significant gains in overall reading comprehension and all sub-skills. Qualitative findings indicated that CSR supported procedural understanding, while CDF-guided tasks clarified disciplinary meaning-making. Participants also reported greater confidence, productive peer-supported comprehension, and perceived transfer to future teaching practices. Future studies should replicate the intervention with comparison groups and larger samples across contexts. Process-focused data (e.g. observations/recordings of peer talk) would clarify how CSR and CDFs operate during reading. The transfer to written and oral scientific explanations should also be examined.

Keywords: Collaborative Strategic Reading, Cognitive Discourse Functions, CLIL, English Reading Comprehension, Preservice Science Teachers, Thai EFL Context

Introduction

English reading proficiency is essential for pre-service science teachers because it enables them to access and evaluate scientific knowledge, which is frequently disseminated through English-medium research articles, reports, and instructional materials. Competent reading supports the comprehension of conceptually dense science texts, the interpretation of evidence and explanations, and the ability to re-express complex ideas in more learnable forms for students, which are core practices of scientific and disciplinary literacy (Norris & Phillips, 2003; Lemke, 1990; Shanahan & Shanahan, 2008). Strong reading comprehension also supports teachers' capacity to scaffold learners' engagement with science texts, including vocabulary growth and meaning-making in classrooms where bilingual or CLIL-oriented language support is integral to content learning (Bravo, 2017; Coyle et al., 2010; Mehisto et al., 2008).

However, preservice science teachers often face persistent barriers when reading science discourse, including technical terminology, dense expository structures, and multimodal meaning (e.g. diagrams and data displays), and limited preparation for teaching reading strategically in content areas ([Lemke, 1990](#); [Shanahan & Shanahan, 2008](#)). In Thailand, evidence consistently shows that many EFL learners rely on translation-driven, bottom-up processing and demonstrate an uneven use of metacognitive strategies needed to monitor comprehension and repair breakdowns—patterns associated with weaker confidence and academic performance ([Anderson, 1991](#); [Rungwaraphong, 2020](#)). These challenges also point to professional development needs, as teachers require sustained support to strengthen advanced academic reading and promote higher-order, evidence-based discourse in science instruction ([Desimone, 2009](#)).

Against this backdrop, the present study is significant because it addresses Thai EFL science preservice teachers' reading challenges through an integrated instruction that combines Collaborative Strategic Reading (CSR) with Cognitive Discourse Functions (CDFs). This integration aims to strengthen strategic comprehension processes while making the discipline-specific discourse of science explicit and teachable, thereby bridging gaps in traditional reading instruction and supporting CLIL-oriented teacher education with practical and empirical guidance.

Research Questions

1. To what extent does instruction integrating Collaborative Strategic Reading (CSR) and Cognitive Discourse Functions (CDFs) enhance Thai EFL preservice science teachers' English reading comprehension?
2. What are Thai EFL preservice science teachers' perceptions of CSR–CDF instruction in supporting their English reading comprehension development?

Research Objectives

1. To investigate Thai EFL preservice science teachers' English reading comprehension skills after instruction in Collaborative Strategic Reading and cognitive discourse functions.

2. To explore Thai EFL preservice science teachers' perceptions of instruction of Collaborative Strategic Reading and cognitive discourse functions in developing their reading comprehension ability.

Literature Review

Reading comprehension in science poses distinctive challenges for EFL learners because science texts are not only linguistically demanding (technical vocabulary, dense syntax, abstract noun phrases) but also discourse- and genre-specific, requiring readers to follow how scientific knowledge is defined, categorised, explained, and evaluated ([Shanahan & Shanahan, 2008](#); [Schleppegrell, 2004](#)). For pre-service science teachers, this challenge is doubled; they must develop personal competence to read scientific English and, at the same time, build pedagogical capacity to scaffold disciplinary texts for future learners ([Cervetti et al., 2012](#)). In Thai EFL contexts, these demands are often intensified by limited sustained exposure to authentic science texts and learners' reliance on translation-driven, bottom-up processing with relatively weak metacognitive monitoring.

CSR is a well-developed model for responding to comprehension processes because of its combination of explicit strategy instruction and the implementation of collaborative learning routines ([Klingner & Vaughn, 1998](#); [Klingner et al., 2004](#)). It teaches four strategies (Preview, Click and Clunk, Get the Gist, and Wrap-Up) that are organised before, during, and after reading, as well as role assignments and peer discussions to facilitate reading for comprehension monitoring and meaning negotiation ([Klingner & Vaughn, 1998](#)). Its theoretical basis consists of metacognitive conceptions of reading and a sociocultural philosophical stance on learning that underscores the role of guided interaction and collaborative talk in learning ([Vygotsky, 2018](#)). Empirically, recent EFL studies have found a positive impact of CSR on comprehension and engagement. For instance, CSR has been found to enhance EFL learners' reading comprehension in Thai university settings, especially for EFL readers with weaker proficiency who may not automatically utilise strategies ([Khampool & Chumworatayee,](#)

2023). Reading science is more complex than simply determining a main idea; it involves identifying how texts construct concepts, categories, representations of natural phenomena, descriptions of processes, and mechanisms for generating explanations and making claims about evidence often supported through multimodal means (Lemke 1990; Norris & Phillips 2003). This is particularly significant for novice teachers, who require examples to ground strategy instruction in the disciplinary literacy demands they will face as educators (Shanahan et al., 2011).

Cognitive Discourse Functions provide a complementary framework that can make disciplinary meaning-making explicit. Developed to conceptualise content-language integration in CLIL and multilingual education, CDFs specify seven recurring functions (classify, define, describe, explain, explore, and report) that represent how learners verbalise their thinking and build subject-matter understanding (Dalton-Puffer, 2013, 2016). CDFs offer a shared pedagogical metalanguage that addresses the “dual focus” problem in CLIL: content teachers may feel unprepared to teach language explicitly, whereas language teachers may lack access to disciplinary discourse knowledge (Coyle et al., 2010; Piacentini, 2021). As argued in CLIL literacy research, CDFs can bridge content, literacy, and language by clarifying the kinds of discourse work tasks required and what students must learn to do with language in disciplinary contexts (Morton, 2020). Empirical research increasingly supports the classroom relevance of CDFs. Dalton-Puffer et al. (2018) showed that CDFs occur systematically in CLIL classrooms, although they are unevenly distributed and often not explicitly taught. Intervention and interaction research have also shown that the explicit instruction of CDFs has the potential to help learners develop disciplinary reasoning and language-mediated performance, for example, in science. These results further support the use of CDFs as a disciplinary focus for science literacy education.

Bringing these strands together, the integration of CSR and CDFs within a CLIL approach is theoretically and pedagogically motivated. CSR provides the “how” of comprehension—systematic methods for monitoring understanding and

coordinating strategy use, whereas CDFs provide the “what” of disciplinary discourse, specific goals regarding how scientific knowledge is represented and communicated in texts (Dalton-Puffer, 2013; Morton, 2020). CLIL, which embeds content themes with more explicit language support while developing an immersion environment, is marked as especially appropriate for Thai EFL settings, where learners require the gradual scaffolding of language as well as reading ability (Ball et al., 2020; Mehisto et al., 2008; Coyle et al., 2010).

Although no published study has yet evaluated CSR–CDFs as a unified intervention model, adjacent evidence supports combining strategy instruction with science literacy approaches and making disciplinary language demands explicit to improve comprehension and content learning. Key gaps remain, including limited EFL research on CSR with authentic science texts, limited preservice teacher-focused CSR research, and limited empirical work examining how procedural strategy routines and discourse-function targets interact in integrated models (Cervetti et al., 2012). Addressing these gaps, the present study investigates CSR–CDF integration for Thai EFL science preservice teachers, examining reading comprehension outcomes and learners’ experiences within a science-themed CLIL-oriented curriculum.

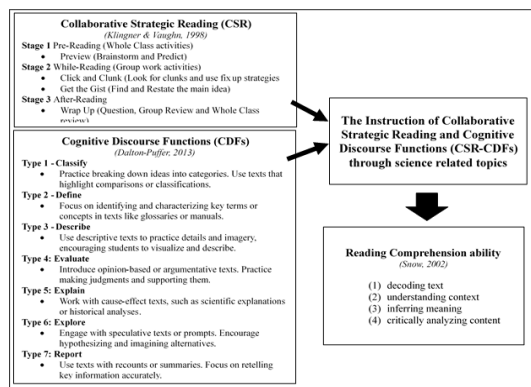


Figure 1 The Conceptual Showing the CSR–CDFs for Science-Reading in CLIL

Methodology

This research was designed as a mixed method explanatory sequential study (QUAN → qual) nested in a pre experimental one-group pretest–

posttest design. The quantitative phase was the main thread used to investigate CSR-CDF instruction to improve English reading comprehension. The follow-up qualitative phase was used to interpret, expand, and contextualise the quantitative findings in terms of learners' perspectives and experiences (Creswell & Plano Clark, 2017).

In the qualitative part, data from students' reflective journals (collected during the intervention) and semi-structured focus group interviews (carried out after the intervention) were analysed to gain insight into how and why the instruction affected the targeted ability of the students. The integration of results took place at the level of interpretation, with qualitative findings employed to interpret and triangulate the quantitative outcomes.

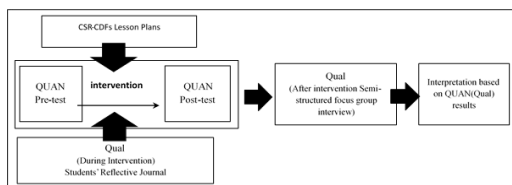


Figure 2 The Research Design Model of this Study

The participants were 27 first-year pre-service science teachers enrolled in a Bachelor of Education (B.Ed.) program in Science Teaching at a public university in Bangkok, Thailand. Participants were selected using convenience sampling, as they were enrolled in a course where the instructional intervention was implemented as part of the regular classroom practice. According to the program requirements, participants possessed a minimum English reading proficiency equivalent to the CEFR A2 level or above. The instructional content was therefore tailored to support their developmental level while preparing them to engage with science-related English texts relevant to their future teaching careers.

Research Instrumentation

Four instruments were used: (1) an English reading comprehension pretest/posttest, (2) CSR–CDFs lesson plans, (3) weekly reflective journals, and (4) a semi-structured focus group interview protocol.

1. Reading comprehension test A researcher-

developed 90-minute test measured overall comprehension and four subskills (decoding, context, inference, critical analysis) using science-related passages. Expert review showed acceptable content validity (IOC = 0.67–1.00), item difficulty ranged 0.33–0.77, and reliability was good ($\alpha = 0.85$).

2. CSR–CDFs lesson plans Lesson plans integrated CSR routines (Preview, Click and Clunk, Get the Gist, Wrap-Up) with seven CDFs (classify, define, describe, explain, evaluate, explore, report) Plans were expert-reviewed and refined prior to use.
3. Students reflective Journal Weekly journals documented strategy use and perceived support from CDF tasks; prompts were expert-reviewed.
4. Focus group interviews were conducted in Thai; the protocol was expert-validated and examined perceived gains and helpful CSR/CDF features.

Data Collection, Analysis, and Ethics

Quantitative data were collected using an English reading comprehension test administered as a pre- and post-test. The test measured overall reading comprehension and four sub-skills: decoding text, understanding context, inferring meaning, and critically analysing content. Pre–post differences were analysed using the Wilcoxon Signed-Rank Test due to the small sample size and non-normal data distribution.

Qualitative data were collected from two sources: (1) weekly reflective journals to capture ongoing learning processes and perceptions during the intervention and (2) semi-structured focus group interviews to explore students' reflections on the instructional approach, their reading development, and the perceived roles of CSR and CDFs. The thematic analysis of the qualitative data followed an inductive coding process, as described below.

Quantitative and qualitative findings were integrated at the interpretation level, whereby qualitative themes were employed to clarify and refine the quantitative results, enhancing credibility through triangulation.

Ethical procedures were followed throughout the study. Approval from the institution was granted before conducting the analysis, and each patient provided written informed consent. The data were anonymised, and confidentiality was maintained.

Findings

In this section, the results of the three data collections are presented in relation to the questions that guided this investigation to determine whether teaching integrating CSR and (CDFs can influence the English reading comprehension ability of Thai EFL preservice science teachers. The sources of data for this study are (1) pretest-posttest scores, (2) focus group interview,s and (3) students' reflective journals. The triangulated results provide a full account of cognitive and affective development when reading scientific texts and reinforce the internal validity of this study by means of methodological triangulation.

Part 1 Quantitative Gains in English Reading Comprehension Ability

According to Table 1, the post-instruction results indicate a clear improvement in Thai EFL science student teachers' English reading comprehension skills. The Wilcoxon signed-rank test showed that posttest scores (M = 15.02, SD = 1.050) were significantly higher than pretest scores. A Wilcoxon signed-rank test showed that students' reading comprehension scores increased significantly from pretest (M = 8.54, SD = 0.891) to posttest (M = 15.02, SD = 1.050), $Z = -4.634$, $p < .001$ (two-tailed), with a large effect size ($r = .88$).

This means that the CSR-CDFs instruction was not only statistically effective but also practically

meaningful, producing a strong gain in overall reading comprehension performance. The effect size suggests that the improvement is unlikely to be trivial and points to the CSR-CDF instruction as a powerful combination for strengthening reading comprehension in this group.

Table 1 Wilcoxon Signed-Rank Test Results for Reading Comprehension

Tests	M	SD	Z	Asymp. Sig. (2-tailed)	r
Pretest	8.54	.891	-4.634	<.001	.88
Posttest	15.02	1.050			

Note. N = 27.

Moreover, the Wilcoxon signed-rank test in Table 2 indicates statistically significant gains across all reading comprehension components after CSR-CDF instruction. Specifically, Decoding Text increased from the pretest (M = 2.17, SD = 0.460) to posttest (M = 3.78, SD = 0.487), $Z = -4.589$, $p < .001$, with a large effect ($r = .88$). Understanding Context also increased from the pretest (M = 2.07, SD = 0.359) to the posttest (M = 3.70, SD = 0.505), $Z = -4.518$, $p < .001$, $r = .87$. Inferring Meaning improved (pretest M = 2.13, SD = 0.492; posttest M = 3.83, SD = 0.416), $Z = -4.582$, $p < .001$, $r = .88$. Finally, critically analysing content increased (pretest M = 2.17, SD = 0.500; posttest M = 3.70, SD = 0.527), $Z = -4.471$, $p < .001$, with a large effect ($r = .86$).

Table 2 Wilcoxon Signed-Rank Test Results for Reading Comprehension Components

Components	Pretest		Posttest		Z	Asymp. Sig. (2-tailed)	r
	M	SD	M	SD			
Decoding Text	2.17	.460	3.78	.487	-4.589	<.001	.88
Understanding Context	2.07	.359	3.70	.505	-4.518	<.001	.87
Inferring Meaning	2.13	.492	3.83	.416	-4.582	<.001	.88
Critically Analyzing Content	2.17	.500	3.70	.527	-4.471	<.001	.86

Note. N = 27.

These findings suggest that the CSR-CDFs instruction strengthens not only overall comprehension but also core sub-skills—ranging from lower-level processing (decoding) to higher-order comprehension (inferring and critical analysis)—with consistently large effects ($r = .86-.88$).

Part 2 Qualitative Insights from Focus Group Interviews

To provide qualitative support for the quantitative gains and gain a more in-depth understanding of the instructional impact, eight participants were selected from each treatment group to participate in a focus group discussion. The semi-structured schedule

focused on participants' views of the pedagogical intervention using CSR and CDFs. Four primary focuses emerged: effects on instruction, growth across components of reading comprehension, affective responses, and transfer to teaching practices.

Theme 1: Instructional Effectiveness of CSR-CDFs

Participants provided highly favourable feedback on the organisation and usefulness of CSR-CDF instruction. The graduated CSR steps were specifically mentioned as being helpful in building reading processes. Participants can be immersed in different text genres. Repeated weekly exposure to CDFs was commonly identified as a key factor in making reading tasks meaningful and diverse.

“The reading group activities provided me a way to read, not just haphazardly pick up.”

“Some weeks were slow-reading weeks. That helped me to practice reading like a science teacher.”

Theme 2: Development Across Reading Comprehension Components

The focus group data indicated that the participants were clearly conscious of their progress in the four domains of reading comprehension identified as decoding, understanding context, inferring meaning, and critically evaluating. Practice with specific types of CDF was supported for each of these.

Decoding + Define (CDF Type 2) Students indicated improved ability to understand and remember technical words.

“For a while, big science words were intimidating to me. But when we made them together, I began to remember them.”

“Glossaries made me notice patterns of meanings repeated in scientific words.”

Understanding Context + Describe (CDF Type 3)

Descriptive texts helped learners build mental models of the processes.

“When we talked about the process of digestion, it helped me visualise it. I understood more.”

Inferring Meaning + Classify & Explore (CDF Types 1 and 6)

Classification and speculation texts encouraged deeper inference.

“When we grouped things that were similar like animals or types of matter, I could guess new words from examples.”

Critical Analysis + Evaluate & Explain (CDF Types 4 & 5)

Students engaged in higher-order thinking when examining scientific claims and causal relationships.

“I used to just take everything in the reading. Now I can plug things in and see if it works.”

“Explain the cause and the effect helped me think about systems like the food chain more easily.”

These results support the idea that CSR strategies, CDFs, and gains in targeted reading sub-skills are well matched.

Theme 3: Confidence and Motivation for Reading Science in English

The participants reported appreciable emotional benefits from the intervention. The vast majority started with little self-efficacy but acquired confidence, which made them want to read scientific texts in English. The deliberate nature of CSR and the collective writing context were noted to decrease anxiety.

“I used to stay far away from English science articles. Now I feel proud that I can read them.”

“My confidence expanded because I knew what to do at each turn, just like a real scientist reading research.”

These emotional changes are particularly important in EFL science education because reading complexity can generate disengagement.

Theme 4: Transfer to Teaching Practice

A powerful theme emerging from the focus group was the potential applicability of CSR-CDFs to the participants' science teaching. They noticed that the techniques used in the course matched techniques that they could use on their own students to support English reading in a science context.

“I hope to use those steps in my future science class. It's not only for English, it's for comprehension.”

Participants demonstrated not only an understanding of pedagogical approaches but also professional awareness of how pedagogy could be actualised.

Table 3 Summary of Thematics from Focus Group Interviews

Theme	Reading Skill	CDF Type(s)	Illustrative Quote
Instructional Structure	Metacognitive Strategy Use	All (CSR + CDFs)	“Each step helped me understand more.”
Vocabulary Growth	Decoding	Define (Type 2)	“Glossaries helped me learn hard science words.”
Visualizing Process	Understanding	Describe (Type 3)	“Describing helped me imagine the system.”
Inferencing	Guessing/ Prediction	Classify (Type 1), Explore (Type 6)	“I guessed words by comparing examples.”
Deep Thinking	Critical Reading	Evaluate (Type 4), Explain (Type 5)	“Now I question the solution in the reading.”
Motivation & Confidence	Affective Domain	-	“I feel proud that I can read science in English now.”
Teaching Transfer	Professional Practice	Report (Type 7), Explain (Type 5)	“I will apply this when teaching experiments.”

This table outlines the main topics that emerged in the focus group interviews, illustrating the alignment between reading ability and CDFs, which were intricately linked with what people thought about CSR-CDFs instruction. This serves as proof of concept. The combined implementation of both CSR and CDFs did not exclusively elevate students’ reading comprehension but also increased their strategic repertoire and built up their confidence wherever they went.

Part 3 Thematic Reflections from Student Journals

Weekly reflective journals from each participant were collected, forming a database of 189 entries. Emergent categories were identified for thematic coding, and saturation was confirmed by the seventh week. The four themes which emerged reflect and expand upon the quantitative data and what was said in the interviews.

Theme A: Improved English Reading Comprehension Ability

Most participants reported that their English reading abilities improved. Students attributed these positive changes to a) having discovered reading strategies which work, and b) the fact that they now have a set of systematic ways to approach scientific texts.

“This time my improvement in reading was profound!”

“I think my reading skills have gotten better because of this activity.”

Some participants also reported they had undergone a shift in their reading behaviour from the passive decoding of words to more active engagement with the text. This is especially true for science-related content.

Theme B: Vocabulary Awareness as a Key Strategy

Vocabulary learning and word recognition were the most frequently mentioned beneficial strategies. Students realised that mastering the key vocabulary would give them a way of getting the whole point in many cases without needing to translate every single sentence.

“I realised I did not need to read every single word. If I know the key vocabulary, I can get the main idea.”

“For me, expanding my word bank was very helpful. Knowing scientific terms made reading much easier.”

Others emphasised that knowing word meanings enhanced their overall comprehension and made them feel more competent when reading unfamiliar scientific texts.

Theme C: Collaborative Reading Promotes Comprehension

Collaborative CSR learning activities were found to improve mutual understanding and self-confidence. Many participants appreciated the chance to compare notes with others or query and discuss difficult parts of the texts.

“I learned more than ever when we worked together as a team. We could talk about the problems and figure them out between ourselves, so I wasn’t afraid to ask any questions any longer.”

Such interactions were seen as reducing anxiety and encouraging engagement, especially when encountering complex scientific content.

Theme D: Increased Confidence in English Reading Comprehension

Nearly all students reported that CSR-CDF instruction significantly increased their confidence in reading English. Repetitive practice, group discussions, and scaffolded activities made them feel more comfortable and less intimidated by scientific English texts.

“Before this, I was not confident at all. Now I feel more comfortable reading English, especially science.”

“I used to be nervous about reading academic articles. After this, I feel more confident and even enjoy it.”

The shift in the affective stance from fear to confidence was a recurring pattern across responses.

In conclusion, the findings consistently support the effectiveness of CSR–CDFs across quantitative and qualitative data sources. Overall, triangulation across sources and a strong alignment between instruction and observed outcomes enhanced the study’s credibility and trustworthiness.

Discussion

This study examined the integration of CSR and CDFs within a CLIL approach to strengthen English reading comprehension among Thai EFL science preservice teachers. An accompanying large pre-post difference in overall reading comprehension and underlying component skills reflects a shift from surface-level processing toward more strategic, meaning-mediated reading of science texts which are characterised by lexical density, dense information packaging, and evidence-supported reasoning (Lemke, 1990; Norris & Phillips, 2003). From an L2 reading perspective, such gains are in line with the development of metacognitive regulation of monitoring comprehension, selecting strategies, and applying fix-up actions when comprehension fails (Grabe & Stoller, 2020). This is especially

true in Thai EFL settings, where students resort to translation-driven, bottom-up reading and are not consistent with strategy use unless instructed to do so. CSR may have contributed to reading improvement through its explicit, teachable routines (Preview, Click and Clunk, Get the Gist, Wrap-Up) that make comprehension processes visible via modelling and guided practice and perhaps lower cognitive load by providing predictable steps that can be internalised (Hudson, 2009; Sweller, 2019). In addition, CSR’s cooperative structure supports comprehension through peer negotiation and shared responsibility, which can reduce anxiety and make reasoning discussable in low-risk interactions (Johnson & Johnson, 1987).

Beyond CSR, the distinctive contribution of this study lies in embedding CDFs as explicit disciplinary discourse targets that clarify what it means to “read scientifically.” CDFs specify recurrent meaning-making functions through which subject learning is enacted in language (see also Dalton-Puffer, 2013, 2016). Because science comprehension depends on recognising how texts define concepts, explain mechanisms, classify phenomena, and evaluate evidence, CDFs likely strengthen the disciplinary specificity of reading and discussion tasks (Norris & Phillips, 2003; Osborne, 2010). It is reasonable to infer explanations for how the pattern of componential gains occurred with this CSR–CDF instruction. Work guided by CDFs (particularly DEFINE/CLASSIFY) may have promoted conceptual vocabulary and stabilised textual meanings in context; CSR routines (Get the Gist/ Wrap-Up) would seem plausible sources to support integration across clauses and sections that were prompted by summarising questioning; and CDFs such as EXPLAIN/EVALUATE would naturally draw attention to causality and evidence-based judgment—aligning with critical analysis demands found in scientific literacy (Klingner et al., 2004; Dalton-Puffer et al., 2018; Morton, 2020; Osborne, 2010). In this way, CSR provided support for how learners self-regulated their understanding, whereas CDFs made explicit what disciplinary meaning-making they were to attend to, discuss, and internalise.

Finally, the findings are particularly relevant to pre-service teacher education. Participants’ reports

indicate that learning to work in teams, having structured materials for collaboration, and routine use of strategy can foster confidence and willingness to interact with challenging disciplinary texts, which is an essential need for future science teachers who are likely to use English-support resources (Johnson & Johnson, 1987). Simultaneously, CDF-oriented framing offers preservice teachers a practical metalanguage for making “language in science” explicit, addressing a common difficulty in CLIL-oriented teaching, where teachers may lack tools for integrating language aims with content reasoning (Piacentini, 2021; Morton, 2020). Situated within CLIL, CSR-CDF instruction appears feasible for Thai contexts where full immersion is often unrealistic and staged scaffolding is necessary to support both disciplinary understanding and academic English literacy (Ball et al., 2020; Coyle et al., 2010; Mehisto et al., 2008). Overall, integrating CSR routines with CDF discourse targets provides a coherent model for strengthening comprehension, strategic regulation, and disciplinary discourse awareness among Thai EFL science preservice teachers (Dalton-Puffer, 2013; Khampool & Chumworatayee, 2023; Klingner & Vaughn, 1998).

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Pedagogical Implications

The results suggest implications for practice of enhancing students’ English reading ability in Thai EFL preservice teachers of science through employable CSR and CDFs integrated in CLIL science-based instruction. CSR provides a teachable routine that organises reading into distinct phases. Embedding CDFs brings disciplinary specificity, making explicit how scientific meaning is realised through activities such as defining, classifying,

describing, explaining, evaluating, and reporting and moving them from general practice to science-focused meaning-making (Dalton-Puffer, 2013; Morton, 2020). Placed within CLIL, the model scaffolds content and language in a realist manner for teacher education and gives preservice teachers an approach to enhance their practice of teaching science supported by English.

Limitations

This study has several limitations. First, generalisability is limited as the intervention took place with one cohort of Thai preservice EFL science teachers from one institution, and integrated literacy practices are contingent on local sociocultural and institutional factors (Foley, 2005). Second, because this content was science-based, transfer to other content areas is unknown; although CDFs are constructed to be cross-disciplinary, discourse expectations and literacy practices differ between disciplines. Third, the pre-experiment design may be seen as having limitations in terms of causal claims, and the need for stronger designs, such as experimental designs with a comparison group, to eliminate alternative explanations is needed. Lastly, while we did capture outcomes and perceptions, enactment at the process level was not well-documented; without recordings, observations, or a discourse analysis capturing how CSR routines and CDF-focused attention functioned in collaborative reading and small-group talk (Creswell & Plano Clark, 2017; Dalton-Puffer et al., 2018), it is difficult to say with specificity what took place.

Suggestions for Future Research and Practice

Given these constraints, a few recommendations are suggested. The use of stronger designs in future research will help support claims about the effect of CSR–CDF in science-themed CLIL contexts. Future research should also include process-level data to capture the enactment of strategies in real time, as well as how attention focused on the CDF supports comprehension and evidence-based reasoning. Finally, transfer beyond reading should be investigated in future studies through synchronous enquiry into science writing and speaking, particularly explanation and argumentation

tasks central to disciplinary literacy. (Osborne 2010; Shanahan et al. 2011).

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