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RESEARCH ARTICLE

Unpacking second language writing teacher knowledge through corpus-based pedagogy training

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Abstract

Corpus-based language teaching is one area of second language (L2) pedagogy in which L2 teachers may benefit from extensive guidance on how to integrate digital tools into pedagogical practices. Direct corpus approaches like data-driven learning (DDL) cultivate learner engagement and language discovery. However, second language writing (SLW) teachers face significant challenges using corpora in the classroom, and these challenges often go unaddressed in language teacher education, particularly for in-service teachers. This paper reports on a case study in which six university SLW teachers participated in an online corpus-based pedagogy workshop. Teachers developed DDL activity plans and wrote in reflective diaries. The analysis of these artifacts shows that the teachers tended to follow one of two paths toward knowledge integration, as either Planners or Seekers, when implementing corpus activities in their classrooms. The teachers also reported increased confidence in applying direct corpus methods to their lessons by the end of the workshops, though they expressed the need for continued, long-term support.

Keywords: data-driven learning; corpus-based pedagogy; second language writing; TPACK

1. Introduction

Corpus techniques garner language awareness in second language (L2) writers, consequently bolstering their writing proficiency, critical thinking skills, self-efficacy, and learner autonomy (Boulton & Cobb, 2017). However, corpus approaches have yet to reach their full potential in the language classroom (Chen, Flowerdew & Anthony, 2019; Pérez-Paredes, 2022). This may be due to a lack of effective corpus-based training for L2 teachers (Chen *et al*., 2019). Such training would ideally provide instruction on searching, analyzing, and interpreting corpus data, and guidance on how to evaluate the validity of these interpretations in specific communicative contexts (Ädel, 2010). An effective corpus-based training would also cover a range of pedagogical strategies for developing students' corpus literacy (Callies, 2016).

Despite such calls for an integrative approach, combining corpus techniques with pedagogical strategies, many teacher education programs isolate technology from its pedagogical application (Godwin-Jones, 2015), treating technology as a separate, general topic that is neither context nor content specific (Lee & Kim, 2014). This results in a one-size-fits-all approach that ignores the individual needs of prospective teachers (Koehler & Mishra, 2009).

Acquiring corpus literacy is a formidable hurdle for many teachers due to the time and effort it requires (Boulton, 2010; Çalışkan & Gönen, 2018; Leńko-Szymańska, 2017). It should therefore be developed slowly and deliberately integrated into language teachers' regular praxis. This agreement that corpus literacy is developed gradually and intentionally has lent itself to new

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inquiries regarding the integration of corpus knowledge with other knowledges required for language teaching.

The current study investigates the corpus literacy journey of six in-service university writing teachers, offering analysis of these teachers' classroom practices and knowledge integration processes as they created and implemented data-driven learning (DDL) activities throughout their participation in a seven-week online corpus pedagogy workshop. This workshop was designed using the technology, pedagogy, and content knowledge (TPACK) framework (Mishra & Koehler, 2006), which, unlike one-size-fits-all approaches to technology-focused teacher education, is a situated, integrative model of teacher knowledge.

2. Literature review

2.1 Data-driven learning and teaching

Data-driven learning (DDL) is a method for using corpora with language learners via direct classroom instruction. Tim Johns (1991) introduced this exploratory, inductive approach to corpus-based language teaching as an alternative to traditional prescriptivist grammar pedagogies, and recent scholarship has highlighted DDL's potential to enhance L2 writing skills (e.g. Cotos, 2014; Han & Shin, 2017). However, most classroom-based corpus studies to date have focused on the student experience. Substantially fewer inquiries target DDL teacher training, and those that do tend to illuminate teachers' perceptions and beliefs rather than their knowledge development. Teacher knowledge is one facet of language teacher cognition, which is defined as "the complex, practically-oriented, personalized, and context-sensitive networks of knowledge, thoughts, and beliefs that language teachers draw on" in their professional lives (Borg, 2015: 272). Concepts and processes associated with teacher cognition include beliefs, interactive thoughts, decision-making, knowledge, motivation, attitudes, emotions, and identities (Schmid, 2017). These processes are envisioned as a complex, dynamic system, which integrates multiple facets of teachers' internal processes (Feryok, 2010, 2018).

In one corpus-based teacher training study, Breyer (2009) developed and taught a semester-long university course for EFL teachers. Following a learner-to-teacher approach, students viewed presentations and completed hands-on exercises before creating their own corpus activities. Breyer then analyzed students' reflective writing and questionnaire responses to determine how they perceived the role of the teacher in corpus-based pedagogy. This study was largely conceptual; as all participants were pre-service teachers, they did not practice teaching their activities within an authentic context. Çalışkan and Gönen (2018) created and delivered a four-week corpus-based pedagogy workshop focused on vocabulary development for in-service EFL teacher trainees. Like Breyer's study, participants in this study experienced the role of the student, completing coursework before designing and implementing their own corpus activities, but unlike Breyer's study, these participants also implemented their activities in their respective classrooms. After the workshop, student teachers' perceptions of corpus teaching were analyzed through semi-structured interviews, reflective logs, and questionnaires. Both studies produced valuable insight into the teacher trainees' perspectives about corpus pedagogy and the need for in-service teacher training, though neither evaluated teacher knowledge development.

Other studies have integrated corpus tools into existing teacher education curricula. Farr (2008) introduced two consecutive semester-long courses into an ELT master's program. Corpus research skills were taught the first semester, and a theory and practice module addressing the "use of ICT for teaching purposes" (p. 31) was delivered in the second semester. After taking these courses, student teachers completed a questionnaire to share their views on the corpus component of their studies. Again, this study focused on teacher perceptions rather than teacher knowledge and emphasized using corpora for research rather than teaching. Zareva (2017) also

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integrated corpus literacy training into an existing master's level grammar course to explore TESOL teachers' "opinions, attitudes, and recommendations" on using corpus tools (p. 70). During five lessons in the semester-long grammar course, students workshopped using corpus tools to explore grammar topics. While this additional corpus literacy training guided them to conduct linguistic research, it did not focus on teaching with corpora.

In a rare corpus study exploring teacher knowledge development, a group of MA TESOL trainee teachers completed a four-week training embedded into an existing vocabulary teaching course (Ma, Tang & Lin, 2021). Drawing from Shulman's model of pedagogical content knowledge, the authors divided this training into two main sections: corpus literacy development (knowing how to work with a corpus) and corpus-based language pedagogy (knowing how to integrate corpus tools into the classroom for meaningful learning). Participants attended corpus literacy workshops and collaborated to produce corpus-based lesson plans. Most reported substantial gains in their corpus literacy, and the lesson plans demonstrated increased competence implementing corpus techniques. Based on these promising results, the authors argue that teacher trainees need to develop corpus literacy *before* practicing corpus-based pedagogy. However, the authors do not articulate how teachers approached lesson design nor how lesson design related to knowledge development. In a similar study, Ma, Yuan, Cheung and Yang (2022) followed two language teachers who each attended corpus workshops and designed and implemented a corpus activity in their classrooms. Although Ma *et al*. uncovered valuable insight into the complexity of the interacting knowledge domains involved in corpus-based language pedagogy, they did not implement an iterative approach utilizing reflection and redesign into their exploration of teacher knowledge development. Unlike these studies, the current study analyzes the interplay between teachers' DDL activity design approaches and their knowledge development as they create, reflect on, and revise three separate DDL activities.

2.2 Designing DDL teacher training programs

Among the corpus studies investigating teachers' needs, knowledge, and perceptions, widespread consensus exists on how to teach corpus pedagogy to pre- and in-service teachers. Recommendations include starting corpus training as early as possible, during the initial pre-service training, and extending support to in-service initiatives (Çalışkan & Gönen, 2018). Furthermore, DDL training should be structured so that "student teachers can experience the use of corpora for language learning from two perspectives: as learners *and* as teachers" (Breyer, 2009: 167).

Finally, most agree that corpus-based pedagogy is complex because teachers not only have to "assess the materials for their appropriateness in the respective learning context" but also must possess enough corpus literacy to "teach with these materials and integrate them meaningfully into the classroom" (Breyer, 2009: 156). To address this complexity, teachers need learning experiences that carefully scaffold corpus technology, research-focused skill development, and the situated application of corpus-based lessons into the classroom (Ma *et al*., 2021; Zareva, 2017). Such training integrates the various skills teachers need to use corpus technology with their students. Pérez-Paredes (2022) found that the integration of technology and pedagogy is central to teaching DDL. Vyatkina (2020) likewise discovered that "only a deep understanding of pedagogy, technology, and their interaction by teachers can lead to a successful implementation of instructional innovations" (p. 325). Leńko-Szymańska (2017) addressed similar claims by citing the need for a conceptual model of teacher education that integrates technological skills, corpus linguistics knowledge, and pedagogical knowledge. As Boulton and Cobb's (2017) meta-analysis revealed, such integrative learning experiences should also be situated within the context of teachers' daily routines. Boulton (2010) similarly asserts that teachers need training on "the implementation of DDL rather than the [isolated] nature of the techniques themselves" (p. 535).

Thus, it is established that DDL teacher training requires the integration of a complex knowledge base consisting of corpus literacy and corpus-based pedagogy, and it should be situated

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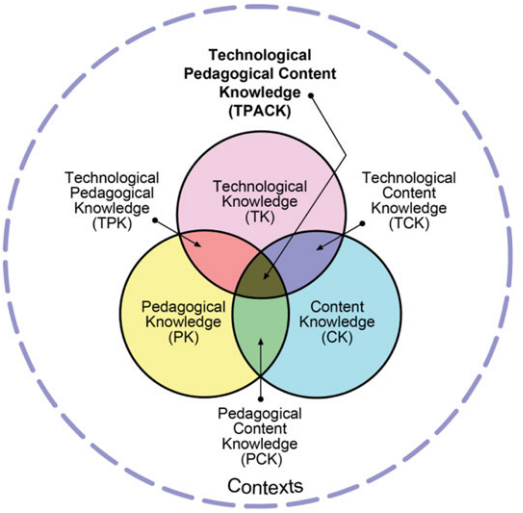


Figure 1. TPACK framework. Reproduced with the permission of the publisher, © 2012 by tpack.org

within a teacher's daily learning and teaching environments. It is also a long-term endeavor, lasting well into a teacher's in-service years. However, what remains to be articulated is precisely how teachers develop the complex knowledge base required for DDL implementation. The current study offers an integrative, situated model of DDL teacher training to monitor and hone this knowledge development for in-service second language writing (SLW) teachers.

2.3 The TPACK framework

The training developed for this study was designed in accordance with Mishra and Koehler's (2006) framework of TPACK. The TPACK framework provides a theoretical foundation for explaining the integrated knowledge that a teacher must possess to implement technology for meaningful learning (see Figure 1). TPACK, emerging from professional development research of faculty in higher education, is based on the premise that teachers possess multiple knowledge domains (i.e. technological, pedagogical, and content knowledge) that interact with each other as a complex system during the act of teaching. TPACK is an extension of Shulman's (1986) model of pedagogical content knowledge (PCK), with technological knowledge as an added construct.

In existing literature, TPACK has been applied to structure teacher education and to empirically investigate how teachers learn new skills and practices. TPACK is especially well suited to DDL teacher training due to its emphasis on both *situated knowledge*, or knowledge that teachers gain from practice (Angeli, Valanides & Christodoulou, 2016), and *situated practice*, which involves using one's knowledge directly in the classroom (McLaughlin, 1998). Importantly, the situated nature of teacher cognition cannot be extracted from its physical environment and studied in an isolated fashion (Kubanyiova & Feryok, 2015). Like DDL training, TPACK-based training should be orchestrated in a way that allows teachers to apply what they are learning directly to their teaching (Angeli & Valanides, 2009). Although few previous studies have applied the TPACK framework to design a corpus-based pedagogy workshop, the workshop design of the current study was influenced by various TPACK-based professional development initiatives (Jaipal Jamani & Figg, 2013; Lee & Kim, 2014; Koh & Divaharan, 2011; Tai, 2015).

This case study explores in-service SLW teachers' knowledge integration practices throughout their participation in a seven-week online DDL-TPACK workshop. During the workshop, each

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Table 1. Background of the participants

Teacher	Years teaching writing	Years teaching at the writing program	Position at the writing program
Maya	2	1	Graduate teaching assistant
Sabina	2	2	Graduate teaching assistant
Pinar	6	2	Graduate teaching assistant
Carlos	1	1	Graduate teaching assistant
Lydia	10	10	Career-track faculty
Alya	10	2	Graduate teaching assistant

teacher's use of DDL was explored through their lesson planning and reflective diaries to answer the following research questions:

1. What kinds of techniques and strategies do SLW teachers use when they integrate DDL in their classrooms?
2. How do SLW teachers apply TPACK when integrating DDL in their classrooms?

3. Method

3.1 Procedure

The purpose of this case study was to explore teachers' knowledge integration processes as they completed workshop activities. After inductively establishing a set of open codes, these codes were deductively aligned with the TPACK knowledge domains. Such a case study as this is exploratory, and results are not intended to be generalizable. The goal was to implement an online workshop that builds teachers' technological, pedagogical, and content knowledge of DDL for the SLW classroom. The principal investigator developed and facilitated the workshop and was, at the time of the study, a colleague (of equal rank) of each participant. The seven-week workshop, delivered via one southwestern US university's learning management system, occurred during the fall 2018 semester. Throughout the workshop, teachers developed and implemented DDL course materials using a variety of corpora, including MICUSP, the BYU-BNC corpus, Crow (https://writecrow.org/), COCA, and AntConc concordance (http://www.laurenceanthony.net/) software.

3.1.1 Participants

Six SLW instructors from the same southwestern university were recruited via convenience sampling for this study (Table 1). A departmental email was sent to all writing program instructors via an official listserv; 18 of these instructors were SLW teachers. The first six respondents who were (1) actively teaching SLW students during the workshop session and (2) had minimal previous exposure to corpus linguistics were selected to participate. Only one of the teachers, Sabina (all names are pseudonyms), had undergone formal training in using a corpus. Sabina was exploring the use of corpus techniques for her dissertation in rhetoric, but she was unfamiliar with corpus-based pedagogy. Carlos and Lydia had heard about corpus linguistics from past professors, but neither had attempted to use one in their teaching. No participants had used a corpus in their writing classes before the study.

All six teachers, five females and one male, taught English composition to international university students. Carlos, Lydia, Maya, Pinar, and Alya taught either English 106, 107, or 108 courses, designed exclusively for SLW students. The sixth teacher, Sabina, taught English 101, built for domestic students, but had several English learners in her course. Sabina was a

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PhD student in rhetoric and composition. Sabina and Lydia, a full-time writing program lecturer, were US citizens. Alya and Pinar were Turkish PhD students studying L2 acquisition and teaching at the university. Carlos, a master's student from Mexico, and Maya, a master's student from Brazil, also studied L2 acquisition. All teachers spoke fluent English and had at least one year of experience teaching English language skills.

3.1.2 Workshop design

The workshop was divided into seven modules, one module to be completed per week. Each module applied a TPACK construct to DDL pedagogy. Module 1, the content knowledge (CK) module, involved a theoretical overview of corpus linguistics. Activities included conducting simple corpus searches, analyzing concordances, and relating corpus linguistics to language learning. The second module covered pedagogical knowledge (PK) and emphasized DDL teaching strategies. Module 3, the technological knowledge (TK) module, introduced teachers to the digital tools required for teaching corpus techniques, including online corpora and concordance software. In this module, teachers were guided to perform such tasks as importing corpus data into the AntConc concordance program, running coded searches, and exporting concordance data into spreadsheets. Following this, the technological pedagogical knowledge (TPK), technological content knowledge (TCK), and PCK modules (Modules 4, 5, and 6 respectively) explored the intersections between knowledge domains (see Table 2). The final week of the series combined all knowledge domains (TPCK) as teachers finalized instructional materials, used them in the classroom, and reflected on the experience.

Each module began with an explicit discussion of TPACK to familiarize teachers with the knowledge domain targeted in that module. Following this were readings, activities, and interactive video lectures to engage teachers in pedagogical conversation about the module theme. During the final four weeks, teachers designed their own DDL activity sequence. They shared their activities with each other and offered feedback through asynchronous online discussions. At the end of each module, they reflected on what they had learned that week, created revision plans for their DDL activities, and submitted revised lessons from the previous week. This established an iterative redesign cycle within each module.

3.2 Data collection

Data collection included teachers' DDL instructional materials, reflections, and revision checklists. Each teacher participant created and piloted three DDL activities in their classes. Activity descriptions were posted to the learning management system (LMS) discussion board, where peers were assigned to provide feedback. Additionally, weekly reflective diaries were posted privately in the LMS. In these reflections, participants described what they had learned from workshop activities, and they created a revision checklist for the DDL activity they had taught that week. The prompts for DDL activities, reflective diaries, and revision checklists can be viewed online as supplementary material.

3.2.1 Instructional materials

During the third and fourth weeks of the workshop series, each teacher selected a topic, or several topics related to their writing course, and used these topics to develop a sequence of DDL activities for their classes. During Weeks 5, 6, and 7, they developed and tested one new DDL activity each week. For each activity, they received a template to guide their response. Activities and supplementary materials, like worksheets, were posted to the LMS and were downloaded, archived, and analyzed. An example DDL activity description can be found in Figure 2.

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Table 2. Corpus pedagogy workshop design

Module	Module learning outcomes	Learning activities
Module 1: Content Knowledge	• Define corpus linguistics • Describe the basic elements of a corpus • Identify basic corpus analysis techniques	• Video: Introduction to corpus linguistics • Reading: Defining corpus linguistics • Activity: Explore three corpus websites (BNC, COCA, and MICASE); analyze concordances • Module 1 Reflection
Module 2: Pedagogical Knowledge	• Distinguish between direct and indirect corpus pedagogy • Compare different techniques for applying DDL in the L2 writing classroom • Identify language features that you can use in corpus-based language teaching	• Reading: What is data-driven learning (DDL)? • PK VoiceThread: Analyze three pedagogical sequences from past DDL studies • Module 2 Reflection
Module 3: Technological Knowledge	• Generate search results using the Crow corpus and AntConc software • Perform basic analyses of corpus searches • Describe how to implement corpus technology to create learning activities	• Activity: Compare functionality of several corpus tools (Time Magazine Corpus, Google Ngram, and Just the Word) • Activity/Demonstration: Using AntCont and the Crow corpus • Module 3 Reflection
Module 4: Pedagogical Content Knowledge	• Assess the alignment of content and pedagogical approaches in DDL activities • Select appropriate pedagogical strategies to match DDL materials • Modify existing lessons to more effectively align content with a pedagogical approach	• PCK VoiceThread: Analyze DDL instructional content from two different researchers • Activity: Plan a 3-part DDL activity sequence and exchange peer feedback • Module 4 Reflection
Module 5: Technical Content Knowledge	• Evaluate the alignment of DDL materials with the available corpus tools and classroom context • Design methodologically sound DDL teaching materials for classroom use • Relate corpus-based lessons to authentic context of your instructional settings	• TCK VoiceThread: Demonstration/Discussion of two online corpora (ASLA and MICUSP) • Flipgrid: What's Your TCK? • Activity: Design DDL Activity 1 and exchange peer feedback • Implement DDL Activity 1 in class • Module 5 Reflection and Revision Checklist
Module 6: Technical Pedagogical Knowledge	• Assess the alignment of technology and pedagogy in DDL instruction • Examine problems and solutions for using corpus technology when teaching • Refine your sequence for implementing DDL into your classroom	• TPK VoiceThread: Assess alignment of technology and pedagogy in DDL instruction • Flipgrid: TPK Problems & Solutions • Activity: Design DDL Activity 2 and exchange peer feedback • Implement DDL Activity 2 in class • Module 6 Reflection and Revision Checklist
Module 7: Technological Pedagogical Content Knowledge	• Integrate your corpus-based materials into your classroom • Evaluate how you applied your knowledge to develop and implement your activities • Modify existing lessons to more effectively align content and pedagogical approach with use of technology	• TPCK VoiceThread: Share one of your DDL activities; analyze the TPACK involved • Activity: Design DDL Activity 3 and exchange peer feedback • Implement DDL Activity 3 in class • Module 7 Reflection and Revision Checklist

DDL Activities

Context: Now that the students have examined their project prompt in detail, brainstormed and proposed about the argumentative essay they will work on, analyzed sample argumentative essays, and practiced using MLA/APA formatting style, they are ready to work on their drafts. It will be a good time to have some corpus activities regarding how to integrate sources into their essay using various reporting verbs correctly before they start drafting their paper.

Activity 1: What reporting verbs do we use the most in academic writing?

Learning objective:

Students will be able to list the most frequently used reporting verbs in academic writing.

Resources: AntConc corpus software; Laptops; Projector

Procedure

Before class:

- Iwill create a folder of sample scholarly articles on various issues (15-20 articles)
- I will make an announcement on D2L for the students to download AntConc and the folder I created on their laptops and share the steps to follow to do so.

In class:

- I will show and explain what AntConc is (assuming that it will be their first corpus activity and they have already uploaded the software on their laptops) and how to see the words in a collection listed according to their frequency.
- Once I run the search (projecting on the board), I will repeat the process as the students will follow the steps. I will ask which of the verbs they see listed could be considered as reporting verbs.
- Students will discuss the possible reporting verbs in small groups and double check them by running a quick Google search.
- Students will list all the reporting verbs they see in the corpus and identify the most frequently used one (top 3).

Figure 2. Alya's DDL Activity 1

3.2.2 Teacher reflections

In weekly reflective diaries, teachers described what they had learned during the workshop activities. In Modules 4–7, teachers critiqued their own DDL activities, reflecting on how the activities were applied in the classroom. They also reflected on peer feedback from other participants' DDL activities, following prompts to guide their reflections.

3.2.3 Revision checklists

Along with weekly reflections, for Modules 5–7 of the workshop, each teacher submitted revision checklists for the DDL activity taught that week. The following week, they submitted their revised activity for feedback. An example of a participant reflection and revision checklist can be found in Figure 3.

3.3 Data analysis

Data analysis consisted of two consecutive phases of coding. The inductive phase involved open coding (Saldaña, 2013), and the deductive phase involved selective coding, using TPACK precodes (Lee & Kim, 2014; Simons, 2009) derived from the definition of each knowledge domain (see Table 3). To ensure reliability, the principal investigator recoded her data two months after the initial coding occurred.

To answer the first research question, explaining each teacher's DDL approach, teacher-created course materials and revision checklists were analyzed. An initial round of open coding targeted how each teacher developed their DDL activities. This open coding resulted in five codes: course

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[redacted]
25 October 2018

Module 5 Reflection

Part 1: I did my first activity in my ENGL 102 class yesterday, and it was overall helpful. We had some hiccups, which I'll talk about below, but overall they thought it was beneficial. I agree with [redacted] assessment of my first activity under Discussions. I am trying to achieve a lot, so I need to cut some things so that my students can actually accomplish these tasks in the remaining weeks. As for the activity in class, my students were split on if I had spoken a written or spoken argument. They quickly found spoken and written arguments and converted them into non-identifying texts for the shared Google folder, and they had a fun time guessing which were spoken and written arguments. They even had rich insights for the discussion questions. However, in their assessment, many of them guessed wrong if a text were spoken or written. I attribute this to my absent instruction on genre. We focus a lot on audience awareness in class, but I think genre awareness would have been a more beneficial pre-lesson. My students also gave some vague responses like, "questions are used in both written and spoken argument." When I asked for follow-up, they couldn't really answer fluidly. Perhaps that's due to situational factors, but regardless, I would revise my questions and instructions to yield more specific responses.

Part 2: Revision Checklist

- Learning Outcome: How do rhetorical strategies manifest in written arguments? How do rhetorical strategies manifest in spoken arguments?
- Instructions would be fairly the same. But I would revise some discussion questions
  - Identify if the texts you chose are spoken or written arguments. How do you know?
  - What are phrases common in both written and spoken arguments? **Revision:** List the ways rhetorical strategies are used in spoken and written arguments.
  - What phrases are different? **Revision:** How are the rhetorical strategies used differently?
  - How is tone similar or different? **Addition:** What specific ways let you know the tone is a informal/formal/casual/academic?
  - How is the delivery of examples used in the texts similar or different? How are they told differently?
  - How does this activity help you prepare for your presentation?
  - **Addition:** What conclusions about language use can you draw from this activity?
- The assessment would stay the same: informal assessment seeing if students mention key words/phrases/concepts in their small and big group discussions (i.e. audience awareness, register, formal and informal language, genre conventions)

Figure 3. Sabina's Module 5 Reflection.
Note. Higher resolution versions of this figure can be viewed online as supplementary material

embeddedness, lesson focus, corpus analysis, corpus tools, and content representation (see Table 4). These five open codes were discovered through an exploratory process that began by reading each text and adding general comments in the margins. Eventually, categories were designated for each comment, and through constant comparison of these categories, open codes were identified.

Open codes were analyzed for each teacher and then summarized across teachers. In the process of comparing codes across teachers, two dominant themes emerged, distinguishing each teacher as either an "Planner" or a "Seeker." The Planner/Seeker patterns arose organically, based on the repeated observation that each teacher was either orchestrating DDL activities to support one main pedagogical goal or, conversely, they were using the DDL activities to explore a variety of pedagogical goals.

For the second research question, regarding the teachers' use of TPACK, DDL open codes from RQ1 were mapped to the TPACK pre-codes and triangulated with teachers' reflective diaries. In this mapping process, each open code was paired with the TPACK knowledge domain with which it was most closely aligned (see Table 4). Teacher's reflections were layered into the analysis to provide insight into underlying knowledge processes.

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Table 3. TPACK pre-codes

Knowledge domain/pre-code	Description
Content knowledge (CK)	Knowledge of area of instruction; curricular knowledge; for L2 instruction, knowledge of the target language and its culture (van Olphen, 2008)
Pedagogical knowledge (PK)	Knowledge of general (not discipline-specific) processes and methods of instruction; general knowledge of learners
Technological knowledge (TK)	Knowledge of functional use of digital technologies in both professional and personal contexts
Technological content knowledge (TCK)	Knowledge of reciprocity between technology and content (Mishra & Koehler, 2006); for language teaching, using technology to represent cultural and linguistic knowledge (van Olphen, 2008)
Pedagogical content knowledge (PCK)	Knowledge of the interpretation, reformulation, and adaptation of content for teaching (Koehler & Mishra, 2009); transformation of subject-specific representations "to make the content more comprehensible to students" (Graham, Borup & Smith, 2012: 532)
Technological pedagogical knowledge (TPK)	Knowledge of technology adaptations for teaching processes and pedagogical approaches
Technological pedagogical content knowledge (TPACK)	The "thoughtful interweaving of all three key sources of knowledge" (Mishra & Koehler, 2006: 1029); for language teaching, understanding of the target language "at the phonological, morphological, lexical, semantic, programmatic and discoursal levels" and the use of technology to represent this understanding (Debbagh & Jones, 2017: 746)

4. Results

The participating teachers brought their unique backgrounds and teaching experiences to the corpus pedagogy workshop. Despite individual differences, two distinct knowledge integration approaches were discovered. Teachers tended to develop their DDL sequences either as Planners, who "stuck to the script" that they had prepared in advance, or as Seekers, who experimented with a patchwork of tools and techniques for teaching writing in a more improvisational manner.

It is important to acknowledge that Planner/Seeker approaches represent dual ends of a descriptive spectrum rather than strictly categorical or mutually exclusive phenomena. They describe trends found in the data, not the teachers themselves. Within the context of this workshop, some teachers displayed more Planner attributes, and others displayed more Seeker attributes. In this section, the open codes are used to characterize the Planner and Seeker paths to DDL knowledge integration, followed by a discussion of how the knowledge domains of TPACK were used when implementing DDL.

4.1 Lesson focus, corpus tools, and corpus analysis

The so-called Planners (Sabina, Lydia, and Alya) exhibited consistency and cohesion of corpus tools, corpus analysis, and lesson focus across their DDL activities. The Seekers (Maya, Pinar, and Carlos), conversely, experimented with myriad representations of instructional content and used various digital tools, corpus analysis techniques, and lesson topics across their three DDL activities.

As for her approach to DDL integration, Lydia offered clear signs of a Planner. She experimented less than the other teachers but compensated for this with consistency. In each activity, she utilized the same corpus (COCA), explored the same grammar point (prepositions), and employed the same analysis technique (concordance). Each lesson was reinforced through homework and in-class review at the start of the subsequent lesson. Similarly, Alya designed her three activities around the same lesson focus (reporting verbs), employing similar analyses

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Table 4. Open codes and pre-codes

Open code	Description	Example	TPACK pre-code + explanation
Course embeddedness	How data-driven learning (DDL) activities relate to course curriculum	Lydia: "As the students generate their public arguments, they will analyze 1–2 paragraphs and identify the prepositions they use and explain the function of them with the surrounding words."	PCK: Reformulating corpus content to achieve curricular goals Lydia uses her DDL activities to scaffold teaching the public argument, an assignment defined in the course syllabus.
Lesson focus	The lexico-grammatical purpose of each activity	Pinar lesson focus: "Identify the meanings of *be allowed to* and *be supposed to*."	CK: Curricular knowledge of L2 writing for a specific group of students; corpus linguistics knowledge Pinar uses L2 curricular knowledge to identify challenging lexical constructions and corpus linguistics knowledge to select a DDL lesson focus.
Corpus analysis	Corpus analysis techniques used	Carlos: "By using an asterisk, I can search for the suffixes and prefixes. *fire (misfire) sleep* (sleeping). So maybe students can see some grammatical patterns which could help their writing."	PK (process): Knowledge of how to construct a DDL activity TPK (technique): Knowledge of how to use corpus technology to construct a learning activity Carlos understands that using an asterisk in a corpus search engine allows him to teach students about affixes (TPK). He explains how he demonstrates this learning activity to his students (PK).
Corpus tools	Corpus tools used	Sabina: "For this activity, they will explore AntConc by . . . "	TK: Knowledge of functional use of digital corpora Sabina has adequate knowledge of corpus tools to select one for her DDL activity.
Content representation	How DDL activities were conveyed to students	Carlos: "Class game: I will provide one word at a time (ppt) and student teams have to write what they think is the most common prefix and/or suffix [for that word]." *After they guess the suffix, students consult the corpus to find the most common affix.*	TCK: Knowledge of reciprocity between content representation and corpus tools when teaching L2 writing Carlos combined multiple digital tools (PowerPoint and the corpus) to create instructional content that teaches students about affixes.

(concordance) in her final two activities, and using the same corpus tools (AntConc and a self-developed mini-corpus of academic journal articles) in all three activities. Sabina developed a three-part lesson on register variation and used the same corpus (student-developed mini-corpus of spoken and written arguments) across all three activities, although her topic evolved slightly, from general register variation to a more focused rhetorical exploration of questions in written versus spoken language.

Carlos, in contrast, clearly exhibited the characteristics of a Seeker. His first lesson focused on the syntax and rhetorical functions of pronouns, determiners, and verbs across multiple genres (e.g. annotated bibliography, interview report, argumentative paper) using the Crow corpus. His second activity explored syntactic patterns accompanying affixes, using the BYU-BNC corpus, and his final activity was a syntactic analysis of random words selected by his students, allowing their choice of either MICUSP or Crow as a corpus tool.

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Like Carlos, Maya leapt from Crow to MICUSP mid-sequence. Her analysis techniques transitioned from concordance to frequency to genre analysis, although she held a consistent focus on conjunctions as a lesson topic. Pinar dabbled in specific lexical constructions ("be allowed to" and "be supposed to") in her first activity, coordinating conjunctions in her second activity, and rhetorical analysis of source integration in her third activity. She also transitioned from COCA and Crow to the MICUSP corpora as her topics evolved.

Interestingly, Planners began creating DDL activities by assessing students' writing needs, whereas Seekers implemented dynamic assessment methods, learning about students' needs as their courses progressed. Lydia, a Planner, noted in her second reflection, "I have just finished reading my students' rhetorical analysis essays, and I have a list of language features where I think DDL would be helpful." She chose one of those language features, prepositions, and used it in all three lessons. Lydia asked her students, who "indicated a desire to gain more proficiency with prepositions," to help her choose the topic for this assignment. Thus, she was able to embed DDL content into the writing curriculum while also being responsive to student needs. Similarly, Alya, when planning her first DDL activity, "put myself into the shoes of the students when I decided on what kind of activities would work."

On the other hand, Pinar, a Seeker, reflected on how, throughout the workshops, she had gradually sharpened her focus on her students:

> . . . when we first talked about a DDL sequence, I did not think critically about the needs of my students. However, as time went by, I deduced (and even asked my students) what would be important to study in the class as a corpus DDL activity.

Meanwhile, Carlos structured his DDL activities in a way that allowed his students to "take the lead and discuss their own grammatical problems and ways that they could use corpus."

In addition to lesson focus, corpus technology was another distinguishing factor. Generally, Planners selected technology to help them meet predetermined pedagogical goals. Alya's decisions about corpus tools were based on her pedagogical goal of showing students "how reporting verbs could be explored in an 'academic' corpus." She had initially intended to create her own corpus and analyze it using AntConc, but when she realized that she could analyze academic writing with the COCA corpus, she incorporated this corpus into her activity plans, noting her fear of technical constraints:

> I was also afraid to use AntConc because in case of a failure that the students could have experienced while downloading the program. I would probably not be able to help them, which could ruin all the following activities.

Planners expressed trepidation over using tools with which they were not yet entirely comfortable. As Lydia explained, "I am the type of learner who needs to review unfamiliar things, like certain technology, several times in order to feel comfortable using it."

Seekers, on the other hand, were content to experiment with new technologies, to take risks, and to learn from them. They were also more open to defining pedagogical goals spontaneously as they went along. Carlos, reflecting on his final activity, in which he gave his students a choice of three corpora (COCA, MICUSP, and Crow), wrote, "I liked giving them a chance to go and choose their own." Pinar, who tried each tool presented in the workshops, spontaneously transitioned from COCA to Crow in the middle of her first activity because she realized during the writing lesson that she wanted students to compare native speaker language use (in COCA) with English learner use (in Crow). Although she felt that "it would be better to use one platform," Pinar also believed introducing multiple corpora gave her more troubleshooting options. Finally, Maya, who experimented with both Crow and MICUSP, noticed that Crow exposed students to genres that they were using in their English course, whereas MICUSP offered authentic "examples of texts from disciplines [students] are pursuing in their majors."

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4.2 Course embeddedness

Course embeddedness, or the extent to which the DDL activities were integrated into the writing course curriculum, was another point of distinction between Planners and Seekers. Planners tended to embed DDL activities into their courses by connecting them to major writing projects. Lydia, for instance, integrated her DDL sequence into a public argument assignment, explaining in her final reflection that embeddedness had been a long-term predetermined goal:

> My understanding of corpus-based teaching has changed in that I have learned to scaffold and to incorporate the activities into the rest of the unit. I know this may sound obvious, but it was not until this workshop that I began to realize the importance of this organization and implementation.

Alya, another Planner, developed a three-part lesson on reporting verbs to prepare her students for the upcoming argumentative essay assignment, stating she hoped these activities would help students "integrate sources into their essay using various reporting verbs." The third Planner, Sabina, explained that her corpus activities would guide students to "understand how questions function rhetorically [to] help them prepare for [their graded] presentation."

Seekers, however, targeted language issues not explicitly linked to course content. Pinar did not explain her topic selection, but Carlos described how his second activity resulted from his general perception that "prefixes and suffixes are a big part of the English language, and I know that some students study them heavily to get good scores on the TOEFL test." In his third activity description, Carlos expressed that he was less concerned about targeting a specific grammar point than cultivating students' "general appreciation/understanding of corpus, so that they might use it later in their academic careers."

Maya's activity selection was not embedded into the writing course per se, but it was based on her assessment of student needs ("I have noticed that conjunctions are tricky for most of them, [so] I prepared a lesson about that grammar topic"). In her final activity description, Maya stated that her current and previous activities were meant to support students in completing their argument narrative assignment and their rhetorical analysis essay, but this connection was not stated in earlier activity descriptions or reflections, which suggests that Maya, a Seeker, gradually began to embed her DDL activities into the curriculum.

Like Planners, Seekers were concerned with course embeddedness, although their course content showed that they did not practice it as much as the Planners. Pinar reflected on her attempt to connect her final DDL activity to other course content, though she had not mentioned this in previous activity plans. Carlos considered embedding DDL activities into his course *before* he developed his lessons, but he did not ultimately do so. Maya expressed that she was concerned with embeddedness, but she was uncertain how to achieve it. This suggests that Seekers were actively thinking about ways to pursue course embeddedness, although this practice was not clearly reflected in their DDL content.

4.3 Content representation

Regarding content representation, Planners were more likely to use computer-based approaches whereas Seekers preferred paper-based methods. In one reflection, Alya wrote of paper-based materials: "I do not prefer to use such mechanical practices in my classes, as I do not see them as authentic enough for the students." Sabina also explained that her students tended to use computers in her class, though she did not explicitly connect this to her decision for computer-based DDL. Lydia, however, transitioned from a paper-based to a computer-based approach. While her first DDL activity was paper-based, her second was computer-based because she had not found the time to create a worksheet before the lesson. She was surprised that her

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pacing had improved without the worksheet, remarking that "it worked out for the best." So she continued with computer-based content for her third activity.

Conversely, Pinar, a Seeker with some Planner attributes, initially expressed a preference for computer-based DDL because she saw it as more "flexible and enhanced." However, she ultimately transitioned to using paper-based worksheets for all three DDL activities, finding the worksheet approach extremely useful for classroom management ("Everything went well as I used a worksheet again. The students followed each step with me. I was able to control the students."). Other Seekers concurred that paper-based approaches were easier and safer options. Carlos elaborated on this sentiment, stating his intention to "start with a paper corpus [activity] just to get students – and myself – a bit more comfortable with corpus." Maya also wrote, "Based on the context of my class and on the fact that students are novice to corpus, I would use paper-based resources."

5. Discussion

From the Vygotskian (1987) perspective, concept development becomes unified when teachers integrate a coherent set of ideas and practices into their daily routines. The current study uncovered the knowledge processes of six in-service SLW teachers as they attempted to integrate new and complex concepts into daily praxis. Although the teachers expressed and demonstrated knowledge gains after completing the workshop, the concepts embodied by corpus pedagogy had not yet been united into a coherent system for them.

The main finding of this study is that teacher participants tended to follow one of two overarching patterns of knowledge integration using corpus tools in the classroom. They either planned a coherent DDL sequence, or they experimented with a variety of corpus tools, techniques, and pedagogical goals. Notably, all teachers strove for *embeddedness*, though Seekers did not generally achieve it to the degree that the Planners did. Perhaps the curiosity to explore a variety of tools and techniques deprioritized course embeddedness for Seekers. Teacher reflections suggest that some Seekers simply did not know how to embed their DDL activities into their courses effectively, despite their motivation to do so. At least once during the workshop, each teacher expressed a desire to integrate DDL activities into the writing curriculum. This is a promising finding, as syllabus integration is a laudable goal within the field of DDL research (Crosthwaite, Luciana & Schweinberger, 2021; Pérez-Paredes, 2022). Ultimately, the ability to meet such a goal was likely impacted by contextual factors like teaching experience. Lydia and Alya, who displayed the most dominant Planner attributes, had each taught writing for 10 years at the time of the study. The Seekers, Maya and Pinar, had taught SLW for two years, and Carlos had taught for only one year.

Finally, it is important to reiterate that the Planner–Seeker spectrum describes knowledge integration processes based on empirical data; this does not encompass the more complex notion of teacher cognition, which, according to Borg (2015) includes "what language teachers think, know and believe" (p. 1). Teachers' internal processes are complex and dynamic (Feryok, 2018) and often lead to inconsistencies that cannot be categorically reduced. For example, there were instances when Seekers, like Maya, displayed Planner attributes by eventually embedding her DDL activities into regular course content. In other instances, Planners, like Alya, who changed her selection of corpus tools after learning more about them, acted as Seekers. As this was a case study, it was meant to be exploratory and hypothesis generating rather than generalizable to all SLW teachers.

6. Implication and suggestions

Everyone learns differently, but when teacher-developed content and teacher reflections are analyzed, patterns emerge. The fact that all teachers wanted to embed new practices into their existing curriculum suggests that syllabus integration could be a goal for future in-service teacher

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training initiatives. However, trial and error is equally, if not more, important than embeddedness to some teachers. Considering this, it is advisable for future DDL teacher trainings to provide space for exploration while scaffolding explicitly toward course embeddedness.

Another important finding of this study is the clear need for long-term teacher support, especially considering the complexity of DDL. Although each teacher progressed in their knowledge and application of DDL during the workshop, this progress was sometimes hampered by frustration. Like previous studies (Abdel Latif, 2021; Çalışkan & Gönen, 2018), the teachers acknowledged their increased language awareness through their participation in the workshop while also reflecting on their difficulties navigating corpus technology. One conclusion, similar to Leńko-Szymańska's (2014), is that SLW teachers need long-term guidance to fully conceptualize and implement corpus-based techniques. Seven weeks, or even a full semester of training, may not be enough. On an optimistic note, in correspondence with Ebrahimi and Faghih (2017), these struggles evoked metacognitive awareness and inspiration to continue using corpora in the classroom. In her final reflection, Alya summarized the general sentiment expressed by most participants:

> These seven modules have provided me with a brief introduction to the use of corpus in language classes. I cannot say that I feel very confident now about the use of corpus tools in my classes, or I know how to use them exactly for various purposes, yet I believe that I had a nice mini step into the corpus world, and it is a matter of creativity and practice from now on.

7. Conclusions and limitations of the study

This workshop offered in-service SLW teachers a situated professional development opportunity to integrate DDL into their teaching. Its main contributions are twofold. First, it applied an empirically validated framework of teacher knowledge to structure the workshop and to analyze how teachers approached DDL activity design in response to workshop guidance. Also, it identified two possible pathways to teacher knowledge development, as either Planners or Seekers. These knowledge integration approaches support the notion of differentiated structures for teacher education. As Harris (2016) noted in her review of TPACK professional development models, there is no "one-size-fits-all" approach. Teacher educators should consider the full range of professional development approaches and methods to suit a particular context.

While this study has contributed some valuable results to the literature, there were several limitations that should not be ignored. An important part of teacher education research is the setting in which the teaching occurs (Cook, Smagorinsky, Fry, Konopak & Moore, 2002). Much teacher cognition research has explored the "ecologies of teachers' inner lives without considering how this connects to student learning" (Johnson & Golombek, 2020: 125). Although the current study applied a situated approach to the workshop design, it did not consider each teacher's actual teaching environment. Future studies might observe DDL activities within a classroom setting, evaluating the connection between teachers' experiences in the workshop and their students' learning. Moreover, while this study yielded insight into the knowledge integration processes of SLW teachers, the data analysis did not focus on the efficacy of the workshop. A future study could adopt a design-based approach to evaluate the workshop according to the Planner/Seeker patterns identified in this study.

Finally, this study merely grazes the surface regarding the complex relationship between corpus-based pedagogy and the university SLW teachers' TPACK. Not only were the teachers grappling with new pedagogical and technological knowledges, but they were also sifting through multiple layers of content knowledge (i.e. language acquisition, university writing, corpus linguistics), along with pre-existing teaching, learning, and language ideologies. Future DDL research could probe more deeply into the complex web of teacher ideology, practice, and knowledge.

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