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Gary G. Fogal [ID]

Faculty of Liberal Arts, Sophia University, Tokyo, Japan

ABSTRACT

This work examines how system mapping, an established exploratory and analytic technique grounded in complex dynamic systems theory, can operate as a heuristic to increase learners' language awareness (LA) and develop their L2 writing proficiency. Accordingly, this study addresses repeated calls in the instructed SLA literature for effective research methods that directly serve learners at the point of enquiry. That is, although related research often foregrounds learners and pedagogy rather than theoretical abstraction, questions remain about how participants benefit at the time data are collected. To explore this concern, this work engaged system mapping through a LA pedagogy and followed two intact university classes (one using system mapping, and one not: $N = 30$) over one semester. Comparative quantitative and qualitative analyses of learners' narrative reflections and academic essay writing highlighted that system mapping facilitates the raising of learners' LA in service of developing their writing. This work demonstrates how system mapping capitalizes on learning theories that support image-schematic interventions and underscores how system mapping engages with and advances LA pedagogy in service of researchers, instructors, and students alike.

PLAIN LANGUAGE SUMMARY

Studies on second language (L2) learning often focus on theory or fine-tuning teaching practice. However, the research tools employed (e.g. classroom observations or fill-in-the-blank tasks) sometimes offer little benefit for student participants. Accordingly, researchers have repeatedly called for new exploratory techniques that help students improve their L2 while they are being investigated. To address this concern, the present study explores the potential of *system mapping*—a research tool typically reserved for investigating how L2 learning unfolds—as a teaching instrument. This work examines the following questions: Can system mapping increase learners' awareness of the different ways language works as a communicative tool? If so, will increasing learners' awareness result in students becoming stronger writers? To answer these questions, this study followed two university classes for one semester (one that used system mapping as a teaching tool and one that did not). To explore differences between the two groups, writing assignments from both classes were collected in the first and last week of the semester, and language awareness measures were collected three times during the term. The dataset was compared

CONTACT Gary G. Fogal ✉ ggfogal@sophia.ac.jp 🖳 Faculty of Liberal Arts, Sophia University, 7-1 Kioi-chō, Chiyoda-ku, Tokyo, 102-8554, Japan.

across the two groups using statistical and non-statistical analyses. The findings show that system mapping helps students better understand how language works, and that such insights translate positively onto students' writing. Collectively, these findings demonstrate that system mapping can (1) raise students' language awareness in service of L2 writing and (2) act as an effective tool for learners, instructors, and researchers alike.

ABSTRACT (日本語; JAPANESE)
この研究では、複雑動的システム理論に基づいて確立された探索的および分析的手法であるシステム・マッピングが、学習者の言語認識を高め、L2ライティング能力を向上させる発見的問題解決法としてどのように機能するかを検証する。したがって、この研究では、研究の時点で学習者に直接役立つ効果的な調査方法を求め、関連するSLA文献で繰り返し求められている問いを解決するようつとめる。その問いとは、関連研究では理論的な抽象化よりも学習者やペダゴジーを前面に打ち出すことが多いものの、データ収集時に参与者がどのようなメリットを得られるかについては疑問が残るというものである。この疑問に答えるため、この研究では言語認識ペダゴジーを通じてシステム・マッピングを利用し、1学期にわたり2つの大学のクラス (システム ・マッピングを使用するクラスと使用しないクラス: N=30) を調査した。学習者自身による振り返りとアカデミック・エッセイ・ライティングを量的および質的に比較分析した結果、システム・マッピングが学習者の文章力の向上に役立つ言語認識を高めることが明らかになった。この研究は、システム・マッピングがいかにイメージスキーマの介入をサポートする学習理論を活用しているかを実証する。また研究者、指導者、学生に役立つように、システム・マッピングが言語認識ペダゴジーとどのように関わり、それをどのように進歩させるかを強調する。

Introduction

Instructed SLA scholarship has long considered how research methods serve the learners we probe, specifically at the point of enquiry (De Costa, 2015; Gosden, 1998; Ushioda, 2021). However, while research sometimes foregrounds learners and pedagogy rather than theoretical abstraction, concerns remain about how the participants of such studies benefit (Hiver & Al-Hoorie, 2020; Ushioda, 2021). For instance, experimental studies and classroom observations may yield meaningful long-term findings about best-practice conditions, but the stakeholders involved in said research practices often fail to benefit from being probed or observed. Accordingly, Ushioda (2021) highlights the need for researchers (and researcher-practitioners—see too Sato et al., 2021 and Sato & Loewen, 2022) to move beyond a myopic focus on the quality and reliability of our research instruments and to focus too on 'the pedagogical value and potential of these tools' (p. 278). As Ushioda and others (Rose, 2019; Sato & Loewen, 2019) argue, integrating the concerns of researchers (informing theory) and teachers (facilitating learning) lays the groundwork for sound ethical practice that can serve learners at the point of data collection. To address this concern, this paper explores the potential of system mapping to double as an effective teaching *and* learning resource.

System mapping is an exploratory and analytic technique in applied linguistics and teacher-training contexts (Ell et al., 2017; Fogal, 2020, 2022, 2023; Ludlow et al., 2017). As a diagramming technique, system mapping capitalizes on the well-established benefits of

visual-spatial learning (Czuchry & Dansereau, 1996; Jonassen, 1996; Novak & Gowin, 1984). For example, visual-spatial images (e.g. flow charts and Venn diagrams) are known to work with memory load to preserve large chunks of information in the short (Mathewson, 1999) and long term (Pintoi & Zeitz, 1997), and can be used by instructors as a heuristic to test learner comprehension (Evagorou et al., 2015; Phillips et al., 2010). With system mapping, stakeholders (e.g. administrators, instructors, and students) employ a mapping board to visually consider the strength of influence of a variable set on a phenomenon of study and how said variables interact to guide administrative, teaching, and learning outcomes (the application of the technique is unpacked in the *Method* section).

As a diagramming activity, the promise of system mapping as a L2 teaching resource is not without precedent. Early research has established the utility of visualizing the language learning process as a heuristic for language development. Research in cognitive linguistics (Boers et al., 2008; Langacker, 1987), a Vygotskian approach to sociocultural theory (Lantolf & Poehner, 2014; Masuda et al., 2015), and L2 writing scholarship (Fogal, 2017; Gosden, 1998; Negretti & McGrath, 2018) attest to this. Further, previous studies into mapping tasks specifically (Kane & Trochim, 2007; Ojima, 2006; Wette, 2017) underscore the effectiveness of image-schematic structures as meaningful L2 learning resources, with L2 writing studies in particular highlighting how said heuristics can develop students' awareness of their writing spaces (a concept discussed in the next section). This focus on image-schematic structures echoes the sentiments of Wette (2017) insofar as system mapping aims to move students' awareness of the writing process beyond one locked on conventional attention to macro (e.g. discourse) and micro (e.g. lexical) features in service of developing a broader schema of the writing space that students can employ, as Wette notes, to inform their writing process.

To explore and operationalize system mapping, the current study pairs with a sub-discipline of SLA studies that focuses on language awareness (LA) and language learning (unpacked below). LA research frequently examines how raising learners' metacognitive awareness of meaningful aspects of language learning (e.g. syntax, morphology, bilingualism, and language ideologies) can serve L2 development (Chen & Ren, 2022; Ruan, 2014). In this study, a LA approach to L2 writing instruction—an area of research where system mapping has shown relevant promise (discussed subsequently)—is explored in a Japanese university where English is the language of instruction. While related L2 writing studies certainly explore LA issues, said methods are primarily limited to genre awareness-raising activities (Cheng & Tsang, 2022; Henry & Roseberry, 1999; Negretti & McGrath, 2018) and reformulation and text reconstruction tasks (Adams, 2003; Swain & Lapkin, 2002; Yang, 2016). However, the success of calls like that of Ushioda (2021), among others (De Costa, 2015; Hiver & Al-Hoorie, 2020), for research to serve learners at the point of enquiry, rely heavily on generating new tools that can support researchers, teachers, and students alike. The present study, then, explores the potential of system mapping as an instructional resource capable of informing LA scholarship and the teaching-learning landscape. More specifically, this work looks at how system mapping can advance learners' LA of their developing L2 writing proficiency and examines if said application functions to improve different L2 writing constructs. To facilitate these aims, the following questions guided this study: (1) To what extent, if at all, does system mapping increase L2 learners' awareness of the writing space?, and (2) If system mapping increases L2 learners' awareness of the writing space, to what extent does this increase advance learners' writing proficiency? Using system mapping to explore these issues will address concerns raised by Ushioda (2021) and colleagues, and may provide relevant stakeholders (i.e. researchers

exploring learning processes; instructors facilitating learning; students advancing their L2 proficiency) with a meaningful, shared tool to achieve their goals.

System mapping

Grounded in complex dynamic systems theory, system mapping was originally designed to probe the unwieldy and expansive nature of teaching-learning landscapes through the lens of various stakeholders. The aim of such probing is to better understand the dynamics of diverse educational environments and to offer such spaces evidenced-based solutions for their unique concerns or goals. System mapping helps achieve these goals by laying bare how different stakeholders perceive the educational space to unfold, interact, and organize. To exemplify this, Figure 1 provides a sample system mapping board taken from the current study (a detailed account of how system mapping is conducted is provided in the *Method* section).

As Figure 1 suggests, a completed system mapping board provides an image-schematic structure of an educational space, taking advantage of the affordances that accompany diagramming activities, as discussed above. In doing so, system maps allow researchers to reimagine the study of teaching and learning in ways that reflect the dynamic and expansive nature of such spaces (Koopmans, 2020; van Geert & Steenbeek, 2014). This vast perspective is made possible because stakeholders are asked to consider conventional features of the learning space (e.g. teacher-student dynamics, reading habits, motivation, lexico-grammatical forms) alongside those variables that expand beyond classroom borders (e.g. family relations, school administration, private tutors, writing centers, previous school experiences).
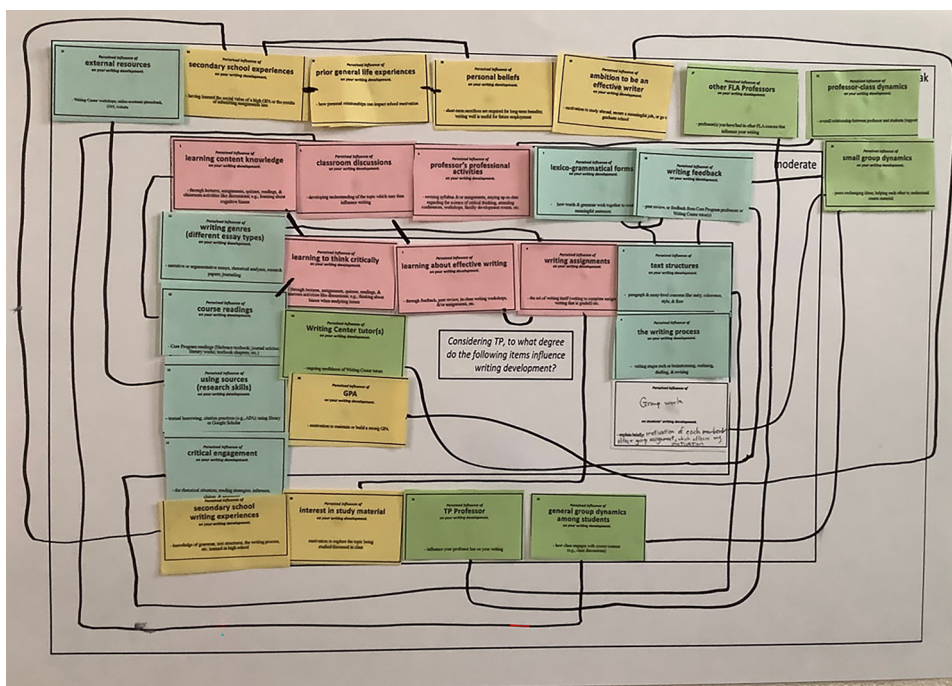
Figure 1. Sample of a completed system map.

As a research tool, system mapping can focus researchers' attention on 'powerful system processes where useful, and previously unexplored, explanations may be found' (Cochran-Smith et al., 2014, p. 26). In the L2 context, this shift in focus away from language performance may provide insights into what or how best to guide language learning. For example, in a Thai university actuary science program, system mapping helped document de-centralized system behavior (e.g. faculty-wide adherence to a writing-across-the-curriculum pedagogy) that assisted L2-English students to meet their educational goals (Fogal, 2020). Here, system mapping revealed positive system behavior that was already guiding successful learning and provided administrators a principled reason to continue to train new faculty in said pedagogy. In contrast, in a Japanese liberal arts context, system mapping helped identify gaps in L2 writing pedagogy that the author (Fogal, 2022) recommended needed attention at the administrative level (e.g. through workshops or faculty exchanges). In these examples, system mapping invites individuals to explore an educational space through image-schematic structures in ways that reveal relations and co-dependencies that they may or may not be explicitly aware of. In this manner, system mapping may function to generate situational and operational awareness, both key modes of awareness in a LA pedagogy. The former focuses stakeholders on a broadly defined classroom space (e.g. group dynamics or interest in the study material), while the latter targets learner and instructor-focused discovery and analysis (e.g. note-taking skills or using corrective feedback). (See the subsequent section for a discussion of a LA pedagogy).

In this particular vein and germane to the present work, other studies using system mapping have emphasized the technique's potential to raise students' LA in service of L2 development. For example, and among other similar instances, in informal discussions about the growth of her writing and in reference to system mapping, a student in a different but overlapping research project noted, 'After we did the first [system] mapping activity… I mean before we did it, I didn't give this [how variables interact] much thought. But afterwards, working in groups and talking about the essays, I could see so many variables working to help us compose'. These and other students in Fogal (2020) address the latent potential of system mapping to expand their awareness of the learning space in service of their writing development. However, the prospect of system mapping as a tool for raising LA has never been formally explored and informs a central aim of this paper.

Language awareness

The Association of Language Awareness defines LA as follows: **'explicit knowledge about language, and conscious perception and sensitivity in language learning, language teaching and language use'** (emphasis in original; ALA, n.d.). As this definition suggests, the presence of LA in applied linguistics research is wide in scope. In a state-of-the-art review article, Svalberg (2007) outlines how LA, building on the seminal volume by James and Garrett (1991), contributes meaningfully to studies of intercultural communication, cognitive linguistics, language use, and language teaching. This paper is grounded in these latter features and explores the role of LA germane to language use and language teaching.

As Svalberg (2007) suggests, five key features inform successful LA as a teaching practice:

1. interpreting and promoting language as a dynamic phenomenon;
2. engaging learners in discussions about language and language use;
3. promoting leaners' analyses of language (e.g. via exploration of language features);
4. developing learners' autonomy regarding language and language use (e.g. strategy testing); and,
5. facilitating learners' engagement of cognitive and affective resources.

Van den Broek et al. (2022) suggest that these components can be divided into two distinct classroom practices: one aimed at raising situational awareness, and the other directed at addressing operational awareness, both in service of student learning. Situational awareness draws learners' attention to the teaching-learning landscape (i.e. variables informing the classroom space), while operational awareness aims to facilitate 'student-centered discovery and exploration, autonomous learning and student engagement' (p. 61)—a description van den Broek et al. derived from earlier observations made in the LA literature (e.g. Borg, 1994; Svalberg, 2007; Wright & Bolitho, 1993). Underlying these components, and central to LA pedagogy, is an attempt 'to develop learners' explicit understanding of language as well as an awareness of their own learning by involving them in discovery-oriented tasks' (Borg, 1994, p. 62). Accordingly, LA pedagogies require instructional materials that guide learners through such experiences.

In L2 writing studies that have examined the utility of LA pedagogy, attempts have concentrated on limited sets of task types, as noted. Related classroom-based research has focused primarily on developing LA *via* genre pedagogies (Negretti & McGrath, 2018; Wette, 2017; Yigitoglu & Reichelt, 2014) and text reconstruction or reformulation tasks (Adams, 2003; Swain & Lapkin, 2002; Yang, 2016) as a means of successfully developing genre knowledge (Negretti & McGrath, 2018; Yeh, 2015), metacognitive knowledge (Hayes & Flower, 1980; Lee & Mak, 2018), and learners' attitudes toward peer feedback (Nguyen, 2016). Although valuable, the task types known to benefit L2 writing development from the perspective of LA pedagogy are limited. The application of system mapping in the present study addresses this constraint by expanding the repertoire of LA-raising resources available to researchers and teachers, answering Ushioda's (2021) call for substantive pedagogical interventions that can serve researchers (by broadening an understanding of the scope and mechanisms informing LA pedagogy) *and* teacher-learner communities (by providing instructors an additional resource that meets their students' communicative needs). As noted, this paper explores these potentials as latent features of system mapping.

Method

Context

This study followed first-year university students in two intact sections of a critical thinking course (*Thinking & Writing* [TW]) that incorporates aspects of the learning-to-write and writing-to-learn paradigms. The course is for-credit and is embedded in an English-medium faculty of liberal arts in a Japanese university. The faculty draws students from a range of different and overlapping linguistic and cultural backgrounds, and many students in the program self-identify as bicultural and bilingual. Combined, 37 students were enrolled in

the two sections. Thirty students consented to participate in the study (15 from Class A; 15 in Class B). Of these thirty students, thirteen were either Japanese or Japanese American, with Japanese serving as their first language. The remaining students were from the Asia Pacific, Europe, and the Americas, with a range of corresponding first languages (identifying these students in more detail would risk their anonymity). The mean TOEFL score of the participants was 106.43 ($SD = 3.87$). There was no significantly statistical difference in TOEFL scores between sections, nor were such differences detected at the start of term across all writing indices employed in this study (described in *Data Coding and Analysis*).

The classes met twice weekly for 100-minutes each session over a 14-week semester, and the two sections of the course met in sequential class periods. Class A, the first of the sequential classes, served as a control and Class B received the treatment (i.e. the system mapping activity). The selection of the treatment and control group was random. After the treatment was deemed a success (as outlined in the *Results* and unpacked in the *Discussion*), the control group was invited to attend a workshop during the semester break that focused on the treatment described below. Six of the fifteen participants in the control group attended the workshop.

The same instructor taught both sections of the course, and the classes were pedagogically matched. Students in both sections composed 20 short response papers (approximately 500 words each, submitted almost twice weekly). Students also composed a mid-term and final paper of approximately 2000 words and 3000 words, respectively. The short response papers all required students to synthesize their reading of a required text with the instructor's lecture, and classroom and small-group discussions. Sample readings explored in the course include excerpts from Aristotle's *Nicomachean Ethics*, Nietzsche's *Thus Spoke Zarathustra*, and Byung-Chul Han's *The Transparency Society*. In addition, although the course foregrounds content knowledge, in week three and seven the instructor provided explicit writing instruction. This guidance was delivered as three distinct writing workshops. Workshop one first engaged students with abstract concepts about why good writing matters. Related discussion was followed by explicit instruction on syntax (grammar and punctuation) and concision. Workshop two included attention to formality, style, nominalizations, referents, anaphoric nouns, and proofreading. The last of the workshops included paragraphing (coherence) and the importance of working memory as a function of the reader. Moreover, every other class commenced with a 15-minute discussion of an anonymous sample essay taken from the most recent writing assignment or a news article derived from random media sources (discussion topics included the strengths and weaknesses of the writing sample). Both classes received the same writing workshops and engaged with the same writing samples.

Data collection

To explore learners' awareness of their writing spaces (Research Question (RQ) 1) and their writing development (RQ2), data were collected from a series of classroom activities across both classes over the semester (see Table 1 for an overview).

The primary difference in treatment between the two groups was the use of Likert-based surveys (Class A) and system mapping activities (Class B). In both cases, the activities were designed to enhance learners' appreciation of and attention to a series of variables (defined subsequently) that inform the writing space. As described below, the overarching difference

Table 1. Overview of data collection and procedure.

Class	Data collected	Week data were collected	Purpose for data collected (related RQ[a])	Procedure for task completion
A (control)	Likert-based survey	1, 8, 14	Measure changes in LA[b] (RQ1) and examine impact of activity on writing performance over time (RQ2)	Completed in class (allotted 25 min)
B	System mapping activity	1, 8, 14	Measure changes in LA (RQ1) and examine impact of activity on writing performance over time (RQ2)	Completed in class (allotted 25 min)
A and B	Bloom's taxonomy pre-test & post-test essay	Pre-test: 1 Post-test: 14	Examine group-level changes in writing within and across groups (RQ2)	Completed in class (allotted 40 min)
A and B	Reflective narrative essay	14	Measure components of LA pedagogy: situational and operational awareness (RQ1) Explore impact activity may have had on writing development (RQ2)	Completed for homework

[a]Research question.
[b]Language awareness.

between the two activities was the visual component in the system mapping group. That is, both the Likert survey and the system mapping activity asked students to rank the variables on a corresponding scale of 0–3; however, the system mapping group did so with the aid of an image-schematic structure (i.e. the system map itself—see Figure 1). Comparing the two activities, then, could bring to the fore what added value, if any, an image-schematic structure like system mapping could have on this context. Accordingly, engaging the control group in the Likert-style survey was important to measure—and potentially rule out—the effect of being exposed to the variables alone. That is, based on previous studies (Ell et al., 2017; Fogal, 2020, 2022, 2023; Ludlow et al., 2017), it was hypothesized that the system mapping task itself (and not just considering the variables *via* a Likert-style survey) would lend notably greater pedagogical support for learners. This hypothesis follows from the positive association of diagramming and mapping tasks with learner uptake, as noted above (Kane & Trochim, 2007; Lantolf & Poehner, 2014; Ojima, 2006; Wette, 2017).

In total, the dataset comprised of 43 Likert-style surveys and 44 system maps, both designed to explore changes in LA over time and the impact of such activities on writing development. In addition, 30 reflective narratives (Class A: $M = 461.34$ words; $SD = 23.37$); Class B: $M = 459.79$ words; $SD = 25.63$) and 60 essays (Class A: $M = 478.78$ words; $SD = 16.35$); Class B: $M = 484.28$ words; $SD = 16.6$) on Bloom's Taxonomy were collected. The essays on Bloom's Taxonomy were employed to detect group changes in writing from the start to the end of the semester. The instructor selected Bloom's Taxonomy to provide students with a framework for discussing course content. The reflective narratives were collected to measure two components of LA pedagogy (situational and operational awareness) and to probe for insights into what impact, if any, the mapping task had on any changes in writing proficiency. In addition to informing LA pedagogy, these reflective narrative essays function as a reflective heuristic and follow numerous studies that underscore the efficacy of reflection for learning (e.g. Moon, 2006; Thorpe, 2004) and L2 writing development (Casanave, 2011; Fogal & Koyama, 2022). As tasks designed to inform learning, the mapping, survey, and

writing tasks (essays on Bloom's taxonomy and the narrative reflection) were a required part of the course.

Procedure

As part of their studies (i.e. to assist with developing situational and operational awareness in service of writing development) and as a data collection procedure, students in Class B engaged in the system mapping activity. Students were asked to map 36 variables known to impact writing development (following Fogal, 2020, 2022) onto a mapping board that used nested rectangles (inner, middle, and outer rectangles) to distinguish between strong, moderate, and weakly influential variables, respectively. The 36 variables were divided into four categories: variables related to the course (e.g. learning content knowledge, learning to thinking critically, and classroom discussions), the curriculum the course follows (e.g. teaching lexico-grammatical forms, the writing process, and writing genres), agents (e.g. course professor, writing center tutors, and students' peers), and students' motivations and experiences (e.g. ambition to be an effective writer, secondary school experiences, and languages other than English). Students were seated at individual desks and received their own mapping board and cards. Students were invited to place the cards according to their strength of influence relative to a guiding question under consideration (*Considering TW, to what degree do the following items influence writing development?*). Students were then asked to contribute variables to the board (blank cards were provided) and were told to exclude cards that carried no influence. When students completed this first phase of the activity, they were requested to consider their system map holistically (rather than examining each card as a discreet item) and were invited to make changes to the placement of any cards. In the third phase, students were then asked to draw lines that linked together groups of variables thought to be meaningfully connected. Students were given 25 min to complete the task. See Figure 1 for a completed system map.

In the control group, students were required to consider the influence of the same variable set. However, rather than employing the system mapping activity, students utilized a computer-based survey to rank the variables relative to the same guiding question using a Likert scale: 0 (item not at all influential); 1 (weakly influential); 2 (moderately influential); 3 (strongly influential).

To examine how (if at all) these two activities (i.e. Likert-based survey and system mapping) facilitated learners' perceptions of the writing space (RQ1) and their writing development (RQ2), a follow-up activity was employed to capture changes in learners' situational and operational awareness, two key components informing LA pedagogy (van den Broek et al., 2022). To this end, and after the last iteration of the Likert survey and system mapping activity, students downloaded a summary of their survey responses (Class A) or took a photograph of their mapping board (Class B) and were asked to compose a 4–500 word reflective narrative outside of class that (1) explained some of the choices they made with the mapping or survey task, and (2) outlined their general positive and negative impressions of their respective activities as a learning tool.

Further, to explore changes in writing (defined below) over the semester across both groups (RQ2), semi-matched writing assignments (the first and last of the semester) were analyzed from both classes. On day one of the course, students in both classes responded

to the following essay prompt that employed Bloom's Taxonomy as a conceptual framework for addressing thinking processes and critical thinking—key focal points of the course:

> How has Bloom's Taxonomy informed your education to date (i.e. from elementary school onwards), and how might this framework be useful going forward in this course?

> On the last day of the course, students responded to a nearly matched writing prompt:

> How has Bloom's Taxonomy informed your education over this past term, and how might this framework be useful going forward in your university studies?

In both tasks, students were exposed to the same diagram of Bloom's Taxonomy (Bloom et al., 1956) and a short paragraph outlining the basic tenets of Bloom's framework. To ensure the writing prompts were closely matched, both tasks asked students to orient themselves to the *past* (prompt one: to their education to this point; prompt two: to the nearly completed semester) and the *future* (prompt one: to the course that had just begun; prompt two: to further university studies). In both instances students were given 40-minutes of in-class time to compose the essays using paper and pencil and without access to notes or a computer. This step ensured that students composing on the last day of class could not access their day one essay. Students also received no forewarning that they would be engaged in a writing task on each of these days. For coding purposes, the essays were transcribed verbatim, including all errors, into MSWord.

Data coding and analysis

The reflective narratives composed by learners after the final mapping task and Likert-scale survey were analyzed using MAXQDA. A content analysis mined the narratives for emergent categories and themes that provided evidence of changes in situational and operational awareness, key features that inform LA pedagogy (Svalberg, 2007; van den Broek et al., 2022), and for other dominant themes relative to the teaching instruments (RQ1). After the categories were established, the author and a second rater explored the dataset independently and then met on two occasions to discuss their coding. Rater reliability was measured using Cohen's Kappa ($\kappa = 0.83$). Following common practice, coding differences were discussed until resolutions were reached.

To examine changes in writing after one semester (RQ2), the writing samples on Bloom's Taxonomy from the first and last writing task of the semester were analyzed for a series of CALF (i.e. complexity, accuracy, lexical complexity, and fluency) features primarily using the L2 Syntactic Complexity Analyzer (Lu, 2010). As a single measure of syntactic complexity is rarely sufficient from which to draw conclusions (Norris & Ortega, 2009; Wang & Lowie, 2021), a series of measures across dimensions of syntactic complexity were selected. Following Wang and Lowie (2021), such features were chosen for their ability to assess change with advanced L2 writers, such as those in the present study. Table 2 outlines syntactic and other CALF constructs and measures employed to trace changes in writing over one semester of studies.

Regarding accuracy, Polio and Shea (2014) synthesis underscored a series of related indices that were correlated. Following Torres (2023), then, only one index (error-free T-unit) was employed. Herein, deviations in morphosyntactic structures were used to measure error-free

Table 2. Text-based CALF measures of different writing dimensions.

Construct	Dimension	Index	Index description
Syntactic complexity	Length of unit	Mean length of T-unit (MLT)	Number of words per T-unit
	Amount of subordination	Clauses per T-unit (CL/T)	Number of clauses per T-unit
	Amount of coordination	T-units per sentence (T/S)	Number of T-units per sentence (T/S)
	Degree of phrasal sophistication	Complex nominals per T-units (CN/T)	Number of complex nominals per T-units
Accuracy	Accuracy	Error-free T-units (EFT)	Percentage of error-free T-units
Lexical complexity	Diversity	Guiraud Index (G)	Number of word types divided by square root of total word tokens
Fluency		T-units per text (TU/T)	Number of T-units in complete text

T-units and, in line with Wigglesworth and Storch (2009), the following errors were not accounted for in the coding: capitalization and lexical choice, spelling, or punctuation when they did not impede meaning.

As a marker of advanced writing (Jarvis, 2013; Read, 2000), lexical complexity was operationalized as lexical diversity (the proportion of words in a text that do not overlap) using the Guiraud Index. Finally, despite concerns about how well fluency is seen to mark good writing (for example, task or learner-related variables that may impact fluency, Abdel Latif, 2013), the similarity of the task types and the allotted composing time in this study suggests that T-units per text may function as an indicator of changes in fluency over the semester.

To complement the analytic component of the text analysis, three different raters scored the essays holistically. This analysis was included to provide another perspective on writing changes over the semester. The raters all had advanced degrees in TESOL or applied linguistics, were experienced L2 writing instructors and researchers, and had experience scoring essays in EFL contexts in Japanese universities. The essays were scored in random order. In addition to scoring them impressionistically, raters were asked to examine the essays for content, structure, and expression using a rubric designed specifically for the course. Fleiss' kappa coefficient (Fleiss, 1971) was used to measure interrater reliability ($\kappa = 0.84$).

The purpose of the CALF measures and the holistic essay scores was to determine changes in writing within and across groups over the semester. Accordingly, relationships between indices (e.g. correlation) were not examined. As the data were not normally distributed, non-parametric tests were used to examine the writing samples. A Wilcoxon signed-rank test was used to compare changes in writing within groups between time 1 and time 2 (T1 and T2). Mann-Whitney U tests were employed to explore differences between groups across the same timeframe. Effect sizes were calculated using Hedge's *g*, a modification of Cohen's *d* that corrects for biases with small sample sizes (Hedges & Olkin, 2014), with effect sizes greater than 0.2, 0.5, and 0.8 representing small, moderate, and large effect sizes, respectively.

Results

Research Question 1: To what extent, if at all, does system mapping increase L2 learners' awareness of the writing space?

Table 3. Themes and corresponding samples from MAXQDA analysis of reflective narratives.

Theme	Reflective narrative samples
Class A (survey group)	
- situational awareness: disconnect between writer and writing space (47%)[a]	Each item we gave a ranking to made sense to me. But when thinking about how they are helping together [interacting], there is not a lot to think about. It's not clear how these variables connect or if they should. Moreover, if they did, how would noticing connections be helpful for my writing? (Student F)
- operational awareness: doubts about the Likert-survey task (60%)	While thinking about this survey assignment, it was unclear how these surveys were helpful. I believe they can be good for thinking about different influences if we talked about them, but it was not clear how I could use them to make my writing better. Maybe it would be better if we had discussed these things with classmates or something, instead of just rating them. (Student A)
Class B (system mapping group)	
- situational awareness: focused on task and learning space, and - operational awareness: focused on discovery and exploration[b] (53%)	Making a diagram of what is more important and connecting individual cards helped with realizing what I should be focusing more on. For instance, receiving critiques has the biggest influence on my writing. Therefore, I should utilize the writing center more, ask questions about my writing to the professor, and request for feedback from acquaintances. This would strengthen my writing, since there is a lot of room for improvement. This activity also made me realize what my incentive is, when writing. This has given me a lot more motivation to utilize resources. (Student DD)
- operational awareness: focused on discovery and exploration (73%)	Visually observing and creating the general flow of the factors in the mapping assignment enabled me to think about the less influential elements and how they can be practically used in my writing. For instance, prior experiences and personal beliefs can be a useful tool in not only writing argumentative and expressive essays but also in choosing topics for expository essays. The assignment helped me to identify my weaknesses and realize that the neglected factors may be useful in my writing. (Student BB)
- situational awareness: focused on resources (60%)	As the [mapping] board helped me understand, by searching for resources and making connections with other university courses (sociology, history and economy courses), I could find different perspectives to support my point of view and thus make my writing stronger. (Student MM)
- situational awareness: focused on agents (47%)	The relationships between peers also contribute a lot to the final work, since people will share more ideas or even discuss them deeply with friends who are close to them. I think the activity helped me realize I need to talk about my ideas more. This way, I can understand the ideas we study, and that can make my essays better. (Student JJ)

[a]Indicates what percentage of students ($n = 15$) generated ideas informing this theme (due to space constraints, only one sample per theme is documented here); totals exceeding 100% indicate where student narratives included multiple themes.
[b]Instances were both situational and operational awareness are present in students' reflections.

As noted, the narrative reflections were examined for insights into how each activity (Likert-scale survey and system mapping) informed learners' situational and operational awareness of their learning space. Table 3 provides an overview of the primary themes that emerged from the dataset across groups.

The reflective narratives of Class A (Likert survey group) provide a generally negative appraisal of the Likert-survey task. The themes highlight a dissatisfaction with the activity, list questions and concerns about its ability to engage learners' LA as a tool for developing writing proficiency, and demonstrate the inability of the survey task, from learners' perspectives, to meaningfully engage students in autonomous learning—a key pedagogical component of LA pedagogy.

In contrast to the survey group, Table 3 documents that Class B (system mapping group) enjoyed a much more developed sense of the teaching-learning landscape (situational awareness) and the different aspects and strategies available to them (operational awareness) *via* autonomous, discovery-centered learning (i.e. through the system mapping activity) in service of academic writing development. Evidence for developing this awareness of these two aspects of LA pedagogy is present across a wide swath of the narrative reflections, and samples in Table 3 only provide a glimpse of this phenomenon. As the narrative reflections strongly suggest, system mapping provided students with an opportunity to broaden their awareness of the educational landscape in ways that the Likert survey alone could not, suggesting that exposure alone (i.e. the Likert survey group) to the variables informing this study was insufficient for developing either LA or, noted subsequently, writing proficiency.

> Research Question 2: If system mapping increases L2 learners' awareness of the writing space, to what extent does this increase advance learners' writing proficiency?

Results of the Wilcoxon signed-rank test (see Table 4) highlight statistically meaningful differences within groups between T1 and T2 across a series of measures. In Class A (Likert survey group), however, differences were limited only to the content of the writing samples ($z = -3.14$, $p = .002$, $g = .79$). In Class B (system mapping group), statistically significant differences were seen in syntactic (MLT: $z = -3.18$, $p = .001$, $g = .93$) and accuracy (EFT: $z = -3.21$, $p = .001$, $g = 1.04$) measures, as well as across all holistic indices (content: $z = -2.99$, $p = .003$, $g = .84$; structure: $z = -3.33$, $p = <.001$, $g = 1.27$; expression: $z = -3.29$, $p = <.001$, $g = 1.29$; impressionistic: $z = -3.35$, $p = <.001$, $g = 1.21$). Even though both classes experienced some change in their writing over the semester, such changes were notably more pronounced with Class B, the system mapping group.

Table 5 documents the results of the Mann-Whitney U test, highlighting differences between the two groups at T2 across all indices. (As noted earlier, differences at T1 were calculated at the start of term, and no statistically significant differences appeared.) Table 5 documents statistically meaningful differences regarding measures of accuracy ($z = -3.02$, $p = .003$, $g = 1.33$) and lexical complexity ($z = -2.14$, $p = 0.33$, $g = 0.84$), as well as said differences in holistic content ($z = -2.05$, $p = .04$, $g = 0.68$) and general impressionistic scores ($z = -2.49$, $p = 0.13$, $g = 1.03$). These findings suggest that across these measures, there were statistically notable differences in writing outcomes between the two groups over time, favoring Class B, the system mapping group. These results lend support for the efficacy of system mapping for developing aspects of L2 writing proficiency.

Table 4. Descriptive and inferential statistics (Wilcoxon signed-rank test) for CALF and holistic scores.

Construct	Index	Class A (Likert survey group)								
		Mean SD	95% CI		Mean SD	95% CI		z	Sig.	g[a]
		T1	LL	UL	T2	LL	UL			
Syntactic complexity	MLT	20.14 4.1	18.07	22.21	22.15 3.81	20.22	24.08	−1.31	.191	0.51
	CL/T	1.67 0.26	1.54	1.79	1.7 0.22	1.59	1.81	−0.17	.865	0.77
	T/S	1.07 0.08	0.94	1.2	1.11 .09	1.07	1.16	−1.78	.75	0.47
	CN/T	2.21 0.56	1.93	2.49	2.3 .54	2.03	2.58	−0.11	.91	0.16
Accuracy	EFT	2.93 0.89	2.48	3.38	2.87 0.99	2.37	3.37	−2.12	.034	0.42
Lexical complexity	G	9.92 0.73	9.55	10.29	9.93 0.68	9.58	10.27	−2.07	.038	0.81
Fluency	TU/T	21.67 3.58	19.86	23.48	22.6 3.42	20.87	24.33	−0.95	.34	0.26
Holistic	Content	7.54 0.81	7.12	7.94	7.8 0.53	7.53	8.07	−3.14	.002**	0.79
	Structure	7.83 0.7	7.48	8.19	8.33 0.49	8.09	8.58	−2.62	.009	0.83
	Expression	7.67 0.79	7.26	8.07	8.17 0.65	7.84	8.49	−2.27	.023	0.69
	Impressionistic	7.83 0.77	7.44	8.22	7.97 0.64	7.64	8.29	−2.31	.021	0.54

Construct	Index	Class B (System mapping group)								
		Mean SD	95% CI		Mean SD	95% CI		z	Sig.	g
		T1	LL	UL	T2	LL	UL			
Syntactic complexity	MLT	19.09 2.03	18.06	20.12	21.35 2.77	19.96	22.73	−3.18	.001***	0.93
	CL/T	1.67 0.5	1.41	1.92	1.5 0.28	1.36	1.64	−1.99	.047	0.42
	T/S	1.07 0.08	1.03	1.11	1.05 0.05	1.02	1.08	−0.74	.46	0.3
	CN/T	1.95 0.4	1.75	2.15	2.22 0.56	1.94	2.5	−2.21	.027	0.55
Accuracy	EFT	2.9 1.1	2.71	3.82	1.8 0.56	1.52	2.08	−3.21	.001***	1.04
Lexical complexity	G	10.05 1.04	9.53	10.58	10.53 0.75	10.15	10.91	−1.19	.233	0.29
Fluency	TU/T	24.07 3.67	22.21	25.93	24.8 5.26	22.13	27.47	−0.29	.776	0.16
Holistic	Content	7.03 0.94	6.56	7.51	8.3 0.9	7.84	8.76	−2.99	.003**	0.84
	Structure	7.23 0.96	6.75	7.72	8.23 0.56	7.95	8.52	−3.33	.000***	1.27
	Expression	7 1.04	6.48	7.52	8.13 0.67	7.8	8.47	−3.29	.000***	1.29
	Impressionistic	7.1 0.93	6.63	7.57	8.63 0.64	8.31	8.96	−3.35	.000***	1.21

[a]Hedge's g.
$^*p < 0.05;^{**}p < 0.01;^{***}p < 0.001$.

Discussion

This study explored the utility of system mapping as a pedagogical tool for raising LA, defined as situational and operational awareness of the teaching-learning space (RQ1), and whether or not system mapping could also assist learners to develop their L2 writing

Table 5. Descriptive and inferential statistics for Mann-Whitney U test across CALF and holistic scores at T2.

Construct		Mean SD		z	Sig.	g[c]	95% CI	
		A[a]	B[b]				LL	UL
Syntactic complexity	MLT	22.15 3.81	21.35 2.74	−.64	.520	0.24	−0.95	0.48
	CL/T	1.7 0.22	1.5 0.28	−2.49	.013	0.79	−1.51	−0.03
	T/S	1.11 0.09	1.05 0.05	−2.21	.027	0.82	−1.54	−0.05
	CN/T	2.3 0.54	2.22 0.56	−0.66	.507	0.15	−0.86	0.57
Accuracy	EFT	2.87 0.99	1.8 0.56	−3.02	.003*	1.33	−2.08	−0.5
Lexical complexity	G	9.93 0.68	10.53 0.75	−2.14	.033*	0.84	0.07	1.56
Fluency	TU/T	22.6 3.41	24.8 5.27	−1.56	.118	0.5	−0.24	1.21
Holistic	Content	7.8 0.53	8.3 0.9	−2.05	.04*	0.68	−0.08	1.39
	Structure	8.33 0.49	8.23 0.56	−0.35	.726	0.19	−0.90	0.53
	Expression	8.17 0.65	8.13 0.67	−0.64	.949	0.06	−0.77	0.67
	Impressionistic	7.97 0.64	8.63 0.64	−2.49	.013*	1.03	0.25	1.77

[a]Class A (Likert survey class).
[b]Class B (System mapping class).
[c]Hedge's *g*.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

proficiency (RQ2). The results of RQ1 indicate that system mapping holds promise as a meaningful teaching tool to develop learners' awareness of the learning landscape; the findings from RQ2 suggest that system mapping can support learners' L2 writing across a series of measures. These findings are discussed below.

The data from the reflective narratives emphasize how system mapping helped Class B students develop situational awareness of their learning space (RQ1). For example, one student noted that 'The mapping activity allowed me to look at information not directly related to class, like using library resources or online searching. Now I see how using resources isn't just for filling in the reference list. It makes my ideas stronger' (Student FF), while another shared that 'sources of information such as [writing] workshops allow individuals to gain exposure to knowledge outside the course curriculum, which helps improve their thinking capacity and discover common errors, which they might also be committing' (Student KK). As these and many other students in Class B noted, the mapping activity encouraged learners to move beyond their immediate, individually-oriented spaces (i.e. their study setting, computer, notes, and thoughts) and to engage through exploration with a wider learning context (i.e. their peers, professors, classroom discussions, and study groups in libraries, cafes, and online)—all hallmarks of effective LA pedagogy (Borg, 1994; Svalberg, 2007). In this vein, system mapping widened and reinforced learners' awareness of what resources are available to them.

In addition, the results show that exposure to the variables alone and considering their influence (*via* the Likert survey) was insufficient to increase LA and to support writing development. As results from RQ1 and RQ2 demonstrate, the system mapping activity appears capable on both fronts. This technique shares pedagogical characteristics with other

image-schematic structures including, for example, mind maps (Wette, 2017), concept mapping (Liu, 2011; Ojima, 2006), and concept-based learning (Fogal, 2017; van Compernolle, 2011), all heuristic devices or approaches known to facilitate L2 development. Additionally, the iterative operation of the mapping task employed here may have further benefitted students, as the mapping of variables in the second and third iteration of the task rests on previously developed (and developing) schemata from the initial iteration of the mapping activity—what Wette (2017) describes as prior knowledge integrating with new information structures to generate increasingly sophisticated schema, a learning theory well supported in the literature (Ausubel, 1968; Kolb, 2015; McVee et al., 2005). Accordingly, the results of this study are encouraging, and suggest that system mapping, as a topological representation of learners' educational spaces, is well positioned to engage these learning processes in support of developing learners' LA and writing proficiency.

As discussed above, the system mapping activity broadened Class B's awareness of L2 learning resources at their disposal. As findings from RQ2 suggest, this widening perspective also developed their understanding that different facets of their writing (e.g. content, structure, and lexico-grammatical concerns—elements explicitly related to RQ2) can be fine-tuned using a wider set of strategies than students were initially aware of. In doing so, system mapping expands Wette's (2017) description of the macro (discourse) and micro (linguistic) schemata available to writing students that moves beyond the classroom space, tapping into a wider awareness of the teaching-learning landscape than exposure and ranking of the variables alone (Class A) could support. Concerning writing development, this finding is particularly important as this increased awareness is known to facilitate L2 learning (Lee & Mak, 2018; Negretti & McGrath, 2018)—manifest here in Class B's semester-long writing development. In this way, system mapping operationalizes van den Broek et al. (2022) description of LA pedagogy as both drawing on situational awareness (increasing attention to the educational space) and operational awareness (engaging students in activities that encourage discovery and exploration) in service of L2 learning (here, L2 writing), echoing earlier foundational sentiments of LA pedagogy (Borg, 1994; Svalberg, 2007; Wright & Bolitho, 1993).

However, as noted students in Class A demonstrated minimal change in their writing development, comparatively. This result may be surprising, considering the common expectation (e.g. Cumming, 1995; Wette, 2010, White, 1994) from students, instructors, and administrators that writing skills advance even through short instructional periods (i.e. that even without exposure to system mapping, students in Class A should have more fully developed their writing). This belief is not without reservations. As some researchers suggest (e.g. Huck, 2015; Rifkin, 2005; Storch, 2009), changes in students' writing may require considerable time to manifest (i.e. after data are collected), or may not occur in a single semester. Alternatively, a plateau effect (Cumming, 2020; Ortega, 2003; Rifkin, 2005) may result in subtle changes that may be difficult to detect with the present instruments (but see Fogal (2019) for a microgenetic approach to L2 writing development that could prove useful); similarly, individual changes in writing may have been hidden in the aggregated dataset. Given these potential scenarios, one may reasonably ask why students in Class B improved as they did. As described above and discussed again below, the findings suggest that Class B's changes are closely related to the positive impact system mapping had on raising learners' LA in service of advancing their writing proficiency.

From a pedagogical perspective, the iterative nature of this approach substantiates previous research (e.g. Bygate, 2018; Larsen-Freeman, 2012; Ungerer & Schmid, 1995) that emphasizes task iteration for building LA and L2 learning—a benefit also present in L2 writing studies (e.g. Baba & Nitta, 2021; Huh et al., 2018; Nitta & Baba, 2014) that demonstrate how iterative activities can impact writing development, including CALF measures (RQ2). Reflecting on task iteration, an ideal number of iterations cannot be prescribed (Fogal, 2023), and so applying the mapping task iteratively should account for concerns related to task fatigue and be case specific (e.g. consider the length of the study period and the age of students).

System mapping also complements previously successful attempts to advance learners' writing *via* pedagogy grounded in image-schematic structures that effectively mimic an LA pedagogy approach, here with a specific focus on students' text quality (RQ2). For example, Negretti and McGrath (2018) demonstrated how visualization techniques can serve learners' metacognitive awareness of L2 writing genres that translated into writing gains. Similarly, Wette (2017) demonstrated how mind maps facilitate a comparable end. The present work thus expands the discourse examining the relationship between image-schematic models and LA raising techniques to promote learners' writing abilities. This is achieved by emphasizing how system mapping can enhance learner's LA of the writing landscape, primarily *via* attention to situational and operational awareness. Accordingly, this work further substantiates the advantages of visual cues for advancing L2 writing (RQ2) and the utility of LA pedagogy for supporting such interventions (RQ1), and thus builds on the repertoire of diagramming techniques available for LA raising activities in L2 writing (and other) contexts.

Collectively, the findings and ensuing discussion also respond to calls by Ushioda (2021), among others (e.g. De Costa, 2015; Hiver & Al-Hoorie, 2020), to develop research tools that serve researchers, instructors, and learners alike at the point of data collection. This study demonstrates that system mapping holds initial promise for addressing this need—a promise that merits further study.

Limitations and conclusion

Although the findings underscore the potential of system mapping to serve LA pedagogy and develop L2 writing, this work is not without its drawbacks. First, the small sample size resulted in a lack of statistical power. The results, then, should be interpreted accordingly, and a larger-scale study could help substantiate the findings. In addition, while the end-of-term reflective narratives provided meaningful insights into how learners interpreted the system mapping activity, tracking learners' thoughts on the technique as it was employed throughout the term could provide a useful developmental perspective (i.e. tracking shifts in learners' views). This approach could be achieved by collecting reflective narratives more regularly, for example. Further absent from this work was the instructor's perspective, who may have provided novel insights into the learning space. To remedy this concern, later studies may consider the educational landscape from the viewpoint of stakeholders with diverse interests (e.g. instructors and administrators). In this vein, interested readers may see Fogal (2022, 2023) for system mapping techniques that capture the views of a wider set of stakeholders.

This study explored whether or not system mapping functions as a meaningful heuristic to increase learners' LA, defined as situational and operational awareness, and if this mapping technique facilitates L2 writing development. To examine these topics, the academic writing and narrative reflections of two groups of students in different conditions (Likert survey group and system mapping group) were examined using quantitative and qualitative means. The results from the Likert survey group (Class A) were not very promising, comparatively: exposure to and ranking of the variables alone, *via* the survey task, was insufficient for broadening learners' LA and for supporting notable changes in L2 writing proficiency. In contrast, for students in the system mapping group (Class B), the results were encouraging, and the findings emphasize that system mapping can facilitate increases in LA and aspects of L2 writing development, including holistic measures and CALF indices of lexical complexity and accuracy.

The results also demonstrate how system-mapping capitalizes on learning theories that support image-schematic interventions and that such visual-spatial engagement, in the form of system mapping, can assist learners with their communicative needs. Moreover, the findings underscore and advance the importance of LA pedagogy (i.e. raising learners' awareness of the breadth and complexity of the learning space they occupy) and how that importance can be realized *via* system mapping. Last, this work underlines the pedagogical utility of system mapping to support iterative teaching practices, thus contributing to L2 writing pedagogy by adding to a list of visual-schematic structures that serve L2 writing development. However, despite the apparent effectiveness of system mapping, more studies across varying contexts and concerned with different constructs are certainly needed to further verify the claims thus made. Accordingly, the results here should be interpreted cautiously, keeping in mind that the present study represents a first attempt at examining the promise of system mapping beyond its established utility as an analytic and exploratory technique.

Moving forward, interested readers are invited to further probe and consider the value of system mapping for raising LA and facilitating L2 writing development, among other underexplored contexts. More specifically, insights into the development of LA may be further derived by probing individual learners (e.g. stimulated recall interviews or case studies) to better appreciate nuances informing learners' choices and processes while completing the system mapping task and developing their LA. To do so, an explicit LA questionnaire may assist with capturing varying perspectives on learners' LA (see Pfenninger, 2020). Such decisions come with trade-offs, however (e.g. minimizing resources available to researchers due to time constraints), and so must be balanced according to the scope of the study, what one can reasonably expect to accomplish, and how such additions and variations to methods remain to benefit learners at the point of data collection.

Disclosure statement

Notes on contributor

Gary Fogal is an associate professor of Applied English Language and Linguistics at Sophia University, Japan. His primary research engages a complex dynamic systems theory account of L2 writing development. He has recently co-edited a collection of studies on this topic. His research interests also explore the utility of literary texts for developing L2 proficiency. His recent publications appear in *Journal of Second Language Writing, International Review of Applied Linguistics*, and *Applied Linguistics*.

ORCID

Gary G. Fogal https://orcid.org/0000-0001-6012-5188

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