

# Toward Transdisciplinarity in Computer-Assisted Language Learning

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## Abstract

*From its beginnings, computer-assisted language learning (CALL) has been widely seen as an enterprise that draws on inputs from multiple disciplines. Scholars tracking the development of such enterprises in other domains have developed generally accepted terminology distinguishing concepts of multidisciplinary, interdisciplinary, and transdisciplinarity along a continuum from lesser to greater integration, coherence, and synthesis. We begin with an overview of the three preceding concepts with particular attention to interdisciplinarity in contemporary CALL. We then explore the notion of transdisciplinarity as an emerging theme in applied linguistics, arguably the field most closely related to CALL. In the following section, we look at theoretical options that are less connected to single disciplinary positions and represent the interdisciplinary state of the field and its movement toward transdisciplinarity. We expand on the basic notion of CALL as a potential transdisciplinary field and provide a descriptive framework of transdisciplinary types. The final section offers a model for visualizing transdisciplinarity for CALL with accompanying examples, arguing for a set of common transdisciplinary notions and a lingua franca for CALL stakeholders from a range of disciplines to use when communicating. We conclude that the future of the field lies in a much stronger transdisciplinary orientation than is currently the case and call upon our colleagues to pursue the concept.*

**KEYWORDS:** TRANSDISCIPLINARITY; TRANSDISCIPLINARY; INTERDISCIPLINARITY; INTERDISCIPLINARY; MULTIDISCIPLINARITY; MULTIDISCIPLINARY; CALL; APPLIED LINGUISTICS; FRAMEWORK; SLA

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## Introduction

The terms *transdisciplinarity* and *transdisciplinary* are appearing with increasing frequency across a number of fields. Computer-assisted language learning (CALL) is at first glance a primary candidate for this concept. CALL serves as a cover term for a wide range of instantiations of technology in language learning, including tutorial application development, digitally-mediated communication, collaborative learning, informal learning, and teacher education to name just a few. More formally, it sits at the intersection of more established fields, such as linguistics, psychology, sociology, education, and computer science. In recent years, CALL has branched out from its core of the interface of technology and language pedagogy to cover a wider range of related individual and social issues, such as hegemony (Lamy & Pegrum, 2012) and equity (Ortega, 2017).

CALL is seen by many as a subfield of applied linguistics (e.g., Chapelle, 2001), a field that is currently in the process of exploring the concept of transdisciplinarity itself as reflected by the fact that it was the theme of the 2017 American Association of Applied Linguistics (AAAL) conference. As conference chair Tim McNamara noted,

The choice of transdisciplinarity as a theme for this conference is motivated by a desire to bring closer to researchers in our field the rich intellectual and imaginative resources of thinkers outside Applied Linguistics whose work on language can act as a stimulus and trigger for our own thinking. (AAAL On-site Program, p. 3)

Yet the use of the term *transdisciplinarity*, and hence the concept as a coherent construct, remains limited within CALL literature. A full-text search of the *CALICO Journal* articles found no instances of *transdisciplinarity*, just two examples of *transdisciplinary*, 62 of *interdisciplinary* (including one [O'Neal, 1983] going back to the first issue of the journal), and 16 for multidisciplinary (<https://journals.equinoxpub.com/index.php/CALICO>, September 23, 2018). A similar search of the year before of the journal site for *Language Learning & Technology* (<http://llt.msu.edu>, July 31, 2017) identified no instances of *transdisciplinarity* and only two of *transdisciplinary*, while *interdisciplinary* and *multidisciplinary* appeared 93 and 37 times respectively (unfortunately, the current LLT site at <https://lltjournal.org> no longer appears to support such a search). What these numbers suggest is that although CALL is widely viewed as involving interdisciplinarity or multidisciplinary, and has been to some degree since its inception, there is no evidence within these two prominent CALL journals at least that transdisciplinarity is a defining characteristic for the field.

As a first step in understanding transdisciplinarity, it is important to distinguish it from the two related terms *multidisciplinary* and *interdisciplinarity*

(noting that the term *cross-disciplinarity* is sometimes used for one or the other or some combination of the two (Borrego & Newswander, 2008)). Writing in the context of the health sciences, B. C. Choi & Pak (2006) state, “The terms multidisciplinary, interdisciplinary and transdisciplinary are increasingly used in the literature, but are ambiguously defined and interchangeably used” (p. 351). They then offer the following definitions to distinguish the three:

Multidisciplinarity draws on knowledge from different disciplines but stays within their boundaries. Interdisciplinarity analyzes, synthesizes and harmonizes links between disciplines into a coordinated and coherent whole. Transdisciplinarity integrates the natural, social and health sciences in a humanities context, and transcends their traditional boundaries. (p. 351)

They conclude from an extensive review of 25 years of literature in health research that the terms represent additive (multidisciplinary), interactive (interdisciplinary), and holistic (transdisciplinary) implementations along a continuum where inputs from multiple disciplines are involved, and they call for more precision in their use.

Precision, however, is tricky. Multidisciplinary work seems easiest to isolate: the boundaries between the disciplines remain clear. All members of a development team for a CALL app, for instance, would have specific roles to play based on their knowledge and skill bases (see Colpaert, 2018a, for a critique of this multidisciplinary approach). Now suppose this same team were to be led by a product manager with knowledge and experience in several of these disciplines. Assume further that the members of the team took pains both to be understood by the other members and to reach out and acquire a fundamental understanding of others’ knowledge and biases. The result would be a more interdisciplinary team. This might be seen as moving *toward* a transdisciplinary team, but if we follow B. C. Choi & Pak’s definition above, the boundary between interdisciplinary and transdisciplinary may not be obvious in such cases. At what point does a synthesized and harmonized “coherent whole” become distinguishable from an “integrated” one?

Indeed, the previously noted numerical dominance of the term *interdisciplinary* in *LLT* and *CALICO Journal* articles suggests that in the views of those researchers, “interdisciplinarity” is the status quo for CALL. A deeper review of interdisciplinarity thus seems to be called for before taking up transdisciplinarity. Yet here we seem to run into a similar problem: S. Choi & Richards (2017) acknowledge that interdisciplinarity itself is an “elusive concept” (p. 42) due to the wide range of definitions for it. They nevertheless attempt to isolate a useful set of factors that have triggered interdisciplinary research and development across fields:

- New problems needing to be addressed;
- New lines of research demanding a wider approach;
- New technologies opening up fresher possibilities;
- Shifts in the intellectual landscape giving rise to new questions and new demands;
- Major challenges confronting society, such as HIV/AIDS.

(p. 41)

The first three of their bullet points are clearly central factors influencing the development of CALL and have been for most of the field's existence. The last two are becoming more common for CALL, influenced by movements in applied linguistics and other closely related disciplines. In particular, trends toward more encompassing theoretical perspectives such as those provided by ecologically-oriented theories (see Blin, 2016) are bringing this about. An example of the final point arguably is encapsulated in recent work challenging "native speakerism" in language pedagogy and policy (Ortega, 2017) as well as embracing multilingualism and diversity (Ortega, 2013).

At its core, interdisciplinarity starts with "communication and collaboration across disciplines" (Jacobs & Frickel, 2009, p. 43). The degree to which this communication and collaboration moves from interaction alone toward effective integration of theories, concepts, and methods from the fields involved takes interdisciplinarity further down the path toward transdisciplinarity.

### Interdisciplinarity in CALL

As noted above, the use of the label *transdisciplinary* within CALL publications is limited. *Interdisciplinarity*, however, is much more prevalent in the CALL literature. The term *interdisciplinary* occurs early in CALL, with Markosian & Ager's (1983) article on a project for teaching Armenian to university students through computer-assisted instruction. They note that a parser developed for a symbolic logic course was remarkably effective for teaching Armenian, giving their paper "an interdisciplinary flavor" (p. 65).

The recognition of CALL as an interdisciplinary field takes off from there, although the reader should be aware that the term *interdisciplinary* in CALL has not been used as precisely as the B. C. Choi and Pak definition above would imply and may include instances of what those authors would consider *multidisciplinary* instead. Chapelle (1997), notes "cross-disciplinary" references to 14 distinct fields and perspectives used in "the profession's quest for principled means of designing and evaluating CALL" (p. 19). Levy (1997) describes CALL as "interdisciplinary" and devotes a whole chapter to the concept, providing a list of 24 distinct disciplines that writers up to that time had claimed held relevance for CALL. Chapelle (2001) similarly characterizes

CALL in terms of its interdisciplinarity. She reframes the core question of technology-centered subfields of six parent disciplines (educational technology, computer-supported collaborative learning, computational linguistics, artificial intelligence, corpus linguistics, and computer assisted assessment) in terms of computer applications in second language acquisition (CASLA). For example, the general question “How can computers be used to improve learning?” in educational technology becomes “How can computers best be used to promote development of communicative L2 ability?” for CASLA (p. 41). Looking explicitly at instances of the term *theory* rather than at disciplines per se, Hubbard (2008) notes that in 25 years of *CALICO Journal* articles, a total of 166 yielded 113 distinct theory references from a variety of disciplines, notably linguistics, natural language processing, psychology, education, SLA, and human-computer interaction.

At several levels, then, it would seem that CALL is “comfortable” as an interdisciplinary field. As a recent example of such interdisciplinary research and development in CALL, Ziegler et al. (2017) present a project involving insights from CALL, natural language processing (NLP), and SLA aimed at determining the potential of different types of enhanced input in language acquisition. They created a system aimed at helping ESL learners acquire proficiency in English articles (*a*, *an*, and *the*) allowing them to test four types of input enhancement: (1) showing the articles in a contrasting color from surrounding text, (2) requiring learners to find and click on instances of articles in a text, (3) having learners select the correct form from a multiple choice (MC) set, and (4) getting learners to fill in a blank in the text with the correct form. Feedback in the last three variants was provided for right and wrong answers. The students were tasked with reading 30 items of their choice from a Reuters news feed over two weeks while employing the system. The authors conclude that “The case study presented in this article illustrates the promise of research conducted at the intersection of CALL, NLP, and instructed SLA by not only providing further empirical evidence supporting the efficacy of input enhancement for L2 development, but by also exploring how innovative technologies might deepen our understanding of L2 acquisition” (p. 226.). Their final point is indicative of the type of transdisciplinary outreach advocated in Ortega (2013).

## The Transdisciplinary Turn in Applied Linguistics

In this section, we move from a discussion of interdisciplinarity in CALL to one of transdisciplinarity within the overlapping field of applied linguistics and most notably SLA. Larsen-Freeman (1997) wrote a seminal article in which she incorporates the concept of transdisciplinarity, drawing parallels between second language acquisition and chaos/complexity theories within physics. A number of more recent works expand on this topic. Larsen-Freeman (2012)

introduces a set of 12 principles aimed at providing a foundation for a transdisciplinarity turn in applied linguistics, focusing on those of dynamism, complexity, and the role of context. Ortega (2013) explores a somewhat different sense of transdisciplinarity for SLA research, seeing it not just as incorporating insights from other fields but as “the proclivity to pursue and generate SLA knowledge that can be of use outside the confines of the field and contribute to overall knowledge about the human capacity for language” (Ortega, 2013, p. 1).

The shift toward transdisciplinarity as a guiding principle in SLA/applied linguistics has perhaps its most comprehensive statement in a position paper by the Douglas Fir Group (2016). Here, we provide a summary of some key elements of that piece, co-authored by 15 prominent SLA scholars. Rather than focusing on the content (their “10 fundamental themes”), their definition of and rationale for transdisciplinarity are highlighted. The authors begin their “bid” for transdisciplinarity by noting that for some time researchers studying the processes and outcomes of additional language learning “have looked to other disciplines for insights and research directions” (p. 23). However, they claim that the results have not bridged the disciplines in a sustainable way. Instead, they believe the field needs a transdisciplinary framework that “assumes the embedding, at all levels, of social, sociocultural, sociocognitive, sociomaterial, ecosocial, ideological, and emotional dimensions” (p. 24). The framework the authors envision is depicted as three concentric circles representing different levels of analysis. It begins with the innermost circle at the micro level of social activity and focuses on the semiotic resources (linguistic and other) that individuals bring to bear when engaging with others in multilingual contexts, both formal and informal. This micro level is embedded in a meso level of sociocultural institutions and communities (families, schools, etc.) incorporating social identities along dimensions of investment, agency, and power. At the outermost macro level, we find the belief systems and cultural, political, religious, and economic values. These factors influence both additional language learning and its teaching.

This proposal is important to the present discussion because it illustrates both the structure and content of a transdisciplinary framework for a field closely allied to CALL. Indeed, in the section leading up to introducing their framework, the authors mention *technologization* as one of the three recent phenomena (along with *globalization* and *mobility*) that are shaping today’s multilingual world. This should provide an invitation to those who straddle the CALL and SLA fields to become more involved in transdisciplinary movements.

However, despite some commonalities, the issue of transdisciplinarity for CALL is in principle different than for SLA/applied linguistics. The latter is

a widely recognized discipline in its own right, with established academic departments or subdivisions in institutions worldwide. A new transdisciplinary orientation represents a path to enriching and even transforming the discipline but does not seem to be necessary for its continued institutional existence. CALL is in a different position. As Colpaert (2018a) argues, “CALL remains vulnerable to absorption by other disciplines due to its feet of clay” (p. 1). For CALL to survive as a field, there is a compelling need to establish a body of CALL knowledge, along with CALL concepts, theories, models, frameworks, and methodologies. Thus, while we can learn from and embrace elements of transdisciplinarity from applied linguistics, we should keep in mind that the central role of CALL lies more specifically in exploring, understanding and controlling the mediating function of technology in language learning and teaching.

### **Theory Instantiations, Ensembles, and Syntheses: Building Blocks for Transdisciplinarity**

To date, CALL has not experienced as visible a transdisciplinarity movement as applied linguistics has. There are, nevertheless, some interdisciplinary trends, especially at the theoretical level, that hold promise to serve as a foundation for CALL moving in the transdisciplinary direction.

This section looks at three types of theoretical entities used to ground CALL research and development from the typology by Hubbard & Levy (2016).

The first of these involves broad theoretical constructs originating from outside of CALL that have the important characteristic of allowing a place for the technology and language learning components, so-called *theory instantiations* (see also Blin, 2016). These are distinct from theories of SLA in particular (e.g., the Interactionist Perspective), where the influence of technology is typically represented only by analogy to human–human interaction (Chappelle, 2001). For instance, Activity Theory is instantiated for a specific CALL context by Blin & Munro (2008) to show how both production and delivery technologies serve in the capacity of tools mediating interactions among stakeholders. Hubbard and Levy (2016) note that other theoretical frameworks such as Ecological Theory, Complexity Theory, and Dynamic Systems Theory similarly allow for the integration of the influence of technology mediation.

The second type is *theory ensembles*. These are collections of two or more theories, models, or frameworks in CALL research, development, or practice that act in concert to provide a relatively coherent and more complete understanding of the item under study. As the term *ensemble* implies, these are not just combinations—the goal is to provide useful overlapping and integrated perspectives. For example, in the area of using games for language



learning, Cornillie, Clarebout, & Desmet (2012) tackle the problem of combining insights from SLA and theories of gaming. As noted in Hubbard & Levy (2016), this work interweaves a number of theoretical sources, including “the cognitive mediational paradigm (p. 260), 4-Component Instructional Design Model (p. 265), self-determination theory (p. 262) and flow theory (p. 262), the latter being highly relevant in the design of the game. Each theory is included to serve a particular purpose” (p. 34).

Finally, there are *theory syntheses*. These are akin to theory ensembles, but they integrate the parts even further into a whole. Where an ensemble might typically be put together for a specific context, a theory synthesis creates a new and potentially stable theoretical entity available for reuse. An example is Plass and Jones (2005) synthesis of elements of Carol Chapelle’s interactionist account for CALL and Richard Mayer’s Cognitive Theory of Multimedia, resulting in an integrated theoretical framework for using multimedia in second language teaching.

Theory instantiations, ensembles, and syntheses can be seen to lie along a continuum between interdisciplinarity and transdisciplinarity for a field such as CALL. As they become more developed and refined, the field will move more toward the latter. They can also be considered the precursors of CALL *theory creation*, representing ascendance beyond disciplinary boundaries to a higher level as depicted in a later section.

## A Descriptive Framework for Transdisciplinarity in CALL

One of the problems with attaching the *transdisciplinary* label to CALL is that it is not always clear what is being referred to as “transdisciplinary”. So far, we have primarily considered the position of CALL (as well as SLA/applied linguistics) in terms of it being a *transdisciplinary field*, and in the next section, we propose a possible path for CALL to pursue in evolving toward that goal. However, before doing so, we would like to discuss a range of relevant manifestations of transdisciplinarity that we believe can serve as the building blocks of such a transdisciplinarity movement.

### Transdisciplinary Theory

Following Hubbard & Levy (2016) and Blin (2016), we are looking at *CALL theory* here as encompassing not just formal theories but also perspectives, models, frameworks, and similar entities. As noted above, we predict transdisciplinary theory in CALL is likely to be an outgrowth of the development of theory instantiations, ensembles, and syntheses. As these become broader, more stable, and better integrated, their interdisciplinary nature will have the potential to shift more toward the transdisciplinary ideal.



### **Transdisciplinary Research**

Transdisciplinary research in CALL is likely to develop in tandem with transdisciplinary theory. Along this path, CALL researchers are already posing questions that cannot be adequately addressed with theoretical tools from individual disciplines and monolithic perspectives.

### **Transdisciplinary Practice**

It is easy to fall into the trap of claiming CALL practice is at its core a transdisciplinary endeavor. After all, when language teachers effectively integrate technology into tasks and activities, they have to draw on many sources that could be traced back to diverse disciplines, synthesizing into a more or less coherent whole notions related to SLA, literacy, assessment, cultural anthropology, the psychology of motivation, the sociology of small group interaction, etc. However, to do so would undercut the “discipline” element of transdisciplinarity. According to Richards (1998) among others, teachers typically rely on beliefs, values, and principles to govern their choices of incorporating these notions rather than a substantive understanding of the research, theoretical, and methodological bases of the disciplines that focus on the preceding domains. In a similar vein, Costa and Norton (2017) invoke transdisciplinarity in relation to language teacher identity. Ultimately, transdisciplinary practice for CALL should synthesize disciplinary knowledge from relevant sources and not rely predominantly on practitioner experience and intuition. In an ideal world this would go hand-in-hand with the evolution of transdisciplinary theory and research.

Finally, transdisciplinary practice is not just about teaching. Park and Son (2010) describe a model for transdisciplinary learning and test it in a language class, finding, however, that the reality falls well short of their ideal. De Meester, Lieber, Dimou, & Verborgh (2018) call on transdisciplinarity when addressing learning analytics. By creating a model to use across different learning systems, “the learning analytics can easily be integrated, on the one hand, with Information about the Learner, and on the other hand, with learning analytics across contexts, thus paving the way for transdisciplinary learning analytics” (p. 30).

### **Transdisciplinary Program**

If CALL is to become transdisciplinary at its core, then it requires groups of researchers and graduate students acting in concert to move it ahead. The aim of a transdisciplinary program would be to integrate the diverse disciplinary elements of CALL coherently into an institutional unit. It could be a degree, certificate, or specialty focus within a more traditional academic department, or it could eventually be its own academic department. Such a program would

most likely start with the label “interdisciplinary” as this is much more widely accepted within academia.

### **Transdisciplinary Development Project**

CALL development projects have long been a common setting for multidisciplinary approaches, but transdisciplinarity holds promise here. The key to such projects would be a combination of a team of experts who already had an interdisciplinary bias and openness to communication across disciplinary lines. This would critically require the crossing of disciplinary boundaries to achieve a higher level of synthesis as proposed in Colpaert (2018a) and the following section.

### **Transdisciplinary Researcher, Developer, or Practitioner**

In line with the notions of CALL specialist or CALL professional (Hubbard & Levy, 2006), a transdisciplinary researcher, developer, or practitioner has taken the skills and knowledge from multiple disciplines and melded them into a more or less coherent whole. As a move at the individual level, this path does not require any sort of consensus among formal institutions, including professional conferences or journals, provided the individual can make a persuasive case for his or her transdisciplinary expertise. Levy (1996) refers to this as the “holistic view” and called for language programs to offer courses blending humanities and technology to teacher candidates. On the development side, Farmer and Gruba (2007) see transdisciplinarity in terms of the openness of individual CALL developers to what they call “productivity interference”, a necessary distraction for integrating the engineering side with knowledge and practices from other domains. Specifically, they call for a systematic classification scheme for CALL developer characteristics to support such an endeavor.

### **Transdisciplinary Outreach**

To paraphrase Ortega (2013) as quoted earlier in this paper, transdisciplinary outreach here would be to pursue and generate CALL knowledge that can be of use outside the confines of the field and contribute to overall knowledge about the human capacity for language. This could include theories and models of technology-mediated communication and language learning as well as practice and research methodologies of value to other disciplines, including native-language education.

It is likely that other categories could be added to this typology, but from the current list alone, it should be clear that transdisciplinarity in CALL (or in any context for that matter) has multiple dimensions. Some of these are individual,

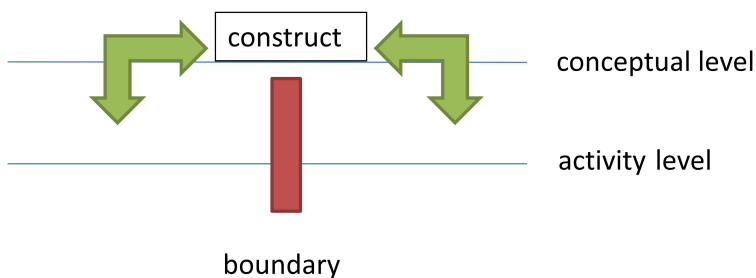
some involve collaborations, and some are institutional. In the final section, we return to the most comprehensive level of “CALL as a field” and discuss how transdisciplinarity can play a key role in whether and how CALL survives and prospers in the coming decades.

## CALL as a Transdisciplinary Field

Mitchell (2005), writing in the context of a health science (nursing) states: “True transdisciplinarity goes beyond simply drawing together concepts from the disciplines ... it creates new frameworks that break down (transgress) the traditional boundaries of the disciplines” (p. 332). Yet, as we have seen, *transdisciplinarity* is an elusive concept. As such, it runs the risk of becoming a blurred ontology like blended learning, flipped classrooms, 21st century skills, and digital natives. From the start with Nicolescu’s *Manifesto* (2002), the concept has been discussed primarily on a metaphysical level. Where it has been mentioned in more concrete terms (mostly in publications on health sciences and sustainability), it has tended to refer to boundaries across actors as representatives of disciplines, and less to boundaries across disciplines themselves. It is often applied to the idea of opening up a research activity to non-researchers, a knowledge building activity between scientific and societal actors, such as policy makers. We believe that a descriptive framework as suggested above is needed to put the notion of *transdisciplinarity* in CALL in a broader context. At the same time, more concrete examples and definitions are needed in order to operationalize it.

In a recent editorial in *Computer Assisted Language Learning*, one of the authors revisited the notion of transdisciplinarity as a follow-up to a 2004 editorial on the same topic (Colpaert, 2004; 2018a). This section summarizes some of the key ideas from that work and expands on them.

To begin with, we define *transdisciplinarity* as the ontological co-creation of knowledge constructs on a higher, boundary-transcending, level of abstraction (see Figure 1).



**Figure 1.** Transdisciplinarity as a construct transcending disciplinary boundaries.

Transdisciplinarity in this view is an activity and represents a new way of thinking. The activity consists in the co-construction (conceptualization and specification) of mental artifacts or knowledge constructs. These constructs can be models, concepts, objects, methods, metaphors, images, and even frameworks. The activity consists in crossing boundaries both between disciplines (linguistics, pedagogy, psychology, technology ...) and between actors involved (learner, teacher, parent, developer, provider, policy maker ...).

Two levels are distinguished: the activity level and the conceptual level. The activity level is the level where researchers and other actors normally work in their own habitat. The conceptual level is the level where they create new knowledge constructs together, thereby transcending the boundaries between them. These constructs can then be instantiated back on the activity level as concrete discipline- or actor-specific elements.

A typical example in CALL would be a software developer and a language teacher trying to develop something together. A language teacher would typically express his/her requirements in terms of layered corrective feedback, remediation, and personalization, while system developers talk about partitioning, relational data models, or client/server interaction. An interdisciplinary approach where both try to understand each other's conceptual frameworks and language does not work easily in practice because the disciplinary boundaries, while weakened, remain. A transdisciplinary approach goes further: it requires them to co-define ontologies for concepts such as the learner, the learning goals, the teacher, the learning process, and the learning content. These ontologies may then form a new, shared language.

We have already stated that there are not enough CALL-specific models, terms, concepts, methods, and frameworks. CALL mainly borrows and imports from other disciplines and theories (Activity Theory, TPACK [Technological Pedagogical Content Knowledge], Item Response Theory, Cognitive Multimedia Theory, Structural Equation Modeling, Technology Acceptance Model ...). If we want CALL to become a respected and respectable discipline, we need to rethink our strategies and focus on building our own ontologies. Working in an interdisciplinary manner, where theories and concepts from a variety of other fields are adapted and/or expanded, is an important step in this direction, but more is required.

The notion of transdisciplinarity brings us back to some basic questions: What is CALL? An activity type? A group of people? Who are CALLers? Researchers? Developers? Language teachers who use technology? Why call CALL "CALL" (Levy & Hubbard, 2005)? Is CALL obsolete (Jarvis & Krashen, 2014)? We believe that these questions can be addressed most coherently at the higher level of identity for CALL afforded by a transdisciplinary conceptualization of the field.

The need for a transdisciplinary approach in CALL will continue to increase due to the increasing complexity of new phenomena involved: Complex Dynamic Systems, Open Data, Data Protection and Privacy, Learning Analytics, Blockchain Technology, Instructional Design, and the social dimensions in CALL (the last being the topic of the XXth International CALL Research Conference in Hong Kong). More disciplines, and more complex disciplines, entail challenges but also affordances, if conceptualized in a transdisciplinary way. An example of this is *contextualization* of the learning process. New systems can be conceptualized in a transdisciplinary way on the basis of contextual factors such as the geotemporal location of the learner, the learner's goals, preferences, and analytics, data available in terms of Open Data and OERs, interface capabilities of the mobile device, and acceptable task ideas. Imagine you are, say, a learner of Italian (level B2). Wherever you may be, even in your home town, you can be notified around noon that there is an Italian restaurant in the neighborhood with a good rating on TripAdvisor. The system can then show the menu and the specials of the day, adding pronunciation and explanation. It can add information found in Open Data, or exercises found in OERs. You, the learner, then have the possibility to accept, to read, to listen, and to do exercises. Or not.

Another example is situated in a more challenging environment. Imagine you are in the neighborhood of Hong Kong, in the fisherman's village of Tuen-Mun. You neither speak nor read Chinese. You do not know anything about how to have dinner in a local restaurant. A lady tries to sell you fish, but you try to explain to her that you are staying in a hotel and that it does not make any sense for you to buy fish. You go back to the hotel ... you have just missed a golden learning opportunity. A contextualized application could have explained in advance the unique character of this village, what their specialties are, which types of fish and seafood you can buy, how to order and pay for the fish, how to take your food across the street to one of the local restaurants, how the waiter will ask how you want the fish (cooked, steamed, or grilled, with vegetables or not etc.), how to "do the dishes" (cleaning your chopsticks and cups with the tea before you start eating), how to proceed with chop sticks, how to thank the waiter, etc. A transdisciplinary description of this kind of app for contextualized learning could be surprisingly straightforward and easy to understand for all collaborators involved.

After an initial technology-driven period (which was not necessarily bad per se), most scholars agreed that not technology, but pedagogy needed to be the starting point for design. Nowadays, it would seem that psychology (Colpaert, 2014) could also be a good starting point. No matter how good a pedagogical approach is, it will not work if certain psychological-motivational criteria are not met. On the one hand, there is Self-Determination Theory,

a theory that tries to explain human behavior on the basis of three innate psychological needs: competence, relatedness, and autonomy (Deci & Ryan, 2000). These needs are said to be universal. That means we should take them into account when designing learning environments. On the other hand, there is the L2 SELF model which should be applied on the individual level (Dörnyei & Ushioda, 2009). This is why another model was needed for determining psychological aspects to take into account with groups of students when designing learning environments. A learning environment conceptualized as a compromise between conflicting personal goals and pedagogical goals (Colpaert, 2010) has appeared to be an excellent starting point for a transdisciplinary design approach that encompasses all disciplines involved and that is applicable for all specialists and actors involved.

A third example applies to Open Data and learning content. The development of learning content, especially language learning content, has always been extremely labor-intensive. And that content is lost at every new pedagogical approach, at every new curriculum. The advent of technology made things even more complex: on the one hand, we needed more linguistic-didactic functionality—hence more complex data structures—for interactive courseware. On the other hand, the data structure became more and more determined by the technology (dedicated) so that content was not exchangeable nor reusable any more. This is why some have been advocating a generic in-depth structure for language learning content. Recent Open Data initiatives worldwide (Colpaert, 2018c), however, focus on opening up and linking repositories of data in various formats and structures. A Linked Open Data could open up existing learning content in OER-repositories, government services (like *KlasCement* in Belgium), or publisher's collections. A new generation of apps could access and link learning content in the most diverse structures and formats and combine them into new tools and services for supporting language teachers and learners. A transdisciplinary endeavor here would involve more disciplines (linguistics, technology, pedagogy, management, policy, psychology) and more actors (authors, content providers, service providers, publishers, government services, parents, teachers, learners). It would focus on common representation of concepts such as tasks, learning units, learners, and teachers.

As recent work in applied linguistics has shown, the more disciplines that are involved, the more the need for a transdisciplinary approach. For CALL, the more disciplines that are brought together in a transdisciplinary approach, the more possible CALL-specific constructs on the conceptual level. Which brings us to a possible new definition of CALL: CALL can be considered a transdisciplinary endeavor on the conceptual level regarding the discipline- and actor-transcending co-creation, use, and evaluation of knowledge constructs such as models, concepts, objects, methods, metaphors, images, and even frameworks

for technology-mediated language learning, testing, and teaching. The more disciplines that are involved, the more affordances for CALL.

What does this mean now for researchers who are writing a project proposal, designing a research project, or writing an article? What does this mean for developers when designing apps, tools, and learning environments? What does this mean for teachers who are pressured to use more technology in the classroom? What does this mean for evaluators? Policy makers? These are important questions for everyone connected to the field to be addressing.

Software developers, language teachers, applied linguists, SLA-researchers, and psychologists “do” CALL when they create something new, in a discipline-independent way, together with specialists from other disciplines, or when they use or evaluate these mental artifacts. Language learners, language teachers, parents, policy makers, and providers “do” CALL when they contribute to, use, or evaluate these knowledge co-constructions. A common mental image and understanding of the role of technology and its added value would considerably improve the communication among actors.

Authors of project proposals and publications “do” CALL when they apply a transdisciplinary approach to the substantiation of a problem statement and to the logic behind it. That approach can then also be applied to reasoning why something can be a solution. This is the theme of the XXIst International CALL Research Conference in 2020.

Transdisciplinarity can be considered a way of looking at reality, a way of thinking, a way of speaking and writing; in short, a new language. Instead of conceptualizing new solutions every time we need to combine findings from various disciplines, we can ask ourselves to what extent it would be possible to work out *one* language for CALL, one representation of Reality based on multiple angles of attack. This could be an ontology specification language such as Ontolingua, OIL (Object Interaction Language), RDF (Resource Description Framework), or UML (universal modeling language); an educational modeling language such as HTML (tutorial mark-up language), EML (educational modeling language) and LDL (learning design language). A complex endeavor? The pedagogical framework in use in teacher education at the University of Antwerp (Meeus & Verbeek, 2016) is a simple example in natural language of a discipline-transcending way to look at education.

## Conclusion

In this paper, we have explored the notion of transdisciplinarity with respect to CALL and provided evidence and arguments that currently CALL is probably best seen as an established interdisciplinary field. We have also traced the growth of a transdisciplinarity movement within the overlapping fields of applied linguistics and SLA. We have argued that the existence of theory



instantiations, ensembles, and syntheses within CALL is taking it down a path toward greater transdisciplinarity, and we have offered a descriptive framework that incorporates a number of dimensions of transdisciplinarity at the individual, collaborative, and institutional levels.

We believe that transdisciplinarity promises a more comprehensive approach than interdisciplinary teamwork and that there is a definition of transdisciplinarity possible for CALL that will lead to growth and sustainability for the field. It will, however, take much more than merely tossing around the term *transdisciplinarity* to have a substantive impact on current and future CALL endeavors. The problem that not enough CALL knowledge, models, concepts, etc. have been developed over the years is perhaps due to the fact that we have not been approaching it in the right way. We have defined transdisciplinarity as the creation of knowledge constructs in a boundary-transcending way on a higher level of abstraction. As such, transdisciplinarity has the potential to open the gateway for CALL to build its own concepts, methods and language.

CALL is the boundary-transcending conceptual level in an endeavor where multiple disciplines and actors involved with language learning and technology come together. Building collaboratively on this conceptual level is a promising way to put CALL on the map as a respectable and respected discipline. Finally, transdisciplinarity even fits within a broader concept like *trans-cultural communication*, which “in analogy with transdisciplinarity, could be described as interaction leading to the construction of common ideas, constructs or artefacts as bridges between cultures” (Colpaert, 2018b).

To conclude, we have offered some preliminary ideas and a transdisciplinary direction for the future of CALL that we believe is important to pursue. The transdisciplinary turn in our field is just beginning, and we invite our colleagues in CALL and related fields to pursue this notion further through their own “transdisciplining”.

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