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I Can't Program! Customizable Mobile Language-Learning Resources for Researchers and Practitioners

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Abstract: Combining insights from Activity Theory (Engeström, 2014), mobile-assisted language-learning (MALL) (Stockwell and Hubbard, 2013), and computer-assisted language learning (CALL) research (Chapelle, 2001), this paper proposes three levels of teacher involvement in the adaptation and/or creation of MALL resources to enhance learner interaction with the target language and potentially contribute to the field of learner-computer interactions. Specifically, this paper (1) proposes three levels of teacher involvement in MALL material creation, moving from easily adaptable pre-made materials (e.g., Duolingo) to customizable materials (e.g., Quizlet) and finally to teacher-created materials (e.g., Moodle); (2) demonstrates how these levels of design can be implemented in a MALL context to increase target language interaction according to Activity Theory (e.g., how teachers can incorporate gaming features into their online courses); and (3) concludes with recommendations as to how MALL "engineers" can work together to enhance the overall L2 learning experience and potentially collaborate in research and in the design of pedagogical materials. From a pedagogical standpoint, through these three levels of teacher involvement in material creation, teachers can extend the reach of their classrooms by mobilizing the target L2 environments, depending on their MALL/CALL proficiency and/or interests. This approach also invites second language acquisition scholars from a wide range of technological abilities to contribute to CALL research.

Keywords: MALL; material design; teacher role

1. Introduction

When presenting about researcher-designed computer-assisted language learning (CALL) materials, some common questions asked of the researcher are: "How long have you been a programmer?" or "How can I learn how to do this?". These questions, posed by researchers and practitioners alike, indicate that they likely have some interest in creating their own CALL materials, but their curiosity is overshadowed by the perceived necessity of becoming a computer programmer. This sentiment echoes Godwin-Jones' call for language teachers to learn how to program to "follow new developments in technology and be able to understand their potential use in second language instruction" [1] (p. 10).

While we do not contest the importance of learning how to program, learning for the purposes of material creation requires a significant commitment. This paper will instead investigate how many of the latest mobile-assisted language learning (MALL) resources can be customized for specific language learning needs without requiring programming knowledge. This affords a new wave of language researchers and practitioners not only the opportunity to modify existing materials or to create their own to increase the relevance of the material to the learning context, but to also mobilize second

language learning. To this end, this paper aims to help language teachers and researchers enter the world of MALL without requiring a background in programming and will do so by proposing three levels of teacher involvement in customizing and/or creating MALL materials.

Due to the prevalence of mobile technology in daily life, it is seemingly natural for language teachers to take advantage of their students' smartphone use. Already, language teachers face an inherent pressure to possess extensive knowledge in their subject area in addition to striving to become more technologically minded [1]. These expectations present many challenges to the typical language teacher, as they are often limited by "budgeting constraints, equipment/infrastructure issues, teacher overload, or [the] lack of effective training [or] more intangible factors like teacher beliefs and attitudes" [1] (p. 14). Even if the aforementioned barriers are not present when implementing these technologies, successful implementation remains challenging; if digital technology is "integrated into pedagogical practices in an arbitrary fashion, or, if used inadequately, their true additional value to language learning could be quite limited" [2] (pp. 188–189). To ensure successful integration, the approach a teacher takes to implementing CALL materials should involve an iterative process of investigation, testing, and analyzing, as seen in design-based research [3]. Teachers are therefore ideal designers as they experience the successes and failures of implementing new materials in the classroom, gaining the knowledge necessary to make materials as efficient as possible [4].

A challenge of equal importance is whether teachers view themselves as part of the ever-advancing field of CALL. A team from the University of Oulu in Finland, for example, found that, when provided the opportunity to work as CALL designers to develop and implement their own materials, student-teachers may still have difficulty viewing themselves as future CALL designers [5]. The authors argue that since the role of a CALL teacher-designer is not yet clear to future teachers, it should therefore be more clearly established; it is critical for potential teacher designers to feel like they can be worthy participants in CALL material development. This paper aims to contribute to the understanding of how teacher-practitioners fulfill this role.

The ability to tailor MALL materials to help increase interaction with the target language (TL) outside of class provides a compelling approach to aiding in second or foreign language acquisition. Interaction with the target language is here operationalized as the technologically-mediated contact that learners have with the target language in the mobile setting, including opportunities for input exposure and output practice. Traditional mass-produced language learning materials created for a global market are typically paper-based and designed to target a broad audience rather than focusing on a specific population or learning context [6]. Many teachers therefore adapt or create their own (paper-based) materials "to take into account their particular learning environments and to overcome the lack of 'fit'" [6] (p. 101). By applying this same logic to MALL materials, the language teacher can extend the reach of the language classroom while still maintaining relevance to the classroom context, which has the potential to encourage learners to interact with the TL in a meaningful way.

In a new approach to developing CALL materials, [4] recommend adopting an Activity Theory approach to design. We propose applying this same approach to MALL, as the objective of creating activities that increase TL interaction via mobile technology is the same, with the added benefit of mobility. Since CALL and MALL are young disciplines that lack extensive proven research and development methods, a hard sciences approach enables researchers and teachers to gain an understanding of how interactions with and through technology influence language learning [4]. Caws and Hamel [4] point out that Activity Theory [7] can enhance the development of these materials, as developers can better understand the bond between learners and human-made programs through the scope of this theory. This paper aims to help practitioners use MALL technology and Activity Theory to strengthen the bond between language learners and the TL.

We propose three different levels of teacher involvement in modifying and creating MALL materials that can be employed by novice computer users to enhance user-artifact bonds for the purposes of second language acquisition (SLA); (1) working with premade MALL materials, (2) customizing MALL materials, and (3) creating MALL materials. These levels serve as a guide

for language teachers and researchers to enter MALL design at the level that is appropriate for their teaching objectives and available resources (e.g., time, money, familiarity with MALL). The levels are, however, not static, but instead act as a continuum; teachers may engage in MALL design at whichever level is most suitable to their purposes and are not restricted to stay within any one level. Teachers may find, for example, that although they are working on a Level 3 project, they may also be utilizing features and skills acquired in the first two levels. Just as an engineer may customize premade plans to design their creation, it is not mandatory for a language teacher to design MALL materials from scratch in order to mobilize the classroom; they may use or adapt existing material or create their own to serve their needs. By working as "CALL engineers", teacher practitioners also function as researchers and developers, a role that "gives them a privileged insight into the discipline, which engineers might not have the opportunity to acquire"' [4] (p. 4). When adopting the posture of working as a CALL engineer in a mobile setting (henceforth "MALL engineer"), the teacher, also serving as a researcher and developer, can tap into personal classroom experiences to design materials that harness the potential of mobile technology.

2. Teacher-Designed Mobile-Assisted Language-Learning Materials to Increase Target Language Interaction

MALL, a recent field resulting from the combination of CALL and mobile learning (also referred to as m-learning; [8]), is effective in alleviating the traditional roadblocks to language learning such as limitations of time and space [9]. This enables learners to choose a comfortable location from to interact with the TL at their own convenience. As Valamarthi points out [8], students in the mobile setting are able to keep more consistent contact with the materials, the teacher, and their peers. Recent studies suggest that MALL is also effective when it offers a variety of ways to help learners become more engaged in TL interaction. McCarty et al. [10], through a series of case studies, show that MALL technology in Japan has been able to afford learners opportunities to learn a foreign language in a way that considers the learning habits within their cultural context(s), offering a variety of benefits for students of differing learning styles and backgrounds. In particular, the authors take a sociocultural approach to gain a better understanding of how to implement mobile technology.

Other individual differences such as L2 speaking anxiety may decrease through the use of gamified language learning apps (e.g., [11]), while willingness to engage in a task may increase [12]. Additionally, McCarty et al. [10] found that mobile devices may be more effective at holding students' attention than tasks completed on a computer, as students are not as likely to multitask; for example, completing a task on a computer allows students to easily switch between windows or tabs, whereas an app covers the entire screen of a mobile device. In short, language teachers should not ignore the potential of MALL, especially since many people are transitioning towards making increasingly powerful smartphones their sole computer [13].

While many teachers are constrained to teaching from mass-produced textbooks or materials that offer limited opportunities for TL interaction [6], MALL engineers can address this gap by using their unique experiences and a research-based approach to customizing materials that increase interaction with language learning materials [4]. Being able to build materials based on experience is important because publishers take an approach to material development that is more dependent on profit than L2 pedagogy [14,15], which leads to the creation of more generic, one-size-fits-all materials [6]. If teachers are able to take a more active role in material development by using customizable MALL materials, they can extract effective lessons or activities from textbooks and integrate them into MALL tasks to encourage the learners to use the TL to achieve higher goals than merely studying for tests [15,16]. To this end, an approach to MALL design that balances knowledge from SLA and MALL research gives teachers the opportunity to help learners have more meaningful and, quite possibly, more successful TL interactions.

There are many features available within MALL apps for teachers to use (e.g., gamified elements, flashcards, chats), and deciding how to use them to increase TL interaction can be an overwhelming

experience. If TL interaction is the goal, an approach that focuses on how learners interact with materials to achieve specific goals is necessary. Activity Theory, which has origins in the philosophy of Kant, the psychology of Vygotsky, and in the writings of Marx and Engels, addresses the needs of building materials that mediate interaction" [7]. As Engeström points out, "humans can control their own behavior—not 'from the inside,' on the basis of biological urges, but 'from the outside,' using and creating artifacts" [7] (p. 29). In terms of language learning, an Activity Theory approach enables teachers to design materials that increase or enhance the interactions users have with the TL. Activity Theory is, therefore, operationalized here as the use of MALL technology by teachers, with a specific focus on tool and object orchestration; it is through the interplay between these two aspects of Activity Theory that teachers without programming experience can help students transform specific TL objects into actual outcomes regardless of the students' physical location.

The Activity Theory model at the individual level (Figure 1) consists of three key relationships; subject, tool, and object. These relationships are the components of an activity at the individual level, and they result in a specific outcome or outcomes. In this paper, the focus will be on how the object (i.e., the learning goal) can be transformed into an outcome (i.e., the student achieves the goal) by using MALL tools (i.e., hardware and software). The subject (foreign language learners) and outcome (i.e., achieving the objective) are relatively constant, while the tools and objects are what teachers can change to enhance the usage of tools in the process of achieving the outcome. For example, in Moodle (Moodle, Inc., Perth, Australia, https://moodle.org), tools (hardware and software) are utilized differently based on the object. If a teacher were to gamify a Moodle pronunciation activity for the object of pronunciation, students would use a smartphone's camera, internal microphone, and touch screen to record answers; however, a different object such as a spelling newly acquired L2 vocabulary would require the students to use only some of the aforementioned tools and in a different manner. In this way, objects are an essential part of building activities, as "an activity is a form of doing directed to an object and activities are distinguished from each other according to their objects" [17] (p. 24). This means that learners work towards specific TL outcomes, whereas a tool is what a learner uses to turn an object into an outcome. Accordingly, the features specific to each MALL app enable teachers to customize different combinations of tools to help learners increase their interaction with the TL outside of class.

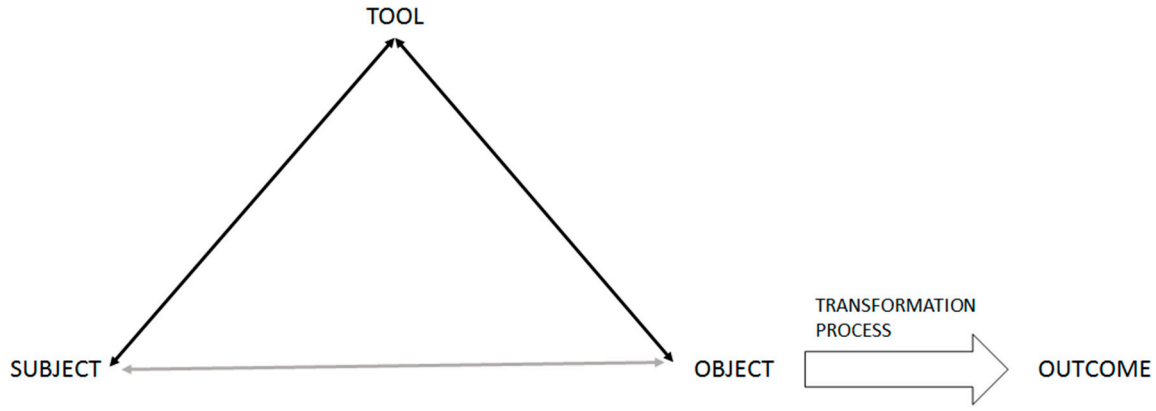

Figure 1. Activity Theory model at individual level (adapted from [17]).

In the process of increasing TL interaction in the MALL setting, teachers need to understand how the available features in apps afford learners unique opportunities to transform objects into outcomes. Kuutti explains that tools can enable and empower learners to make it through the transformation process to achieve outcomes, but learners are simultaneously limited because the outcomes are restricted to interacting with specific tools [17]. Due to this, it is important that teachers are aware of as many different MALL tools as possible and that they can implement them in their courses, as this enables students achieve outcomes in a number of ways and in different settings; most foreign

language students are limited to traditional tool usage (e.g., textbooks, notebooks, pens). By specifically focusing on the degree to which MALL engineers engage in manipulating tools for student use outside of foreign language classes, they can empower students to go through the transformation process necessary to achieve TL outcomes.

When designing MALL materials, teachers, developers, and researchers should engage in an ongoing process that allows them to modify their new materials based on feedback received before, during, and after implementation. Educational design research, a popular approach in the field of Educational Technology, focuses on simultaneously integrating theory and pedagogical insights in order to produce effective materials in real world contexts [3]. According to this research method, in real world contexts, developers should not be isolated from the classroom; the objective is to learn from experience and adapt accordingly. The generic model for design-based research consists of three phases: (1) investigation and analysis; (2) design and prototyping; and (3) evaluation and retrospection. This is not a static model, as it 'is iterative because results from some elements feed into others' and flexible, as following the model in the proposed order is not necessary [3] (p. 77); investigation may influence analysis, evaluation/retrospection may influence investigation/analysis, and so on. If this approach is applied to the development of customizable MALL materials, teachers without programming experience can become a key part of creating effective materials.

A process that positions the teacher as a MALL designer is ideal for developing learning materials and, as in educational design research, relies on interaction with practice [3]; first, issues and/or gaps in learning may be addressed and investigated, which will inform material design and creation. After implementing new materials in the classroom, the developer then revisits the original tool to modify it based on successes and/or failures observed during implementation, just as a teacher working with a paper-based activity may modify it for a second group of learners based on responses from the first group. The teacher is therefore the ideal developer in this scenario, as continuous access to a live laboratory allows foreign language teachers to continuously engage in this cycle. This process results in theoretical and practical outcomes [3], as the knowledge gathered in this cycle can be used to not only inform the use of this tool in a specific teaching context (the practical outcomes), but also to be shared with other educational researchers to inform theoretical practices. This sentiment is in line with Caws and Hamel, who explain that teacher practitioners, who also function as researchers and developers, have unique experiences and understandings that engineers alone are not likely to have [4]. In the process of developing MALL technology to increase TL interaction, teachers, even without programming skills, can make a difference in the development of materials. To this end, this paper aims to achieve the following three objectives:

1. Propose and define three levels of teacher involvement with modifiable MALL materials, moving from adapting pre-made MALL materials (by selecting features for students to use), to customizing or modifying materials (e.g., Quizlet (Quizlet, Inc., San Francisco, CA, USA, https://quizlet.com), digital flashcards), to finally creating their own materials (e.g., Moodle, constructing mobile apps via app creators);
2. Demonstrate how these levels of design can be implemented in a MALL context to increase target language interaction according to Activity Theory; and
3. Conclude with recommendations as to how MALL 'engineers' can work together to enhance the overall L2 learning experience and potentially collaborate on research and the design of pedagogical materials.

3. Three Levels of Teacher Involvement in Mobile-Assisted Language-Learning Implementation

Based on the three objectives outlined in the preceding section, we propose three levels of teacher involvement in "adapting", "modifying", and "creating" MALL materials specifically for their own teaching contexts; (1) working with premade MALL materials, (2) customizing MALL materials, and (3) designing MALL materials. See Figure 2 below for an illustration of our proposed three levels of teacher involvement in MALL implementation. By outlining the three levels, we are not referring

to programming ability but rather the capacity teachers must have to orchestrate tools (i.e., MALL software and hardware) that enable students to work towards specific TL objects (i.e., targeted language features such as vocabulary) to eventually achieve the outcome of increased TL interaction. As will be seen, these levels consist not only of the degree of teacher involvement (e.g., active versus passive roles) in material creation, but also of the time and effort required. As the levels increase (from level one to three), teachers have an increased responsibility to produce content and arrange a variety of customizable MALL materials for their learners.

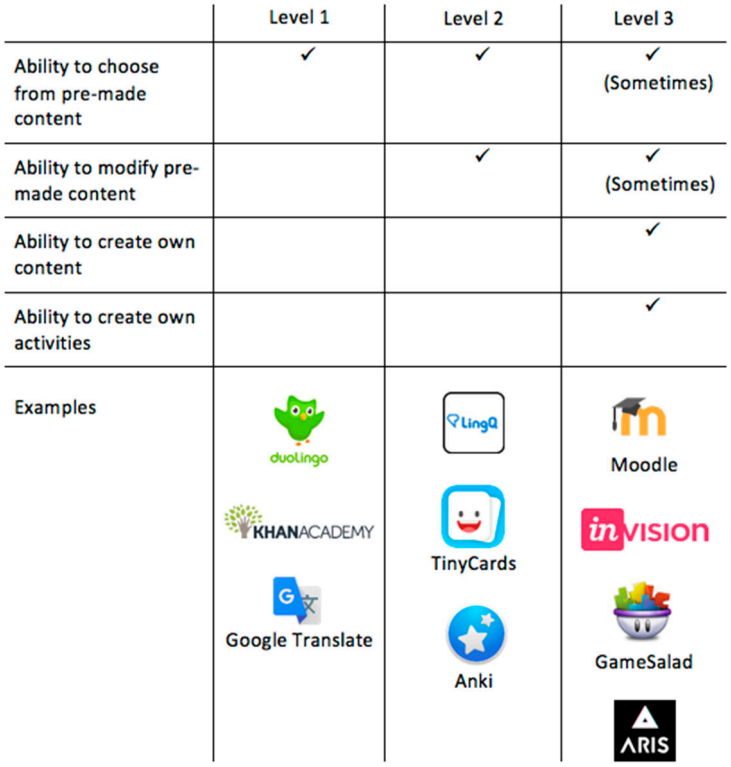

Figure 2. Levels of teacher involvement in mobile-assisted language learning (MALL) material creation and adaptation.

On the other end of the spectrum, as the levels decrease (from level three to one), the effort a teacher puts forth is more focused on integrating pre-existing MALL materials into language learning contexts. As mentioned earlier, although we have outlined the teachers' involvement with these materials as 'levels', these categories are not static: rather, these levels are more of a continuum, overlapping one another depending on how the MALL engineer decides to interact with the materials and resources. Most importantly, MALL engineers at any level can use Activity Theory to gain an understanding of how customizable MALL materials can be used to increase TL interaction. By having an explicit understanding of how objects inform the use of tools to help students achieve specific outcomes, foreign language teachers without any programming experience can use customizable MALL materials to create mobile learning opportunities for their students. Accordingly, the following three levels will offer examples of customizable MALL materials and explore how the use of the available features in each app are directed by the object.

Design-based research suggests that teachers are ideal designers of pedagogical tasks and materials; they can easily engage in a continuous cycle, e.g., [3], to incorporate what they learn from first-hand experience with language learners into the creation process. This is of utmost importance, as teachers can take advantage of their unique classroom experiences to become involved in the design process. Through our discussion of the three levels, we intend to encourage language teachers to move

beyond restrictions such as time, training, and budgeting as outlined by [1] to test out their ideas and adapt or create MALL materials to enhance learner interaction with the TL.

Figure 2 illustrates our proposed levels of teacher involvement in the development and adaptation of MALL materials. At Level 1, which consists of pre-made apps, the involvement of the teacher is limited to integrating pre-made features or aspects of the app into a language learning context or recommending them to students. At Level 2, we begin to see a more active role for the language teacher. MALL materials at this level are customizable and, accordingly, can be manipulated by the teacher to provide the learners more ways to interact with the TL; personalizing them requires minimal time and effort. This level springs from Level 1 as the pre-made materials here are modified by the teacher not simply explored for their potential uses. Level 3 sees teachers take on a more active role as they balance organizing tools and generating materials that can be more specific to their teaching contexts than the first two levels but that are certainly influenced by and may contain elements from the previous levels as well. As teachers progress through the levels, they become more and more involved in the organization of tasks and tools, and each level sees them take on a more active role as a MALL engineer. It should be noted, however, that while these levels do not require the teacher to learn how to program, a significant amount of time and effort is needed to effectively use tools at any level, as discussed below. We also remind the reader that these levels are not static and may influence one another throughout the creative process.

Using customizable MALL materials requires a great deal of teacher involvement, which requires the teacher to balance a proven approach to technology with specific SLA knowledge. Chapelle's [18] widely used criteria for CALL task appropriateness, illustrated in Table 1, provide the practitioner with a practical list of aspects to consider when choosing materials for use with their students (see also [19] for the pedagogical implementation of these ideas). While teachers at all levels are provided with resources to present their learners with personalized language learning materials, it is the teacher's responsibility to find a way to use the materials effectively. By following these criteria, practitioners can evaluate and/or design materials based on which aspects of language the materials focus, the authenticity of this language, the feasibility of incorporating these materials, and so on. We highly recommend that MALL engineers take these criteria into consideration when choosing, creating, or modifying MALL materials for their own purposes, particularly at Level 1. These criteria will be addressed briefly in the discussion of each of the three levels, where appropriate.

Table 1. Criteria for computer-assisted language learning (CALL) task appropriateness [18].

Language Learning Potential	The Degree of Opportunity Present for a Beneficial Focus on Form.
Learner fit	The amount of opportunity for engagement with the language under the appropriate conditions given the learner characteristics.
Meaning focus	The extent to which learners' attention is directed toward the meaning of the language.
Authenticity	The degree of correspondence between the CALL activity and target language activities of interest to learners out of the classroom.
Positive impact	The positive effects of the CALL activity on those who participate in it.
Practicality	The adequacy of resources to support the use of the CALL activity.

We discuss below how the ideas presented here can be applied to real-world contexts, considering the proposed three levels of teacher involvement in the creation of MALL materials.

3.1. Level One: Adapting

Gamified language learning apps such as Duolingo (Duolingo, Inc., Pittsburg, PA, USA, http://www.duolingo.com) have gained popularity for their fun nature and accessibility and for offering pre-defined learning paths for language learning. While Duolingo, available free of charge online as well as for Android and iOS devices, has been shown to be beneficial for individual practice [20] (but see [21] for a recent study on this issue that counters this app's efficiency as a tool for

self-directed learning), it is more suited to the autonomous learner than classroom use, as it follows a preset path for the learner to follow. This means that the learner cannot choose a language feature to target but must instead follow the app's direction for learning. Additionally, although many similar language learning apps (e.g., Memrise (Memrise, Inc., London, U.K., https://www.memrise.com); Mango (Mango Languages, Farmington Hills, MI, USA, www.mangolanguages.com)) adapt to a learner's progress to target an individual's weaknesses, the pre-defined learning path is static and, for the most part, does not allow for customization. For instance, if the learner wishes to practice a certain grammatical tense, he or she must wait until that level of the 'game' has been reached. In these apps, the teacher is therefore restricted by the program and is not able to choose which language items the learners focus on. However, recent developments have made it possible for teachers to personalize their students' learning experience.

At this level, the teacher's ability to customize MALL materials for specific TL objects is limited; instead, the process focuses more on creatively implementing pre-made materials into learning contexts. Returning to the Duolingo example, teachers can still make use of the available features on the application to create effective mobile learning environments, but this relies on ingenuity and balancing the available tools on the app with the desired object. As mentioned above, recent developments have seen Duolingo and other similar educational apps become adaptable. In Duolingo for Schools (https://schools.duolingo.com), for example, teachers can now create digital classrooms online for their students, allowing them to supervise student progress and assign specific language units (such as vocabulary for means of transportation or the simple past tense). While teachers can be more aware of how their students are progressing, which is a critical part of the iterative process of design, students using apps such as Duolingo have opportunities to develop regular study habits as a result of gamified learning environments, instant feedback, and multi-modal, out-of-class assignments. In this way, the teacher is able to focus on the object of L2 vocabulary acquisition, for example, from a few different angles on the app.

When using Duolingo, students complete a variety of exercises such as a vocabulary activity, in which they touch the screen to match words to images, which may be followed by a listening activity, in which they listen to a phrase and type what they have heard. In this way, the object requires students to use different tools (e.g., touch screen, keyboard, speakers) to transform the object into an outcome. This specific outcome is accompanied by an equally important general outcome; increased input exposure outside of class is critical for student development and provides more opportunities for input exposure than traditional materials (e.g., [22]). Similar to Duolingo for Schools, KhanAcademy (Khan Academy, Inc., Mountain View, CA, USA, https://www.khanacademy.org), also available for free across platforms, offers an extensive database of educational videos on a variety of topics, which teachers can select and assign to students to view on their own time. Apps like Duolingo for Schools and KhanAcademy therefore allow teachers to select the materials that are best suited and most relevant for their students. While the teachers do not customize tools beyond what is provided in the app, the ability to implement pre-made materials and to customize language practice for their students by selecting relevant material also makes these materials easier to incorporate into the curriculum.

At Level 1, teachers may also choose to experiment with apps to explore potential pedagogical features in order to make recommendations to their students. Through this experimentation, teachers can discover new uses for existing apps, modifying classroom tasks to fit within the capabilities of the app. In this process, teachers have the chance to become familiar with how students can use their devices as tools to achieve the outcome of interacting with the TL. Apps such as GoogleTranslate (Google, Inc., Mountain View, CA, USA, available for free online at https://translate.google.ca; also on Android and iOS) and intelligent personal assistant programs or devices like Apple's Siri (Apple, Inc., Cupertino, CA, USA, https://www.apple.com/ios/siri/) and Amazon Echo (Amazon, Inc., Seattle, WA, USA, www.amazon.com/echo), for example, can be used for much more than their original purposes. These programs can provide students with listening practice via a computerized text-to-speech (TTS) voice or pronunciation practice via automated speech recognition (ASR),

through which students receive immediate orthographic feedback as they interact with the app. With teacher guidance, language learners can therefore use these apps and programs beyond their original purposes (e.g., as a translator or personal assistant) to provide customized language practice available anytime, anywhere.

Level one sees teachers act as testers of existing software, experimenting with existing programs to discover the best uses of various features to help their students enhance their interaction with the TL. While teachers do not manipulate or change any features within the app, they select and assign features (e.g., language lessons from Duolingo, videos from KhanAcademy, pronunciation exercises in GoogleTranslate or Amazon Echo) to customize the learning experience to encourage relevant practice beyond the classroom setting. At this level, teachers do not require any additional technical training; they simply require the teacher to have necessary linguistic knowledge to select features of the app and the motivation to experiment with various ways of using the features.

We again recommend the consultation of Chapelle's [18] and Chapelle and Jamieson's [19] criteria for evaluating CALL task appropriateness when deciding on which app and which of its features to use. The criteria of learner fit in particular acts as the core of Level 1; by exploring the app and choosing which features and/or tasks will best suit his or her students, the teacher can then select material based on its ability to encourage "engagement with language under appropriate conditions given learner characteristics" [18] (p. 55). When choosing the material or features to use, the teacher must also consider Chapelle's other criteria such as meaning focus (e.g., what is the targeted language feature?), authenticity (e.g., is the language used authentic or inauthentic?), positive impact (e.g., will the learners enjoy the task?), and practicality (e.g., is this activity practical based on my classroom resources?). At Level 1, Chapelle's criteria for CALL task appropriateness are essential to consider when choosing tasks and features of existing, pre-made apps. However, these criteria are just as essential when modifying these tasks and features to create customized language learning activities, as will be discussed next.

3.2. Level Two: Modifying

At the second level, we see teachers begin to take on a more active role as MALL engineers. Apps at this level not only provide teachers with ready-made resources generated by the app's creators or by other users, but also allow them to create their own materials (e.g., by adding their own podcasts, recordings, texts) to tailor the learner experience for specific learning needs. Level 2 affords teachers opportunities to customize not just adapt MALL resources with their classroom contexts in mind by having increased freedom to arrange objects and tools to increase TL interaction. Apps at this level also provide students with the ability to control the direction and pace of their own learning within the task. While material creation and modification at Level 2 sees teachers take on a more active role, the time and effort required of the teacher will vary based on an individual's goals and his or her comfort and confidence when interacting with new software. We will now illustrate how some popular apps fit into our criteria for 'modifiable' MALL materials at Level 2.

TinyCards (Duolingo, Inc.), created by the makers of Duolingo (https://tinycards.duolingo.com, also for iOS), presents users with the ability to access pre-made flashcards or create their own. While the customizability is limited, TinyCards differs from a Level 1 app in that teachers now have the ability to create their own content within the capabilities of the app. Flashcards created with TinyCards are not limited to text and images; users can also add audio clips to their cards, providing additional resources for pronunciation and listening practice. By adding images or audio, learners stay focused on the TL throughout the activity without relying on translation. While these flashcards are typically focused on vocabulary acquisition, the possibilities are endless; users can create grammar-based cards, cards to recognize the pronunciation of words, and so on. Anki (Anki, Inc., San Francisco, CA, USA, https://apps.ankiweb.net, available across platforms), another digital flashcard program, also presents users with the ability to create their own cards. While the TinyCards interface is friendlier and more appealing, Anki offers additional options such as the ability to synchronize cards across

devices, add video clips to cards, and keep track of card use (e.g., how long users spend on each card). With teacher-created (or even student-created) digital flashcards, students can again customize their own interaction with the TL (see [23] for the pedagogical benefits of digital flashcards). TinyCards and Anki materials can be shared easily with students, providing additional opportunities for learners to use mobile technology in multiple ways to interact with the TL outside of class.

Quizlet is another flashcard-based app made for mobile devices that enables learners use text-to-speech (TTS) flashcards in a variety of games and quizzes designed to develop vocabulary. In addition to the basic flashcard functions, Quizlet also allows students to play games such as timed matching contests, fill in the blank quizzes, spelling quizzes, and an asteroid game in which the correct answer must be entered before the asteroid hits the user's planet. Gamified elements in the form of progress bars and motivational affordances contribute to creating an engaging environment that can also be exported from Quizlet to Moodle courses. In terms of Activity Theory, teachers can use Quizlet to help students prepare for spelling quizzes, for example, which means that students would use the device's tools (e.g., screen, keyboard, speakers) to transform the object of spelling TL vocabulary into an actual outcome. To help beginning learners, this activity could be preceded by a simple flashcard activity in which students use the touch screen as a tool to achieve the object of learning the relevant vocabulary. In addition to the hardware, Quizlet, like Duolingo, offers a wide range of tools in the form of gamified elements designed to engage learners and help them to see progress.

For practice in reading and/or listening to longer texts, LingQ (LingQ, Inc., Vancouver, BC, Canada, https://www.lingq.com), an app for mobile devices and Chrome (Google Inc, https://www.google.com/chrome/index.html) browsers, allows learners to practice these skills while building vocabulary. In the app, users can explore existing language lessons or create their own. Each lesson utilizes a variety of tools such as podcasts, audio recordings, or text accompanied by a transcript so that the learner can follow along while listening. Each word in the text is automatically highlighted; when the user clicks on a word, they hear a TTS voice pronouncing the word and have access to online dictionaries and translations. The user has the option to save the word for later practice with digital flashcards or cloze exercises via a gamified system. These words will also be highlighted in other lessons that users complete. By being able to determine the focus of its lessons based on particular interests, LingQ allows the learner to generate a personalized vocabulary list based on particular goals, focusing, for example, on financial vocabulary in an article concerning stocks, rather than focusing on a more common task such as how to book a hotel room or ordering in a restaurant. Therefore, if teachers create a lesson based on a recording or text that they have chosen and share it with their students, the students are still able to modify their own interaction with the content by having control over their own vocabulary lists.

Material creation in LingQ incorporates the implementation process discussed in Level 1 with increased customizability for instructors and choices for learners. At Level 2, teachers have an increased responsibility to utilize customizable MALL materials to afford learners a variety of ways to utilize their smartphones for TL interaction. The required time and effort at Level 2 will depend on the specificity of the outcome. For example, a LingQ lesson can be created in minutes when using a pre-recorded audio file with a transcript. However, teachers may wish to create their own recordings, targeting their teaching context, which would certainly require more time and effort. Similarly, simple digital flashcards may be created easily with text and pictures, while more advanced and engaging flashcards may require more work. At Level 2, teachers can also encourage students to make their own learning resources to serve as review materials and to share with them with classmates to form a more cooperative classroom environment. Time and effort at this level may also depend on the individual teacher's comfort and confidence when interacting with new software. Although the apps mentioned above are not complicated to use, teachers may wish to explore tutorials, FAQs, and forums to accrue knowledge and increase the quality of the materials they produce. Additionally, as discussed in the previous section, Chapelle's criteria for judging CALL task appropriateness must also be considered at this level [18]; Level 2 allows the teacher to further customize criteria such as learner fit and meaning

focus to suit their specific classroom context. The next level, described below, sees the teacher take on an even more pivotal role in the design process.

3.3. Level Three: Creating

At Level 3, the teacher takes on the role of the MALL engineer, creating their MALL resources and apps without needing to learn how to program. At this level of MALL engineering, teachers select from various existing resources, compiling features to create new MALL tools. This may involve, for example, utilizing plugins and online resources to generate an online course management site such as a Moodle course or using a drag-and-drop app creator (e.g., Invision (InvisionApp, Inc., Portland, OR, USA, https://www.invisionapp.com/); GameSalad (GameSalad, Inc., Austin, TX, USA, http://gamesalad.com)). A well-known yet dated example is HotPotatoes (University of Victoria, Victoria, BC, Canada, https://hotpot.uvic.ca), a Web-based application that provides teachers with templates for activities (e.g., multiple-choice questions, crosswords) to create their own online resources for students. Such resources have been created by programmers with the intention of allowing non-programmers to create their own tools, providing language teachers with more freedom to create their own unique materials.

The use of online course management systems is not new in the field of second language education. Many institutions have embraced these systems (e.g., Blackboard (Blackboard, Inc, Washington, DC, USA, www.blackboard.com); Edmodo (Edmodo, Inc., San Mateo, CA, USA, https://www.edmodo.com/); Moodle) to provide online components to complement the classroom. While these systems are typically used as online course management systems (e.g., for sharing course documents, providing feedback, posting assignments), Moodle, for example, can afford teachers the opportunity to use plugins to build dynamic course materials (e.g., video forums, pronunciation assignments) within an interactive layout (e.g., gamified elements, graphics). Gamifying Moodle for language learning (e.g., via the inclusion of levels, coins, badges) has proven to be effective in helping learners improve their pronunciation [24], an activity typically neglected in traditional foreign language instruction. Using Moodle for purposes beyond a basic course management system requires teachers to spend a considerable amount of time designing content, orchestrating tools and, in the case of Level 3, maximizing the potential of the course management system beyond its original purpose.

In 2015, Moodle, traditionally used on computers, launched its first mobile version in the form of an app, Moodle Mobile 2.0 (Moodle, Inc.) to accommodate the increasing number of teachers wishing to implement open-source learning materials in the mobile setting. The current version, Moodle 3.3.0 (May 2017; for Android and iOS), offers smartphone users improved interface and user experience (e.g., smoother navigation), simplified settings and preferences, and offline use for some functions (for a full review, visit: https://download.moodle.org/mobile). This gives teachers the opportunity to build courses by using user-generated plugins to create multi-modal courses from scratch. Teachers can build courses similar to the Duolingo activities discussed in Step 1, with the added benefits of selecting an interface, deciding how the content unlocks, and enabling students to use tools in a manner that is more nuanced than Level 1. For example, a teacher could use the plugin PoodLL (PoodLL, Inc., Nagasaki, Japan, https://poodll.com/), which serves as both a video and audio recorder that enables students to send asynchronous video and audio messages. This could also be paired with Level Up!, a leaderboard plugin that rewards students with experience points and badges for attempting to participate in learning activities rather than for achieving a high grade. These plugins are effective if paired with grammar and vocabulary activities that prepare the students for communication, which can then be followed with in-class discussions to create a blended environment (i.e., part online and part in-person).

Consistent with the demands of "building" at level three, teachers are responsible for creating the content and determining the precise interplay between objects, tools, and outcomes based on the needs of the population of students they teach. Teachers at this level also have access to logs, which enables them to apply data mining techniques to uncover hidden patterns in usage, a key part of the iterative

process. One caveat is that being able to fully customize a course often requires a teacher to register a Moodle page and then set up a domain and server. Since Moodle courses available to teachers through their institutions often do not provide practitioners with the freedom to download plugins, it limits the freedom that teachers have to customize courses. Some institutions also require instructors to adhere to the institution's own course management system, which further limits the customizability afforded by Moodle. Once a Moodle page has been set up, however, teachers have a multitude of ways to build materials to mobilize students' interaction with the target language.

At Level 3, teachers may also choose to create their own mobile apps. Typically, this process requires extensive programming knowledge. However, with the recent advent of online app creators, this process has become accessible to the general public. While these app creators may not allow the non-programmer to create full-fledged, highly aesthetic apps such as Duolingo, for example, they allow the user to choose from a variety of features and elements to build their own MALL tools. Depending on an individual's goals for the final product, there are several options. Some services, such as AppMakr (AppMakr, Inc., Glen Rock, NJ, USA, https://www.appmakr.com) will allow the user to create a basic app for free if the app is intended for private use with a small group of people (i.e., not to be distributed to the general public via GooglePlay (Google, Inc., https://play.google.com/); or the App Store (Apple, Inc., https://itunes.apple.com/)). If, on the other hand, the user wishes to distribute the app more widely, AppMakr allows users to distribute their app(s) for a small monthly fee. If the would-be MALL engineer has grander plans for an app requiring more advanced features, other services such as AppCooker (Hot Apps Factory, Valbonne, France, http://www.appcooker.com; one-time fee) and InVision (Invision, Inc., New York, NY, USA, https://www.invisionapp.com; first one is free) allow the user to create app prototypes via a drag-and-drop interface (in which the user selects buttons, text boxes, etc. and positions them on the screen as they would appear in an app). The prototypes can be used to test the app, and the user can receive feedback from other community members. Once finalized, these prototypes can be sent to developers, who can then program the app to be published and distributed to a wider market.

There are also several options for gamified tool creation. GameSalad (discount available for students and educators) provides the user with tools to create their own interactive games, again via a drag-and-drop interface. An easy-to-follow tutorial will see the user create a basic game in just two hours. While these games cannot be made into apps, the games can be accessed online and formatted to fit the screen of a mobile device. There are also several online services (e.g., ARIS (Field Day Labs, Madison, WI, USA, http://arisgames.org); or ARToolKit (GitHub, San Francisco, CA, USA, https://artoolkit.org)) which provide the user with free materials to create their own augmented reality (AR) app or game (a program altering our view of the real world, typically using the camera on a mobile device such as Pokémon GO (The Pokémon Company, Minato Ward, Tokyo, Japan, www.pokemon.com); see Godwin-Jones [25] for a proposal of how these tools can be used for language learning). ARIS, for instance, "can be used to create quite simple apps such as tours or scavenger hunts or quite complex branching games" [25] (p. 13).

The potential for language targeted via online course management systems such as Moodle or app creators is limitless. Teachers can create their own MALL materials with their own purposes in mind; teachers do not face the same restrictions as they would at levels one or two, which require the integration or modification of pre-made materials. These tools can be used to provide anything from additional pronunciation practice to grammar practice, but all have the same outcome in mind; to increase learner interaction with the TL. The time and effort required from the teacher-creator will also vary; while the most basic drag-and-drop apps or Moodle courses can be created within an hour (once the MALL engineer is familiar with the interface), other apps or more advanced features with personalized tools will certainly require more time to assemble. Chapelle's criteria for CALL task appropriateness again play a vital role at this level, as the teacher should consider each of the criteria when creating a new activity or choosing to integrate elements from pre-made materials or tasks [18]. As such, teachers at this level may wish to work together with students or fellow teachers, not only to

lighten the workload but also to gain insight from others and thus contribute to the iterative process of design-based research.

4. Conclusions and Recommendations

Twenty-first century technology and language learning practices have continued to provide unique opportunities for language learners, ranging from webcam conversations (e.g., [26]) to interactions in gamified learning spaces (e.g., [11,24]). However, given that CALL is a young discipline primarily grounded in the humanities, an alternative theoretical framework to CALL can be adapted from applied sciences, particularly engineering. Consider, for example, Activity Theory [7], an interaction-based approach to activities that analyzes how humans interact with technological tools to influence target language interaction [4]. Within this approach, and building on Godwin-Jones' [1] call for language teachers to become more technologically literate to effectively use CALL materials with their students, this paper proposed three levels of teacher involvement in the implementation of MALL materials to encourage teachers to take on the role of MALL engineers; adaptable materials, modifiable materials, and teacher-created materials. Based on a variety of available tools and apps, we also demonstrated how these three levels of teacher involvement in MALL material creation can be implemented to increase interaction with the target language. Finally, in this section, we provide our concluding remarks and some recommendations as to how MALL "engineers" can work together to enhance the overall L2 learning experience of their students.

It may be natural for one to feel that certain levels of teacher involvement are more prestigious or desirable than others. Our view is that teacher involvement at Level 1 is not necessarily any less or more important than involvement at level two or three; at each level, the teacher should make informed decisions (e.g., based on criteria for judging CALL material appropriateness [18]) to create customized practice for their students, according to their (or their students') needs, interests, and MALL/CALL expertise. In other words, the levels are dependent on teacher involvement in MALL material adaptation and/or creation to achieve the outcome of enhancing learner interaction with the TL. Involvement at these levels depends on a multiplicity of factors, particularly having the time available for material manipulation or creation, teacher motivation, and creativity. Additionally, basing decisions on a scientific approach such as Activity Theory and learning its tenets requires a significant amount of time and dedication, which goes beyond a practitioner's usual duties.

The level of teacher involvement does not impact the research potential for the materials they generate; MALL research can be and has been conducted at each of these levels. For example, Moussalli and Cardoso [27] engaged in research at Level 1 to explore the uses of Amazon Echo, Amazon's intelligent personal assistant device (comparable to Siri), as a tool to provide additional listening and speaking practice for language learners. At Level 2, Librenjak et al. [28] examined the efficiency of student-created digital flashcards created using Anki for the acquisition of Japanese kanji characters. At the end of the three-level spectrum, Holden and Sykes [12] created an AR game using ARIS, entitled Mentira (University of New Mexico, Albuquerque, NM, USA, http://www.mentira.org), to aid learners of Spanish. Regrettably, MALL research conducted within the three levels is driven more by the SLA researcher than the language teacher. While some researchers may also be language teachers, teachers in post-secondary (e.g., [12]) or in private institutions (e.g., [22]) are more popular as this teacher-driven research is more likely to be supported by the institution; language teachers without research support, on the other hand, are less likely to engage in formal research. Instead, this type of research is mainly conducted by MALL/CALL researchers and/or software developers or language teachers with support from their institutions.

According to Stockwell, "research" is often "the point of departure for what happens in practice and practice being the point of departure for what ends up being researched" [29] (p. 26). He points out that the classroom may accommodate research practice to facilitate the integration of new tasks, materials, and so on more than research accommodates classroom practice. We call for language teachers to become more involved in MALL material creation and research; with customizable materials

such as the ones described in this paper, language teachers have the capabilities to become MALL engineers, wherein they can wear a "triple hat of thinker, doer and user of CALL systems" [4] (p. 4) and thus provide a privileged insight into the field of L2 pedagogy and research. Accordingly, the "triple hat" provides teachers with the ability to engage in research practices of their own, learning and adapting based on a continual cycle of evaluation [3]. Language teachers may also wish to collaborate with other practitioners, developers (e.g., with app prototypes), or even students to generate materials to enhance learner interaction with the TL. As Godwin-Jones [1] points out, the role of the language teacher is changing, and teachers must be prepared to adapt to this new role in an ever-changing environment. Becoming MALL engineers will put teachers at the forefront of change and allow their voices to be heard.

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