Learning English L2 vocabulary with clickers

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ABSTRACT

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This study explored the use of clickers (i.e., a polling technology) as a tool to promote the acquisition of second language (L2) vocabulary. A growing body of literature on the pedagogical effectiveness of clickers in an L2 context has revealed that clickers can foster learning gains (e.g., Reynolds & Taylor, 2020). However, the extent to which clickers play a role in learning gains compared to other pedagogical approaches lacks consensus; in addition, most research has focused on adult learners and has taken place in large classrooms (Caldwell, 2007).

To address these limitations, the current research investigated the effects of clickers on L2 vocabulary acquisition in a K-12 educational setting. Two intact groups comprised of 61 Grade 8 students (age range: 13-14) learning English as a second language (ESL) in Montréal (Québec) were assigned to a vocabulary acquisition treatment: while the Clicker Group (CG: n = 31) received instruction via clickers, the Non-Clicker Group (NCG: n = 30) was treated via hand-raising without the target technology. The target vocabulary for the experiment constituted 30 low-frequency words extracted from *James and the Giant Peach*, a novel by Roald Dahl.

The pedagogical effectiveness of clickers on participants' acquisition of the target vocabulary was measured via pretests, posttests and delayed posttests. Overall, the results indicate that the pedagogical use of clickers contributed to L2 vocabulary acquisition, but that the learning gains are comparable in both groups. The discussion of the findings highlights the role of individual differences among members (i.e., some participants improved significantly more than others) and the implications for L2 teaching/learning.

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Author Contribution Statement

Author contribution to the study is as follows: Anne-Marie Sénécal made a substantial contribution to the conception and design as well as data collection and curation of the study with some contribution from Vanessa Mezzaluna (a fellow undergraduate student at the time of the study), who assisted in the design of class materials. Anne-Marie Sénécal confirms sole responsibility for the following: formal analysis and interpretation of results, draft manuscript, and final manuscript. Anne-Marie Sénécal thanks Vanessa Mezzaluna for her contribution in the early stages of the project.

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Chapter One

Before completing my master's in Applied Linguistics, I did an undergraduate degree in Teaching English as a Second Language (TESL) at Concordia University, in which I took a variety of courses that introduced me to theories and practices of second language acquisition (SLA). One course, *TESL 330* (computers in language learning) with Dr. Walcir Cardoso, particularly resonated with me and influenced my interest to specialize in the field of Computer Assisted Language Learning (CALL). Not only did I become familiar with a variety of highly sophisticated technological resources that have the potential to enhance students' learning experience as well as aid instructors' pedagogical approach, but I also discovered and experienced one unique CALL tool used by the professor: clickers.

Clickers

Clickers, most commonly found in the shape of a handheld remote control, allow a group of people to individually respond to multiple-choice questions (MCQs). This polling technology enables answers to be wirelessly gathered and simultaneously tallied in the form of an answer distribution graphic projected on a computer screen (see Cardoso, 2013, for a detailed description of the technology and its modus operandi). In the course *TESL 330*, clickers were employed to prompt a wide array of questions: *comprehension questions* (to assess understanding of important concepts), *application questions* (to assess the application of important concepts in specific situations and contexts), *critical thinking questions* (to prompt an analysis of relationships among concepts), and *survey questions* (to gather a panoply of information without having one correct answer, such as opinions).

The questions answered via clicker technology transformed the learning environment! While many of us in the classroom potentially had a preconceived apprehension that the course

would follow a teacher-centered lecture commonly associated with university-level courses, we discovered that clickers instead fostered a student-centered approach in which each student can answer questions and remain engaged throughout a lesson. Many students would probably agree with me that while our minds can potentially wander around from time to time during a long teacher-centered lecture, clickers are a great fix for this phenomenon!

Student engagement is one of the many affordances associated with the pedagogical use of clickers (Bruff, 2009). Participation may be further increased since answers are gathered anonymously, which can motivate students to answer questions without being worried of losing face in front of the classroom (Caldwell, 2007). Another characteristic of the technology is that since answers are instantaneously gathered and tallied in the form of an answer distribution graphic that can be projected on a screen, this pedagogical approach provides quality feedback for students to assess their understanding as well as for instructors to monitor the overall understanding of the group (Hattie & Timperley, 2007). I would argue that the most interesting affordance of clickers is that they can create opportunities for peer instruction in the same way that small-group discussions can promote learning (Mazur, 1997). Small-group discussions may be prompted by the instructor at different times during clicker questions (e.g., after students answer a question but before the answer distribution graphic is projected), during which students are asked to convince each other of what they think the correct answer is (Lasry et al., 2008). This interaction reinforces engagement and promotes participation from all students in the classroom.

Vocabulary Acquisition

As indicated above, my introduction to clickers took place during an undergraduate-level course dedicated to learning about the pedagogical use of technology in a classroom, which

further motivated me to explore its integration in L2 pedagogy. When I started an internship at the elementary-school level immediately following the *TESL 330* course, I naturally attempted to integrate clickers in my teaching. Since that first experience teaching with clickers, I have consistently implemented their use with all learner levels (i.e., primary, secondary, Cégep, university) targeting a variety of language skills (e.g., speaking, vocabulary, grammar) as well as question types (e.g., comprehension, survey).

In the literature, there has been increasing attention by researchers towards the use of CALL tools to promote different aspects of language learning, such as vocabulary (Ma, 2009). Research indicates that the use of clickers has the potential to promote its acquisition (Reynolds & Taylor, 2020), particularly to support the development of implicit and explicit knowledge as well as related learning strategies (Ma, 2009). Wesche and Paribakht (2000) recommend that an optimal approach to vocabulary acquisition combines elements of implicit and explicit approaches: while implicit vocabulary acquisition is associated with learners having multiple encounters with vocabulary in the input (Horst, 2013), explicit vocabulary acquisition refers to direct attention to the target words (Nation, 2013). Accordingly, since the MCQs associated with the pedagogical approach of clickers can provide multiple encounters with a word (i.e., implicit) as well as to direct to students' attention to it (i.e., explicit), clicker-enhanced instruction seems to have pedagogical potential for vocabulary acquisition.

The Current Study

This study is situated in Cardoso's (2022) chronological framework commonly adopted by researchers to assess the pedagogical potential of a technological tool. Considering that Step 1 (*Development* of the tool) was completed in the 1960s when researchers at Stanford University developed the first clickers (Abrahamson, 2006) and that Step 2 (*Exploration* of the tool's

affordances) has established a variety of affordances associated with the pedagogical use of clickers in L2 education, researchers have now turned to the last two steps of the chronological framework: Step 3 (*Assess Suitability*) and Step 4 (*Pedagogical Effectiveness*). Regarding Step 3 (*Assess Suitability*), research consistently shows that learners have positive perceptions of the pedagogical use of clickers in L2 learning (e.g., Song et al., 2017). However, while the literature focusing on Step 4 (*Pedagogical Effectiveness*) suggests that the pedagogical use of clickers can assist learning (e.g., Reynolds & Taylor, 2020), the extent to which clickers play a role in learning gains compared to other pedagogical approaches lacks consensus. Moreover, research exploring the pedagogical effectiveness of clickers tends to focus on adult learners, large-classroom contexts, and remains limited in the L2 field compared to general education (Caldwell, 2007). More research should focus on providing additional empirical evidence of the pedagogical effectiveness of clickers. Thus, the scope of this study is to further explore the pedagogical of clickers by examining the extent to which this technology can promote L2 vocabulary acquisition in a K-12 educational setting.

After having experienced clickers at Concordia University as a student in *TESL 330* and in subsequent courses with Dr. Walcir Cardoso, I have integrated the technology in my own ESL classroom to promote vocabulary acquisition and other language skills, as well as conducted a study to further assess the pedagogical effectiveness of the tool. I am confident that clicker technology holds great potential in the L2 classroom.

As per the guidelines for a manuscript-based MA thesis, the next section constitutes “a full submittable draft of a manuscript” that presents a literature review, methodology, results, and discussion of the abovementioned research.

Chapter Two

One of the roles of second language acquisition (SLA) research is to uncover what promotes learning. For the acquisition of vocabulary, there is an assumption that words can be learned implicitly through multiple encounters with words in the input and contextual guessing (e.g., Horst, 2013; Ma & Kelly, 2006; Sternberg, 1987), explicitly via instruction (Nation, 2013), or through a combination of implicit and explicit instruction (Wesche & Paribakht, 2000). Drawing on second language acquisition (SLA) perspectives such as the implicit and explicit paradigms (Loewen, 2020), instructors integrate a variety of pedagogical approaches in their classroom with the aim to enhance their students' learning.

In the last decades, the use of computer-assisted language learning (CALL) tools has been the focus of innovative pedagogical approaches to enhance students' learning experience (Chapelle & Jamieson, 2008). However, much remains unknown about the pedagogical effectiveness of many of these CALL tools, such as learner response systems or clickers – a promising technology that has been claimed to facilitate learning (e.g., Lee & Oh, 2014). Clicker-based instruction seems to have pedagogical potential for vocabulary acquisition, since it combines implicit and explicit features of acquisition by promoting opportunities for meaningful encounters with a word (i.e., implicit) as well as a direct attention to it (i.e., explicit) (Reynolds & Taylor, 2020).

To determine the pedagogical potential of a technological tool, Cardoso (2022) discusses a chronological framework in four stages for conducting CALL research: (1) *Development* of the tool, (2) *Exploration* of the tool's affordances, (3) *Assessing suitability* of the tool, and (4) *Assessing pedagogical effectiveness* of the tool. Step 1 of the framework, the *Development* of the tool, was completed years ago as clickers were first introduced in 1966 at Stanford University

(Abrahamson, 2006). Since then, this technology has appeared in the literature under a series of labels, predominantly as audience/learner/classroom response systems (e.g., Kay & LeSage, 2009; Mays et al., 2020) and clickers (e.g., McDonough & Foote, 2015; Yu et al., 2014). The latter term will be adopted throughout the paper. Clickers have since evolved and different types of systems now exist: Bring Your Own Device web-based systems (e.g., *Kahoot!*, *Socrative, Zoom Poll*), and device-based systems (e.g., *Plickers*, clickers).

The pedagogical use of clickers is not a novelty (Kay & LeSage, 2009), but the beginning of the twenty-first century marked a rapid expansion of the use of clickers in educational contexts, predominantly in post-secondary institutions (Abrahamson, 2006; Judson & Sawada, 2002) but also in primary and secondary education (Abrahamson, 2006). In 2010, more than 8% of K-12 classrooms adopted some type of clicker technology in the USA (Moss & Crowly, 2011). Considering the evolution of this technology and the design of a variety of types of systems (i.e., web-based and device-based), it can be estimated that millions of students use a form of clicker technology in their classrooms.

Step 2 of the chronological framework is the *Exploration* of the tool's affordances. Research has extensively explored the affordances associated with the use of clickers (e.g., Cardoso, 2011; Judson & Sawada, 2002; Kay & LeSage, 2009). These established affordances include opportunities for peer instruction to promote learning (Mazur, 1997), instantaneous feedback to assist understanding and inform instruction (Hattie & Timperley, 2007), as well as user anonymity to increase students' willingness to participate (Caldwell, 2007). However, a challenge associated with the implementation of clickers as a pedagogical approach is that it requires a considerable financial investment: a set of 40 clickers with the master software usually ranges between $1,000 and $2,000. This highlights a significant issue in the field of CALL:

while a variety of innovative technological approaches are developed to promote learning, there remains an important financial burden associated with their wide implementation. Therefore, it is essential to assess the suitability (Step 3) and pedagogical effectiveness (Step 4) of a tool to further determine its pedagogical potential and ensure practitioners adhere to technology with a sound pedagogical and theoretical rationale.

To determine if these affordances are transposed into the students' attitudes towards the technology, the goal of Step 3 of the chronological framework is to *Assess Suitability*. There is a general agreement in the literature that learners have positive attitudes towards the use of clickers as an instructional approach in both general education (e.g., Draper & Brown, 2004; Oigara & Keengwe, 2013) as well as in L2 contexts (e.g., McDonough & Foote, 2015; Sénécal et al., 2022; Song et al., 2017). Thus, the literature suggests that clicker technology is suitable for use in a classroom context.

Ultimately, once suitability has been established, it is essential to carry out Step 4 of the framework by investigating the *Pedagogical Effectiveness* of the tool, which corresponds to the actual learning that occurs via its implementation. Thus far, the literature suggests that the pedagogical use of clickers can benefit learning (e.g., Mays & al., 2020; Reynolds & Taylor, 2020). However, more research is needed to provide additional empirical evidence, particularly in K-12 contexts. Accordingly, the goal of this paper is to further explore the pedagogical effectiveness of clickers by examining the effects of this technology for L2 English vocabulary learning in a K-12 educational setting.

Background

Vocabulary

Vocabulary Knowledge

The operationalization of what it means to know a word remains ambiguous and lacks consensus in the literature (Milton, 2009). To simplify this complex concept, Ma (2009) suggests that vocabulary knowledge relates to "knowing the meaning of the word and how to use it appropriately" (p. 27). Among the many frameworks developed to operationalize vocabulary knowledge, one of the most influential is Nation's (2013), for whom knowing a word comprises three knowledge dimensions: form (e.g., spoken and written form), meaning (e.g., definition and associations with other words), and use (e.g., grammatical function and constraints on use, based on register). These three dimensions can each be further divided between productive and receptive knowledge (Treffers-Daller, 2020). Receptive knowledge, also conceptualized as passive knowledge (Milton, 2009), pertains to the ability to recognize the form, meaning, and use dimensions of a word in the input while reading or listening (Nation, 2013). On the other hand, productive knowledge, also referred to as active knowledge, refers to the ability to convey meaning using the word via speaking and writing (Ko & Goranson, 2014).

Vocabulary Acquisition

Based on this multi-faceted operationalization of vocabulary knowledge, researchers have explored vocabulary acquisition, which is defined as the increase of that knowledge over a period of time (Ma, 2009). Focussing on the explicit versus implicit learning paradigm, some authors promote implicit learning, which Nation (2013) defines as learning that occurs without a conscious intention to learn. A key component of implicit incidental learning is that for learning to take place, learners need to have repeated encounters with the target word in a variety of

contexts in the input (Horst, 2013; Ma & Kelly, 2006; Nation, 2013). Using the context in which the word appears, learners can employ contextual guessing and as a result infer the meaning of unknown words (Sternberg, 1987). The exact number of encounters with a word necessary to acquire it is not definitive in the literature: Nation (1990) argues that it is between 5 and 16 encounters, while Webb (2007) posits that 10 exposures are reasonable. However, other researchers argue that incidental learning is not sufficient to acquire vocabulary and that explicit learning targeting specific vocabulary or the development of vocabulary learning strategies is necessary to increase the efficacy of the learning process (e.g., Coady, 1997; Horst, 2013; Ma & Kelly, 2006). Ultimately, there has been a shift in the literature to adopt a mixed approach that encompasses features of both implicit learning (via extensive reading) and explicit learning (via vocabulary-building activities) (Ma, 2009; Wesche & Paribakht, 2000).

Vocabulary Assessment

A variety of tests have been developed to measure vocabulary learning considering that: a test alone is not sufficient to measure all aspects of vocabulary knowledge (Milton, 2009), and there will be some level of overlap between the measures of vocabulary knowledge (e.g., receptive and productive knowledge) (Ma, 2009). Nation (2013) recommends different question types that target dimensions of vocabulary knowledge (i.e., form, meaning, and use), such as those that ask learners to translate the word into their first language (L1; i.e., meaning), or to create a sentence using it (i.e., use). These questions can further focus on the receptive or productive skills associated with the knowledge dimensions. Asking learners to select a definition of the target word can measure receptive vocabulary knowledge while asking learners to translate the word into their L1 targets productive knowledge (Ma, 2009; Nation, 2013).

There has been increasing attention towards the use of CALL tools to promote vocabulary learning, particularly to support the development of implicit and explicit knowledge and related learning strategies (Ma, 2009; Taj et al., 2017). Clicker technology has the potential to enhance this process (Reynolds & Taylor, 2020).

Clickers: Instructional Approach

Clickers have been used as a classroom instructional approach in several fields to allow an entire group to respond to questions, usually multiple-choice questions (MCQs). This technology allows for many students to simultaneously answer questions, after which answers are wirelessly collected, transmitted to a computer, and projected on a screen. The standard procedure to use clickers pedagogically was suggested by Mazur (1997) and involves the following steps:

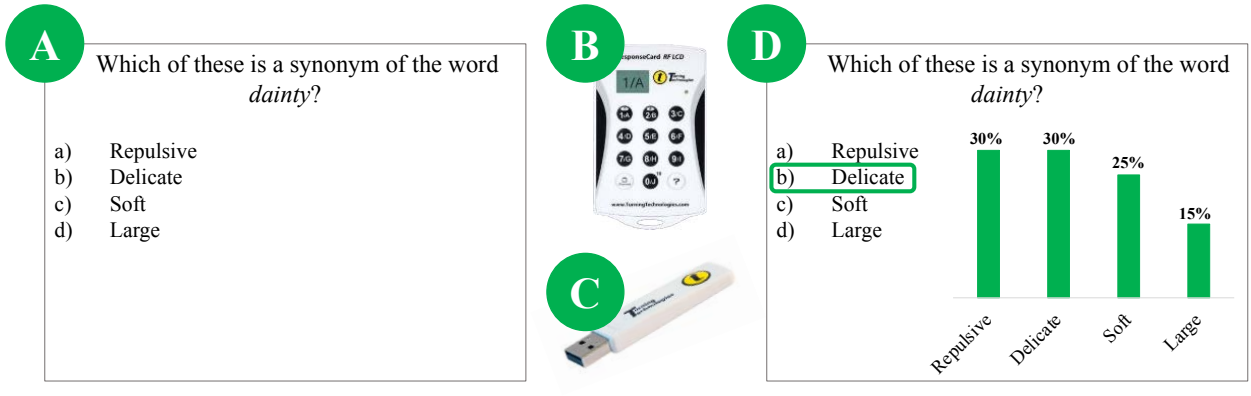
- Step 1: *Creating Questions* – Before the lesson, the instructor creates MCQs in the clicker software (e.g., *Turning Point by Turning Technologies*) and embeds the questions in a presentation software (e.g., *Microsoft PowerPoint*). A variety of questions targeting different aspects of Bloom's taxonomy may be designed (e.g., recognizing or recalling knowledge from memory; for a revised version of this taxonomy, see Anderson & Krathwohl, 2001).
- Step 2: *Asking Questions* – At a specific time during the lesson, the instructor asks a clicker question by displaying it on the projector (Figure 1A). The instructor allocates time for students to read the question and think about their answer. Then, the instructor opens the polling, during which students answer the question. To answer, the students press on the button that corresponds to their answer on the clicker (Figure 1B). Student input is instantaneously wirelessly collected and transmitted to a receiver (Figure 1C)

connected to the instructor's computer for processing (e.g., to calculate answer distributions and other statistical information).

- Step 3: *Providing Feedback* – Once all answers are recorded, the instructor closes the polling. On the instructor's computer (and optionally on the projected screen), the distribution of student answers appears in a visual format (Figure 1D). Lasry et al. (2008) proposes a Peer Instruction Implementation Process to help instructors proceed depending on the answer distribution. If the graphic shows that most students chose the correct answer (>70%), the instructor should display the answer distribution graphic, show the correct answer, and move on. If the graphic shows that students are divided in their answers (30-70%), the instructor should prompt a convince-your-neighbour discussion before showing the answer distribution graphic. During this discussion, students work in pairs or in small groups and provide rationales for their answer to try to convince each other of what the correct answer is. A new polling session can follow the discussion, which allows the instructor to reassess the graphic. Finally, if only very few students have the correct answer (<30%), the instructor should provide further explanation of the topic. Ultimately, the answer distribution graphic informs both the students and the instructor of the level of understanding of the target question and may influence how the instructor proceeds (Bruff, 2009; Cardoso, 2013; Lasry et al., 2008).

Figure 1

Procedure to Use Clickers



Pedagogical Affordances

The rapid expansion of the use of clickers in educational contexts may be associated with the affordances of the technology, which consolidate current educational theories. One affordance is that the technology fosters opportunities for peer instruction, a student-centered approach that is assumed to promote learning (Mazur, 1997), particularly via convince-your-neighbour discussions (Lasry et al., 2008). Peer instruction also creates a collaborative learning environment, which increases opportunities for interactions between learners (Hake, 1998) as well as between learners and technology (Chapelle, 2003).

Another important affordance of clickers is that the answer distribution graphic compiled from the polling results provides immediate feedback (Hattie & Timperley, 2007). For students, seeing the distribution of answers allows them to self-assess their understanding and to compare it to that of the other students (Draper et al., 2002). For instructors, the immediate feedback offered (e.g., in formative assessments) can uncover prevailing misconceptions, which in turn can inform teaching by allowing instructors to instantaneously customize a lesson (Caldwell, 2007).

An additional affordance is that the environment fostered by clickers promotes student engagement and participation. Since all students must press on a button to answer each question, as opposed to a small group of students raising their hand to answer the question, learning attention is improved and participation is increased (Hunsu et al., 2016). Student participation is further incited by the fact that when answering questions with clickers, the process is anonymous, which helps reduce the fear of peer criticism or losing face in front of colleagues (Caldwell, 2007). These pedagogical benefits have motivated researchers to empirically investigate if the affordances fostered by the technology can translate into pedagogical effectiveness.

Pedagogical Effectiveness in General Education

Clicker technology has increasingly been integrated in classrooms in a variety of fields and disciplines (Cardoso, 2011; 2013). However, a large portion of the literature on this tool has investigated its use in the fields of science, technology, engineering, and maths (STEM fields), particularly in nursing (Bristol, 2011), biology (Pan et al., 2019), and maths (Stewart & Stewart, 2013). Research in other educational contexts has also been carried out, such as in psychology (Iwamoto et al., 2017) and educational technologies (Ranieri et al., 2018).

Researchers have also explored specific aspects of the pedagogical use of clickers. For instance, Wang (2015) investigated the possibility of a wear-off effect, also known as a novelty effect, in a study of 252 university-level students from a variety of fields. The author found that, although there was a minimal novelty effect after the integration of *Kahoot!* over a five-month semester, the impact was not substantial and did not affect the pedagogical effectiveness of the tool.

Overall, there is a general agreement that the pedagogical use of clickers promotes learning (e.g., Iwamoto et al., 2017; Pan et al., 2019; Ranieri et al., 2018). However, the literature does not reach the same level of agreement as to the extent that clickers generate more learning when compared to other non-clicker pedagogical approaches (e.g., hand raising or other "traditional" voting methods). For example, Iwamoto et al. (2017), in a study of university students enrolled in a psychology course, revealed that using *Kahoot!* (a clicker-based learning platform) yielded significantly more learning gains compared to not using the technology. Contrarily, other studies do not show significantly higher learning gains in clicker-enhanced learning. Consider Ranieri et al. (2018), for instance, who explored the pedagogical effectiveness of *Kahoot!* among university-level students in large classes in an educational technology program. The authors found comparable learning gains between clicker-enhanced learning and learning without the technology (Ranieri et al., 2018). Similar results were also found by Pan et al. (2019) in a study exploring the acquisition of biology jargon with clickers among university-level students.

Pedagogical Effectiveness in L2 Acquisition

More recently, a growing body of literature has explored the pedagogical effectiveness of clickers focusing on various components of L2 learning. Consistent with the results from general education settings, there is an agreement in past studies that clickers foster learning gains in an L2 context, but there is a disagreement when comparing pedagogical approaches (e.g., Baran-Łucarz et al., 2015; Cutrim Schmid, 2007; Yu & Yu, 2017). Some of these studies reveal that clicker-enhanced learning leads to significantly higher learning gains. For example, Lee and Oh (2014) found that the experimental group using clickers generated significantly higher results than the control group in university-level students' reading comprehension. Similar results were

obtained by Agbatogun (2014), who investigated the effects of clicker technology on grade 6 students' level of communication. However, significantly higher learning gains with clicker-enhanced learning has not been observed in all studies. For example, Mays et al. (2020) found comparable learning gains between the experimental and control groups when assessing reading comprehension in grade 8 students using *Kahoot!*.

A study by Baran-Łucarz et al. (2015) shows mixed findings within their study of university-level students on the acquisition of phonetics between a group using clickers and another not using the technology. They found that the use of clickers improved their participants' learning in a number of measures (e.g., stressing words in reading aloud tasks), but not in all measures considered (e.g., predicting word stress patterns), thus reinforcing the assumption that the pedagogical effectiveness of clickers remains unclear in the literature.

Pedagogical Effectiveness in L2 Vocabulary Acquisition

The same pattern of results can also be observed in the literature specifically focusing on L2 vocabulary acquisition: previous studies agree that the pedagogical use of clickers can promote learning (e.g., Guaqueta & Castro-Garces, 2018; Grindharan, 2013), but disagree on the extent to which clicker-enhanced learning leads to higher learning gains when compared with other pedagogical approaches. For example, while Hung (2017) and Wichadee and Pattanapichet (2018) found significantly higher learning gains with clicker-enhanced pedagogy using *Kahoot!* to promote vocabulary acquisition, Reynolds and Taylor (2020) observed no differences between their *Kahoot!*-enhanced treatment and a control group.

Table 1 summarizes a selection of studies that have explored the pedagogical effectiveness of clicker technology in general education as well as in an L2 context. Some generalizations that can be deduced from this summary suggest that: (1) the technology promotes

learning gains; (2) there is a lack of agreement when learning gains are compared between groups; (3) there are only a handful of studies that focus on the K-12 educational setting; and (4) there is a research focus on large classroom settings.

Table 1

Pedagogical Effectiveness of Clickers in L2 Education: A Selection of Previous Studies

Authors	Age	Sample	Country	Technology	Subject	Learning gains	Group comparison
Agbatogun (2014)	K-12	99	Nigeria	Clickers	L2 (communication)	Yes	>
Baran-Łucarz (2015)	Adults	56	Poland	Clickers	L2 (phonetics)	Yes	>/=
Cutrim Schmid (2007)	Adults	62	UK	ACTIVote	L2 (not specified)	Yes	n/a
Guaqueta & Castro-Garces (2018)	K-12	20	Colombia	*Kahoot!*	L2 (vocabulary)	Yes	n/a
Grindharan (2013)	Adults	40	Malaysia	Clickers	L2 (vocabulary)	Yes	n/a
Hung (2017)	Adults	44	Taiwan	*Kahoot!*	L2 (vocabulary)	Yes	>
Iwamoto et al. (2017)	Adults	49	South Pacific	*Kahoot!*	Psychology	Yes	>
Lee and Oh (2014)	Adults	87	South Korea	Clickers	L2 (reading)	Yes	>
Mays et al. (2020)	K-12	48	Taiwan	*Kahoot!*	L2 (reading)	Yes	=
Pan et al. (2019)	Adults	491	USA	Clickers	Biology	Yes	=
Ranieri et al. (2018)	Adults	≈400	Italy	*Kahoot!*	Educational technology	Yes	=
Reynolds & Taylor (2020)	Adults	24	South Korea	*Kahoot!*	L2 (vocabulary)	Yes	=
Wichadee & Pattanapichet (2018)	Adults	77	Thailand	*Kahoot!*	L2 (vocabulary)	Yes	>
Yu et al. (2014)	Adults	700+	China	Clickers	L2 (listening, speaking)	Yes	>
Yu and Yu (2017)	Adults	79	China	Clickers	L2	Yes	n/a

*Note: Pedagogical effectiveness refers to the learning gains that were observed via quantitative or qualitative methods. The symbols used within the Group comparison header indicate the following: ">" = learning gains were more significant in the group using clickers; "=" = learning gains were comparable between instructional approaches; ">/=" = both more significative learning gains and comparable results were found; "n/a" = the study did not compare between groups.

Current Study and Research Questions

Overall, previous studies show that the pedagogical use of clickers can foster learning gains (e.g., Hung, 2017; Reynolds & Taylor, 2020). However, the extent to which clickers play a role in learning gains compared to other pedagogical approaches lacks consensus. Further, most research has focused on adult learners and has taken place in large classrooms (see Table 1). The goal of this study is to address these gaps by providing additional empirical evidence regarding the *Pedagogical Effectiveness* of clickers (Step 4 of a chronological framework to assess the pedagogical potential of a tool; see Cardoso, 2022) in an L2 learning context in a K-12 educational setting. The following research question guided the study:

- To what extent does the pedagogical use of clickers contribute to the acquisition of L2 English vocabulary in a K-12 educational context?

Despite the inconclusive results observed in the literature in terms of the tool's pedagogical effectiveness, we hypothesize that students learning with clickers will outperform those not using it due to the benefits afforded by the technology, as discussed earlier (e.g., it promotes peer instruction, provides quality feedback, and increases engagement).

Method

Participants

Sixty-one student participants were recruited from a private francophone high school in Montréal, Québec. Participants were in grade 8 (13-14 years old). The students' L1 background was French, except for a handful from different backgrounds that included Mandarin Chinese, Portuguese, Russian, and Spanish. The participants were enrolled in the ministry-mandated Core ESL program, which indicates they were high-beginner learners of English. It is important to note that although the school is a French-medium institution, it is located in a predominantly

anglophone community in which the students had higher exposure to English and, consequently, a higher level of proficiency compared to students in the Core programs in other neighbourhoods of Montréal. As part of the Québec Education Program for high school, students have obligatory English classes that focus on development of three competencies based on which students are required to: (1) interact orally in English, (2) reinvest understanding of texts, and (3) write and produce texts (Ministère de l'Éducation, 2006).

A convenience sampling method was employed to recruit the participants, who constituted two intact groups taught by the same English teacher. The teacher was an English L1 speaker with 15 years of experience teaching ESL. While she regularly used technology in her classroom (e.g., PowerPoint presentations), she had no prior experience using clickers. The groups were randomly assigned to an experimental group: (1) the Clicker Group (CG; $n = 31$), in which students received vocabulary instruction via clicker technology; and (2) the Non-Clicker Group (NCG; $n = 30$), in which vocabulary instruction was carried without the clickers (e.g., via hand-raising and other "traditional" methods). Participation in the study did not count for course grades.

Materials: Vocabulary Instruction Treatment

Over eight weeks, students took part in vocabulary-building activities that targeted words extracted from a required novel for the year, which allowed the integration of the treatment in the regular course curriculum. The novel *James and the Giant Peach* by Roald Dahl was selected because, according to the teacher, it was age- and level-appropriate for grade 8 students. Thirty words were extracted from this novel to assess the students' vocabulary knowledge before and after the treatment. The words included 10 nouns, 10 adjectives, and 10 verbs. These words were extracted from low-frequency word levels according to Nation's (2013) frequency-based word

lists. This allowed us to limit the students' exposure to the items outside of the study, which helped us associate vocabulary acquisition to the instruction method rather than to previous encounters with the target words. See Table 2 for the list of vocabulary items.

Table 2

Target Vocabulary Words for Instruction and Testing

Vocabulary instruction sessions	Vocabulary words with parts of speech		
	Nouns	Adjectives	Verbs
1	Gaze	Dainty	To beckon
	Seesaw	Stale	To glimpse
2	Flock	Steep	To mutter
	Dew	Damp	To shriek
3	Burden	Aghast	To shrivel
	Pandemonium	Scrumptious	To wail
4	Blunderhead	Rambunctious	To quiver
	Candyfloss	Eerie	To gasp
5	Smithereens	Tremendous	To glare
	Nursery	Eager	To haul
Control words	Pail	Ramshackle	To flap
	Nincompoops	Gloomy	To lurk

Note. Control words were not included in the vocabulary instruction sessions. They only appeared on the vocabulary assessments.

The book was divided into five sections, which were each followed by an in-class vocabulary instruction session that lasted approximately 30 minutes (total of 2.5 hours of instruction). Each session targeted six words that corresponded to the previous reading section. For example, the first reading section included chapters 1-8. In this reading, students encountered the word *dainty* at least once (chapter 2). Therefore, the word *dainty* was targeted in the first vocabulary instruction session. The vocabulary instruction sessions were carried out by the teacher, during which students answered MCQs to reinforce their acquisition of the words.

In the CG, the MCQs were created in a clicker software and then embedded in PowerPoint presentations. To answer the questions, students anonymously responded using

clickers. Although there is an increasing popularity for Mobile-Assisted Language Learning and Bring Your Own Device tools (Reynolds & Taylor, 2020), we specifically opted for a device-based technology as an attempt to accommodate our teaching context: high school students. Since we could not assume that all students own or have access to personal electronic devices, using device-based clickers was more optimal. Also, in some institutions, students are not allowed to carry their personal electronic devices in the classroom. In the NCG, the MCQs were included in the PowerPoint presentation, and the participants answered via hand-raising (as is customary in their classes). Therefore, the treatment was identical in both the CG and the NCG groups; the only difference was that students in the CG responded to question using their clickers.

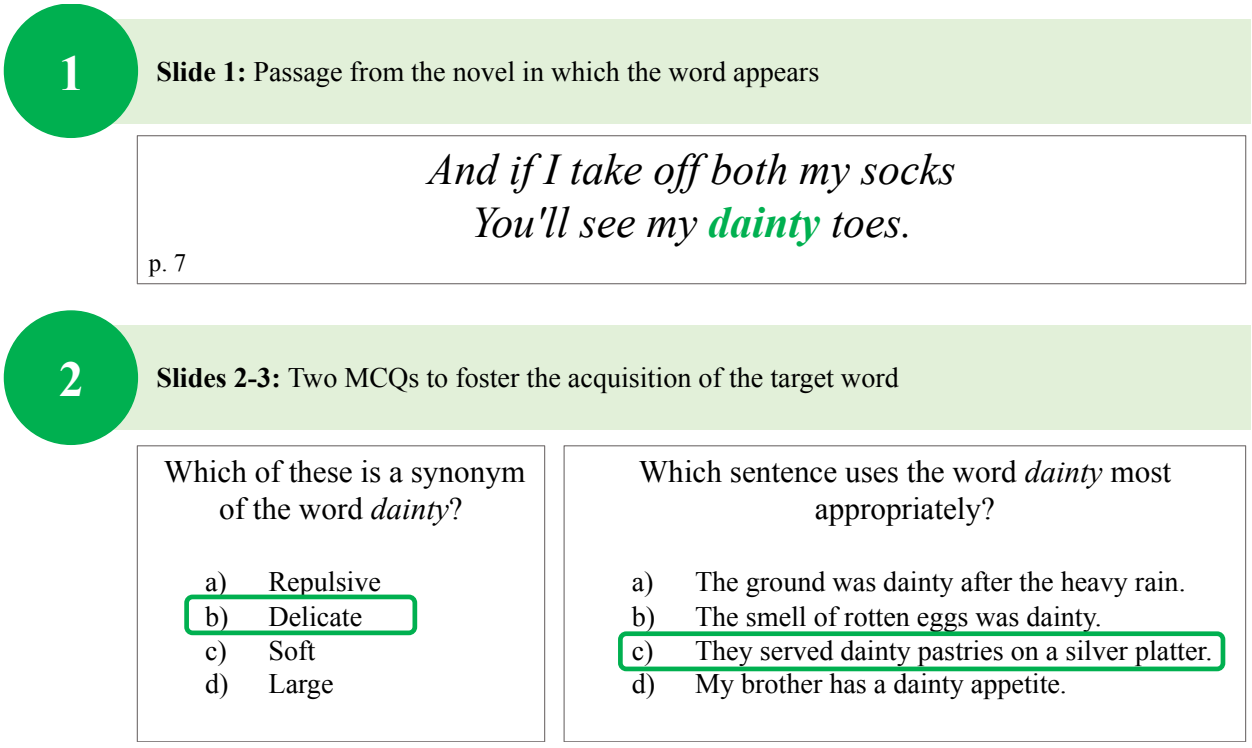
These MCQs, designed by the research team prior to the vocabulary instruction sessions, were based on the context in which the words appeared in the novel. For each word, the first slide included the passage from the novel in which the word appeared. In the passage, the word was bolded, in italics, and in colour, to increase saliency. Then, two MCQs directly addressed the understanding of the target word. In the question, the target word appeared in italics to increase saliency. Students were asked to select the most appropriate translation or definition, or to identify a synonym for the word. Figure 2 illustrated the PowerPoint sequence for the word *dainty*. Through the treatment, the students encountered and interacted with each word at least 10 times by reading it, seeing it, and discussing it. Most target words appeared more than once in the novel, which reinforced the students' exposure to them.

Overall, the treatment was aligned with research that supports a mixed approach for vocabulary instruction, combining features of both implicit and explicit learning (Ma, 2009; Wesche & Paribakht, 2000). For instance, learners encountered each target word naturally in the

input (i.e., implicit learning) and took part in vocabulary-building activities via two clicker-based MCQs (i.e., explicit learning), which increased the opportunities for learners to be exposed to the word (Webb, 2007). Students were also encouraged to develop vocabulary learning strategies (i.e., explicit learning), such as by using context cues in the MCQs to infer the meaning of the word. Hence, the treatment provided learners with repeated encounters with the words both implicitly and explicitly to reinforce the acquisition of the target items, as recommended by Horst (2013) and Nation (2013).

Figure 2

Vocabulary Instruction Session: PowerPoint Presentation Sequence for a Word (Dainty)



Instruments: Vocabulary Assessment

The students were allocated one hour to complete each assessment or test, but the majority finished within 30 minutes. The vocabulary assessment was administered on three occasions: (1) pretest, to measure the participants' initial knowledge of the target words before the treatment, (2) immediate posttest, to measure the participants' knowledge of the target words (i.e., the number of words learned) immediately after the treatment, and (3) delayed posttest, to determine the lasting effect of the treatment four weeks later. The assessment was identical on all three occasions, and it included the 30 vocabulary words from the treatment as well as six distractors. The same assessment was administered in the CG and in the NCG. The types of questions were similar to the MCQ format (i.e., selected-response item) used during the instruction sessions, but they required students to instead produce their own answers (i.e., constructed-response item). For this task, the participants were asked to demonstrate their knowledge of the words through various means: (1) write a definition, (2) create a meaningful sentence using the word (in their L1 or target L2), (3) draw a picture representing the word, or (4) translate the word to French. As discussed earlier, these question types cover a range of measures of vocabulary knowledge, including the three knowledge dimensions (form, meaning, and use; Nation, 2013) as well as receptive and productive knowledge (Ma, 2009).

Procedure

A pretest-posttest-delayed posttest research design was adopted to measure the pedagogical effectiveness of the vocabulary instruction treatment on the participants' acquisition of the 30 target vocabulary words with clickers (CG) and without clickers (NCG).

During *Week 1*, the researcher visited the school twice. On the first visit, signed consent forms (by the students and their parents) were gathered, and the participants completed a biodata

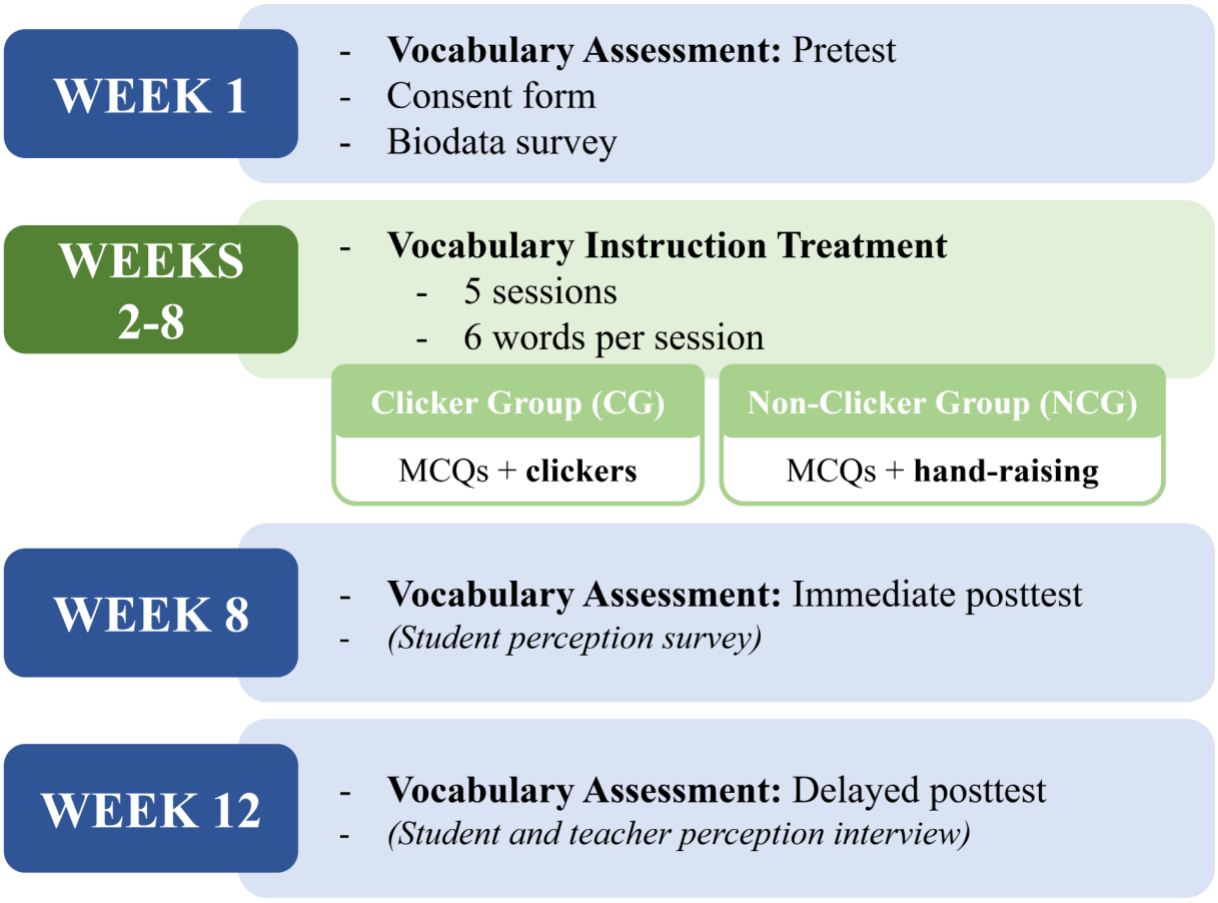
survey as well as the vocabulary assessment pretest. On the second visit, the researchers carried a training session to familiarize the teacher and the students with the use of clickers in the classroom. During that session, the teacher was given clear instructions about the use of clickers and Lasry et al.'s (2008) procedure for convince-your-neighbour discussions (e.g., "if 30% or more students select an incorrect response, prompt a spontaneous discussion").

Between *Weeks 2-8*, the vocabulary instruction treatment took place in the two experimental groups. During the treatment, the participants read the novel *James and the Giant Peach* as homework assignments and took part in the five in-class vocabulary instruction sessions to learn the 30 words. During *Week 8*, the research team visited the school again to administer the vocabulary assessment posttest immediately following the final vocabulary instruction session as well as a student perception survey (not reported here).

During *Week 12*, four weeks after the end of the treatment, the researchers visited the school for the last time to administer the vocabulary assessment delayed posttest. Interviews were also carried with the students and teacher, but due to the scope of this study, the results of user perceptions will not be reported or discussed here (see Sénécal et al., 2022). Figure 3 provides a visual representation of the procedure.

Figure 3

Procedure



Data Collection and Analysis

The quantitative data collected to measure the students' acquisition of the target vocabulary items included the responses for each item on the vocabulary assessments. A score of 1 was awarded if the response showed understanding of the word; otherwise, a score of 0 was given. Two researchers individually scored the three tests (pretest, posttest, delayed posttest). In case of scoring disparities (n = 25/216 answers – 11.6%; for the three testing times in both groups), the researchers reached a verbal agreement. A final score out of 30 was obtained for each test. The numeric test scores were then entered in the statistical program SPSS (25.0).

The pretest-posttest-delayed posttest final scores were first analyzed using descriptive statistics (i.e., mean, median, and standard deviation). An independent-samples *t*-test was then used to compare the participants' initial level of vocabulary between the experimental groups at the pretest (i.e., the number of words the participants knew before starting the treatment). The data were analyzed using a mixed-model ANOVA to determine differences between test scores at times of testing and between experimental groups, as well as to determine whether there was an interaction between time and group. In the case where the ANOVA was significant, Bonferroni adjusted post-hoc *t*-tests were calculated.

Results

The descriptive statistics illustrated in Table 3 show an overview of student performance in both groups at the three testing times. The findings reveal that there were significant learning gains in both groups between the pretest and posttests, but that the difference between the CG and the NCG was not significant. The statistics also reveal a decline in vocabulary knowledge in both groups between the immediate posttest and the delayed posttest; however, delayed posttest results remained significantly higher than pretest ones.

Table 3

Performance on Vocabulary Assessment Tests

Test	Clicker Group (CG) $n = 31$		Non-Clicker Group (NCG) $n = 30$	
	M/30	*SD*	*M*/30	SD
Pretest	1.29	1.77	.93	1.39
Immediate Posttest	6.61	3.81	4.97	2.31
Delayed Posttest	4.29	3.09	3.40	2.08

Before analyzing learning gains, an analysis of pretest results was run to compare the participants' initial vocabulary knowledge of the target 30 words before the vocabulary instruction treatment. The independent-samples *t*-test revealed no difference between the CG (*M*

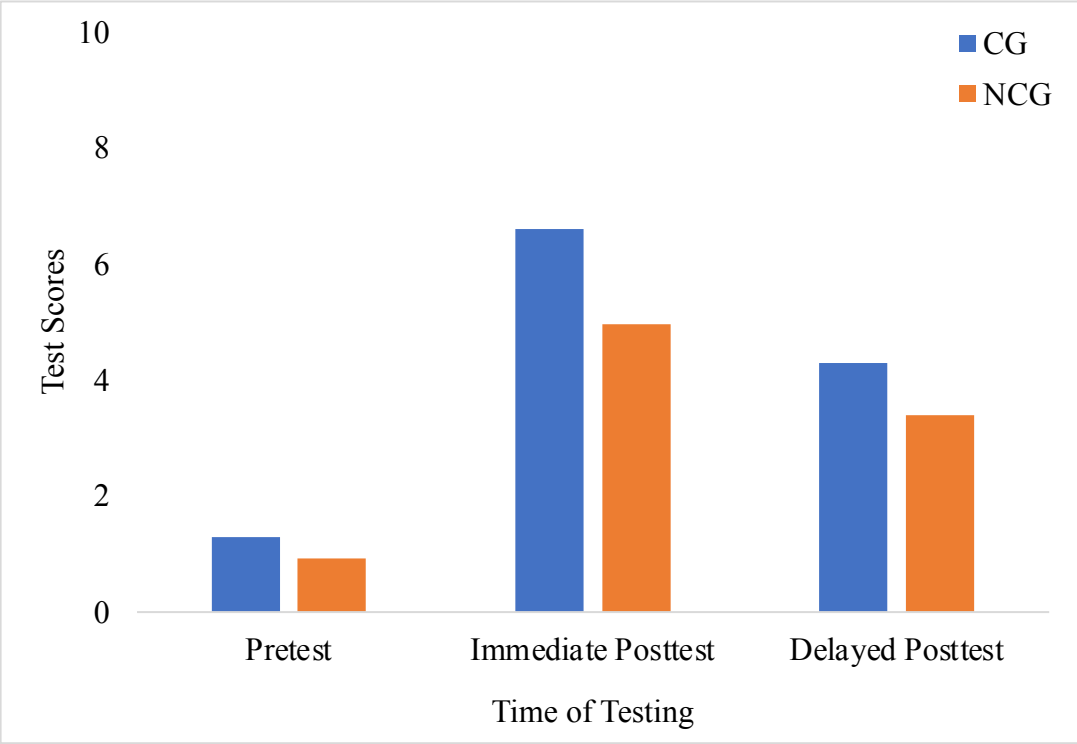
= 1.29, *SD* = 1.77) and the NCG (*M* = .93, *SD* = 1.39), $t(59) = 0.87$, $p = .39$. Thus, both groups had comparable vocabulary knowledge of the target words at the pretest.

To measure the level of significance of the learning gains, a statistical analysis of the data was conducted via an ANOVA, which indicated a significant difference in vocabulary knowledge over time, $F(1.77, 104.50) = 159.53$, $p < .001$, $\eta_p^2 = .730$. Post hoc analysis with a Bonferroni adjustment ($p < .0125$) revealed that there was a significant improvement in learning gains between the pretest and immediate posttest, .31 (95% CI, -5.43 to -3.93), $p < .001$, $d = 1.87$, with a large effect size (Cohen, 1988), but a significant decrease was observed between the immediate posttest and delayed posttest, 23 (95% CI, 1.38 to 2.51), $p < .001$, $d = .67$, with a medium effect size (Cohen, 1988). However, the improvement between the pretest and delayed posttest remains statistically significant, .25 (95% CI, -3.35 to -2.12), $p < .001$, $d = 1.25$, with a large effect size (Cohen, 1988).

When comparing the performance between the two groups over time, we did not observe a significant difference between the learning gains of the groups, $F(1, 59) = 3.03$, $p = .06$, $\eta_p^2 = .049$. This indicates that both groups had comparable gains over time. It is also notable that higher standard deviations were observed in the CG at the immediate posttest (CG: *SD* = 3.81; NCG: *SD* = 2.31) as well as at the delayed posttest (CG: *SD* = 3.09; NCG: *SD* = 2.08). See Figure 4 for an overview of the group comparisons in vocabulary learning.

Figure 4

Performance on Vocabulary Assessment Tests



Discussion

The goal of this study was to examine the pedagogical effectiveness of clickers by researching the effects of this technology on L2 vocabulary acquisition in a K-12 educational context. The vocabulary assessments administered in the CG and the NCG before (pretest) and after (immediate and delayed posttests) the instruction treatment were analyzed to measure the participants' acquisition of the 30 vocabulary items targeted during the treatment. Overall, the results indicate that the proposed treatment contributed to the learning of the target English vocabulary in both the CG (via clickers) and the NCG (without clickers) and, alternatively, that the learning gains in the group with clicker-enhanced instruction (i.e., CG) were not statistically higher than those observed in the group not using the technology (i.e., NCG). These findings suggest that, while the pedagogical use of clickers may promote the acquisition of L2

vocabulary, different pedagogical approaches that target L2 vocabulary may have an equivalent effect on learning. Considering that the literature is inconsistent regarding the extent to which the use of clickers leads to higher learning gains when compared with traditional methods of teaching (e.g., hand-raising techniques), the findings reported here lend support to the claim that clicker-enhanced instruction does not always yield more pedagogical gains (e.g., Reynolds & Taylor, 2002 for vocabulary; Mays et al., 2022 for reading comprehension). Accordingly, it is possible that the benefits afforded by clickers may lay elsewhere (e.g., they create a game-like, motivating environment for learning to occur; Cardoso, 2011).

The lack of a significant difference in the L2 vocabulary improvement between the CG and the NCG may be associated with the design of the treatment. As discussed in this study's methodology, as an attempt to create a "control" group in which the only different variable was the use of the clicker device, characteristics inherent to the CG treatment were *artificially* applied in the NCG. As such, one could even claim that the NCG also received a type of "clicker-assisted pedagogy", which may have inadvertently boosted learning in the NCG. For example, in the CG, small-group convince-your-neighbor discussions were strategically prompted in situations where the answer distribution graphic (i.e., a fundamental feature of clicker-enhanced instruction) showed a disparity in student answers. These discussions were artificially implemented in the NCG: without an answer distribution graphic indicating whether the students had indeed learned the word being taught, a post-MCQ session discussion was arbitrarily prompted (as dictated by this study) in that group. In practice, teachers in settings in which clicker technology is not available would rarely opt for these types of small-group discussions without the cues afforded by the answer distribution graphic.

As a result of the design of the treatment, similar potential for vocabulary acquisition were afforded in both groups, wherein a combination of explicit and implicit approaches to teaching vocabulary was adopted (see Webshe & Paribakht, 2002 and Reynolds & Taylor, 2020 for the rationale). In both the CG and NCG, vocabulary-building activities in the form of MCQs introduced learners to target words in the context in which they appeared in the book (i.e., *implicit* learning) and prompted questions that targeted different aspects of vocabulary knowledge (i.e., *explicit* learning). For instance, to develop the participants' lexical repertoire, the proposed vocabulary-building activities targeted Nation's (2013) three dimensions of vocabulary knowledge (i.e., form, meaning, and use) as well as Ma's (2009) receptive and productive components of what it constitutes to know a word. Further, the MCQs provided students with multiple opportunities to encounter the word in context (Nation, 2013; Webb, 2007). In both treatment groups, repeated exposure to the target lexis was promoted via the small-group discussions, which were prompted *strategically* in the CG (i.e., based on the answer distribution graphic) and *artificially* in the NCG. It could be argued that the similarities in the pedagogical approach adopted for both CG and NCG could partially account for the comparable learning gains in the two groups.

Relatively similar assumptions have also been reported in the clicker literature. In a study on L2 learner perceptions of clickers, for instance, Cardoso (2011) concluded that his participants' favorable attitudes towards the technology may be attributed to characteristics inherent to the pedagogical approach that the technology affords (e.g., small-group discussions, input enhancement via the display of the target word on the screen and a graphic indication of the correct answer) rather than to the clicker itself. This analysis can also be applied to this study, mutatis mutandis, considering that the two experimental groups received a certain type of

"clicker-assisted pedagogy", which consisted of many of the pedagogical affordances that the technology provides.

The lack of difference in vocabulary learning between the CG and the NCG may also be attributed to the presence of individual differences in the acquisition process. In a review of the literature on the effects of clickers on student performance, Landrum (2015) suggests that factors related to individual differences may explain the inconsistent findings regarding learning gains from clicker-enhanced instruction. For example, Roth (2012) explored the effects of aptitude as an individual difference that may affect the learning process when using clicker-enhanced instruction in a calculus course. The author found that lower performing students (i.e., the students below the median score on a previous in-class evaluation) benefited more from the treatment than the higher-performing students. Unfortunately, the role of individual differences in CALL remains an under-investigated topic and has only recently received some attention in the literature (Foroozesh-nia, 2015; Landrum, 2015).

In the study, at the time of the immediate posttest, higher levels of standard deviation were observed among learners in the CG ($M = 6.61$, $SD = 3.81$) than those in the NCG ($M = 4.97$, $SD = 2.31$), thus creating a large disparity in vocabulary acquisition between learners. This indicates that while many participants in the CG highly benefitted from clicker-enhanced instruction, this was not true for some. For example, consider Jordan and Sacha (fictitious names), two participants who exhibited extreme disparities in results (thus contributing to high standard deviations in the results obtained). While Jordan considerably benefitted from clicker-enhanced instruction, learning 10 vocabulary items between the pretest (0/30 score) and delayed posttest (10/30 score), Sacha did not benefit as much and only learned one word between the pretest (1/30 score) and delayed posttest (2/30 score). The presence of such disparities in

vocabulary learning among learners in the CG (also evidenced by high standard deviations) demonstrate the presence of individual differences in the acquisition process, indicating that the proposed clicker-enhanced vocabulary instruction treatment was more beneficial for some students than others.

Conclusion

The purpose of this study was to examine the pedagogical effectiveness of clickers in a K-12 education context to foster the development of L2 vocabulary acquisition. Overall, the results indicate that the two treatment groups that received "clicker-informed" pedagogy (including the use of clickers and/or the techniques associated with them) had significant gains in vocabulary acquisition, and that the learning gains were comparable in both groups. Thus, we conclude that an approach that follows clicker-informed pedagogy shows great potential for enhancing the L2 learning experience.

Despite these interesting results, this study has uncovered limitations that should be recognized and considered for future research. Primarily, the target vocabulary selected for the treatment and tests is an aspect of the research design that challenges the implications of the results. In the study, low-frequency vocabulary from Nation's (2013) word lists were chosen as an attempt to limit exposure to the target words beyond the scope of the project and to control for the frequent words that participants could have learned prior to the study. However, the choice of words may have inadvertently limited learning gains as the learning burden of the target lexis was increased. A word's learning burden is associated with the amount of effort required for its acquisition and depends on a variety of factors, such as the amount of exposure to and usefulness of a word (Nation, 2013). This pattern was observed in both groups. For instance, in the CG, students correctly defined 6.61 words out of 30 on the posttest compared to an average of 1.29

on the pretest. Thus, the results show that between times of testing, participants had a relatively low amount of vocabulary acquisition, which may be associated with the high learning burden of the low-frequency target lexis (Nation, 2013).

Another limitation is that the sample gathered for this study was limited: a relatively small sample size (n = 61) was recruited from only one educational context (i.e., one high school in Montréal, Québec). Accordingly, future research should consider expanding the sample by recruiting a larger number of participants from a variety of educational contexts (e.g., different geographical locations and proficiency levels). However, as Gillespie (2020) notes, empirical studies in CALL tend to be of small scale (e.g., some with fewer than 10 participants). The fact that the target language of instruction is English constitutes another limitation of the study. As Gillespie (2020) highlights, an overwhelming majority of empirical studies in CALL focuses on English as the target language of instruction. Accordingly, the author calls for research to investigate under-researched target languages.

The results of this study have implications for L2 teaching and learning. Teachers should consider implementing this CALL tool in their L2 classroom since clickers not only show promising results regarding their pedagogical effectiveness, but they also promote foreign/second language enjoyment, another crucial dimension of L2 acquisition to cater to students' affective factors (for the rationale, see Zeng, 2021). In fact, clicker-enhanced instruction has been shown to promote engagement and motivation (Caldwell, 2007; Hunsu et al., 2016), as well as to provide opportunities for peer instruction (Mazur, 1997) via small-group discussions and immediate feedback (Hattie & Timperley, 2007) through the answer distribution graphic. However, the individual differences discovered in the CG at the posttest suggest that some learners benefit more than others from this pedagogical approach. Accordingly, another

essential implication for L2 pedagogy is that teachers should vary instructional approaches to capitalize on the affordances of clicker pedagogy (e.g., answer distribution graphic) to accommodate students' needs, interests, and individual differences. Thus, clickers can be considered an essential tool in an ESL teacher's toolkit to promote L2 vocabulary acquisition.

Future research should expand the present study to further explore the pedagogical use of clickers. While this study focused on vocabulary acquisition, future studies should consider exploring the pedagogical effectiveness of the technology on different L2 features (e.g., a grammar concept). Moreover, researchers should compare different types of clicker technology (e.g., *Zoom poll*, *Plickers*) to explore the affordances inherent to the different applications. For example, *Plickers* is a clicker-type tool that has a unique feature: the instructor can create a MCQ spontaneously during a lesson and launch it simultaneously to gather student responses.

Considering that the integration of clickers is widening across educational settings and that the results of this study as well as the past literature show promising results related to their pedagogical effectiveness, researchers should further investigate this technology to better understand their potential in an L2 classroom.

Chapter Three

This chapter will present a review of the result from the previous chapter, as well as their implications in language education. Future directions for research into the pedagogical use of clickers will then be discussed.

Summary of Goals and Findings

The *Make Words Click!* project was designed to explore the pedagogical potential of the implementation of clickers (i.e., polling technology) as a CALL tool to promote English L2 vocabulary acquisition in English. Overall, the literature has identified essential pedagogical affordances fostered by clicker-enhanced instruction, such as peer instruction (Mazur, 1997), immediate feedback (Hattie & Timperley, 2007), as well as student engagement and willingness to participate (Caldwell, 2007). Moreover, there is an agreement in the literature that students have positive perceptions of the pedagogical use of clickers (e.g., Sénécal et al., 2022) and that the technology fosters acquisition (e.g., Reynolds & Taylor, 2020). However, the extent to which clicker-enhanced instruction promotes learning gains when compared to other pedagogical approaches remains inconclusive. Situated in Cardoso's (2022) chronological framework to assess the pedagogical potential of a technological tool, this study focused on the last step of the framework (Step 4) to examine the *Pedagogical Effectiveness* of clicker-enhanced instruction on L2 vocabulary acquisition in a K-12 educational setting.

To assess the pedagogical effectiveness of clickers, 61 Grade 8 ESL students from two intact groups at a high school in Montréal participated in the study. Each group was attributed a treatment that aimed to measure the acquisition of 30 low-frequency target words extracted from a novel by Roald Dahl, *James and the Giant Peach*. While the Clicker Group (CG: $n = 31$) completed vocabulary-building activities via clicker technology, the Non-Clicker Group (NCG:

n = 30) employed hand-raising techniques, without the clickers. A pretest-posttest-delayed posttest research design was adopted to assess the pedagogical effectiveness of the tool on the students' acquisition of the target lexis.

Overall, the results indicate that the "clicker-informed" treatment (via the use of clicker technology and/or characteristics inherent to the approach) contributed to L2 vocabulary acquisition in both groups. However, the results demonstrated that the learning gains in the CG were not statistically higher than those observed in the NCG, suggesting comparable acquisition between the two pedagogical approaches adopted. These results provide additional empirical evidence to the literature regarding the effectiveness of the pedagogical use of clickers in L2 education.

Implications for L2 Education

There are important implications of these results that should be considered for L2 teaching and learning. Primarily, when considering the literature divide in studies that compare clickers to another pedagogical approach, these results indicate that clickers offer comparable learning potential. However, an interesting benefit of clickers is that their pedagogical implementation is associated with another essential dimension of L2 acquisition: the technology fosters foreign/second language enjoyment (Zeng, 2021). In fact, the literature agrees that students have positive perceptions of the technology and that it motivates them to learn (see Sénécal et al., 2022). Based on these findings, teachers should consider the integration of clickers and clicker-informed pedagogy (such as those adopted in the NCG) into their curricula to promote L2 vocabulary acquisition.

Another implication of the findings is that clickers should be considered as a useful tool as part as a teacher's toolkit. Considering the individual differences uncovered in the CG at the

posttest, this study shows that the technology may be more beneficial for some learners. Ultimately, when implementing clickers to promote vocabulary acquisition, instructors should be aware that they are not a pedagogical panacea, and that the integration of the technology should take place alongside other approaches to accommodate students' needs, interests, and individual differences. This would allow teachers to capitalize on the affordances inherent to clicker-enhanced instruction (e.g., answer distribution graphic) as well as to maintain student engagement.

Implications for Research

Considering the rapid adherence to clicker technology in a wide array of educational settings, more research should investigate the pedagogical potential of this CALL tool to further guide practitioners. A main area of research lies in the examination of the potential of clicker-enhanced instruction to foster different areas of SLA. For instance, it would be interesting to explore if the pedagogical effectiveness of clickers projects beyond vocabulary acquisition or differs when a different L2 feature (e.g., grammar, pronunciation) is targeted.

Another potential area of research would be to explore the differences between different clicker software (e.g., *Zoom poll*, *Plickers*) and their pedagogical affordances. Since certain applications have unique characteristics (e.g., *Zoom polls* can be conducted synchronously and virtually), the affordances inherent to different applications should be compared. For example, it would be interesting to further explore *Plickers* and one of its features that allows teachers to create and launch MCQs through the platform instantaneously without having to create them in advance.

Ultimately, the replication of this study would be beneficial for the field to verify the generalizability of the results of this study across different contexts. As highlighted by Chun

(2012), there is a critical need for replication studies in CALL to assess the implications of research findings. To address Gillespie's (2020) call to examine under-researched language, an essential context to consider for replication is to focus on a different language of instruction than English.

Conclusion

Multiple innovative pedagogical approaches can be attributed to the development of CALL tools (Levy & Hubbard, 2005). Considering the rapid evolution of the CALL field is associated with the constant emergence of novel technology, more research is essential to further explore the pedagogical potential of the tools and inform L2 teaching and learning. This study set out to further explore the potential of clicker-enhanced pedagogy in a K-12 educational setting to promote English L2 vocabulary acquisition, and the results reinforced that the technology has great potential in the L2 classroom.

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