SMART CLICKERS IN THE CLASSROOM: TECHNOLUST OR THE POTENTIAL TO ENGAGE STUDENTS?

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ABSTRACT
This exploratory action research investigation provided the opportunity for a collaborative examination of the pedagogy underlying the use of wireless clicker technology within an elementary school environment. It investigated the uncomfortable truths of their use and revealed some unanticipated benefits. Using a triangulated qualitative data collection process, this research revealed this form of information computing technology was more than "technolust". In essence, it was recommended these devices have the potential to enhance and engage learning in accordance with a constructivist understanding of learning.

INTRODUCTION TO THE STUDY
Making the move from classroom teacher to university professor has been an interesting transition. Five years into the career change, I have started to notice a feeling that I can best label as a professional disconnect with the public school teaching culture of which I was so many years a part. Recently, my feeling of disconnect was brought to a higher, almost uncomfortable level, when a student in my Educational Technology Leadership class asked, “Professor Graham, how did the kids respond to the clickers [wireless response system] that we are investigating when you used it with them?” The reply was one that provided the impetus for this research investigation: “I actually never had a chance to use these devices with my students in my classrooms.” Later, back in my office, that response continued to disturb me and led me to begin reading a paper to which I was referred by one
of my tutors for my doctoral studies at Lancaster University. It was by Somekh (1995) on
the topic of action research (AR). From that paper I was able to identify a passage that
seemed to frame my feelings at the time while also offering some insights about my
situation:

Action research is a good example of ‘situated learning’ in contrast to
learning away from the context of practice in which an additional layer of
difficulty arises from the need to imagine practical applications for what is
being learnt, or alternatively manipulate the ideas in an abstract from which
it may subsequently be difficult to translate into practice. (p. 8)

As clarified for me by Somekh, it was really teaching the *imagined* use of the wireless
response system to my students as opposed to teaching from an experience that had been
grounded in a situated context that was at the crux of my feelings of professional
disconnect. Put in another way by Argyris and Schön (1974), it was the resulting conflict
between *espoused theory* and *theory in use*. Confronting the situation is the fact I am no
longer required as a faculty member to supervise my students *in action* and within the
context of a classroom environment. My preservice teachers may have a situated learning
experience with these devices while on their practice teaching placements, complete with
all of the tacit aspects of learning that are off-loaded onto the very contextualized
environment in which they will be teaching. The explanation by Somekh helped to clarify
my feelings and my situation, but it also offered me *action research* as a vehicle in which I
felt I could travel with my research endeavors, however, not comfortably. Although the AR
approach would allow me the opportunity to reconnect with the classroom, it would also
require me to unpack some of the uncomfortable realities that may be impeding the use of
educational technology in teaching practice. It would require me to view them through a
critical lens that sees and magnifies change (Kemmis, 2006).

*ICT: Technolust or Promise of Hope?*
In my educational technology leadership classes, I often begin by stating, “If you truly
believe the educational technology that we are going to investigate today does not have the
potential to inspire and lead to higher levels of classroom engagement and learning, find
another tool that does.” Underscoring all of our technology-enhanced explorations is a
discussion of the pedagogical underpinnings for a particular technology’s use. However,
there is a critical, complex, and often misunderstood relationship that exists among the use
of information and communication technology (ICT), the practice of teaching, and the
affiliated act of learning. As argued by Kirkwood and Price (2006), ICT offers merely *tools*
to help students and teachers attain educational outcomes. Although not a new message,
central to their argument is the idea that although technology can enable new forms of
teaching and learning, ICT alone will not somehow magically *afford* itself to educators; it
must be driven by educational purposes. What I have coined the problem of “putting the
*T* (technology) before the *P* (pedagogy), Lin (2007) views as having some inherent and
serious ethical issues. As noted by Lin, the key ethical issue is that the technology often
takes precedence over the learning needs, “or each new technology is used as a replacement
for all existing learning methodologies” (p.416). The process and practice of knowingly
adopting or recommending ICT that is unnecessary is “technolust” (Bassi, Buchanan, & Cheney, 1997, cited in Lin, p. 416). Unfortunately, it is a practice that continues to perpetuate itself in education, as I have witnessed its happening for years, both in public school education environments and now in higher education. The cure for this malady seems straightforward: conduct an appropriate performance analysis of the technology that specifically locates the learning needs and is able to justify what technologies are the best fit and can aid in an intervention (Lin). This investigation has been built on this understanding.

Clickers: Gimmick or Effective ICT?

Smart Senteos, or clickers as they are more commonly known, have existed as an ICT option for educators for some time. These handheld devices are remotely connected to a computer via a USB attached radio frequency (RF) transmitter (see Figure 1). When used in conjunction with the proprietary software provided, they allow for instant feedback, assessment, and insight into student learning. As noted by Barnett (2006), despite the recent attention they are receiving, these devices have been in existence since the 1960s, when they found most of their use in science education. Notable is the claim by Barnett that little advancement in their development has been made since their inception. This claim seems to be refuted by Caldwell (2007), who highlights improvements to the modern incarnation as being the two-way capacity of them both to send and receive signals in a manner that lets the teacher know whether a signal has been received or not. This, coupled with the now wireless capability of the devices and the more recent development of radiofrequency signals, results in devices that are capable of sending a stronger signal, require just one receiver, and do not require direct line of sight between student and the receiver. There have been technological advances; however, educators must stop to ask a more important question. Is this technology being used to enhance the learning for students?

Caldwell (2007) observes that today the modes of implementation for clickers are as diverse as the myriad of educators using them. A comprehensive list of uses that expands well beyond the clickers most obvious affordance of quick and easy gathering of assessment data follows:

1. To increase or manage interaction
2. To assess student preparation and accountability
3. To gain the insights of students
4. To gather formative assessment
5. To gather summative assessment
6. To review and to guide thinking
7. To differentiate instruction
8. To add a fun factor to the learning environment. (Caldwell, 2007, p.11)

As noted by Caldwell (2007), “This list should in no way be considered limiting. [Clicker] technology is a flexible tool limited only by the imagination of the instructor and the question format itself” (p.11). What we don’t know from her paper is whether the teachers she spotlights have a better understanding of the teaching and learning process than the average practitioner.
The Need for Revitalization
Despite the call for imagined and creative uses of existing technologies, such as clickers, the fact remains many educators seem to be mired in a teaching tradition that has many inherent instructional deficits. Namely, it is a tradition that remains pedagogically grounded in a one-way, transmissive and impersonal style of teaching that fails to capture the attention and imagination of many students. This is in contrast to an understanding of teaching and learning that values a more active and inquiry-based learning method that attempts to provide for a less abstract and more contextualized learning experience for its students. We cannot separate what is learned from how it is learned. In this sense, there is a need to bridge the breach between the know what and the know how (Brown, Collins, & Duguid, 1989). Of course, clicker technology is not going to solve this deep-rooted problem in education; however, Drapere (1998) suggests a technology is worth using only if it can effectively enhance a specific instructional deficit. Does clicker technology have the ability to ameliorate some of the traditional instructional deficits? According to some researchers, several educators and institutions have adopted clicker technology in the hope of reducing attrition rates and creating a learning environment that is more engaging, less impersonal, and more active in nature (Burnstein & Lederman, 2001). The communicative and collaborative possibilities that recent technologies offer represent a key affordance that provides hope for learning enriched by engagement with others (Conole & Dyke, 2004). Much of the focus of the research and use of this technology has been in large higher education classes where the challenges of nurturing the interpersonal and interactive classroom dynamic are greater.
There is a preassumed more passive environment that is associated with the lecture form of instruction that predominates higher education learning environments (Duncan, 2006). As observed by Duncan, “the regular use of clickers can transform a class in a very positive way. Students become active participants, not merely passive listeners to a lecture” (p.2). A notable discrepancy in the existing literature about clicker use seems to be the lack of attention and investigation devoted to their use in smaller sized elementary classroom environments where the need to inspire, engage, and provide a more active learning experience is no less vital.

The Darker Side
Not all researchers share the same view of clickers and their effectiveness in teaching. As highlighted by Willson (2010), the instructional design of the software that is used in conjunction with these devices limits teachers to lower level true/false questions and multiple-choice answers. In this sense, Willson seems to connect with Boud (2000), who asserts that lower level summative assessment practices seem to be overshadowing forms of formative assessment that should aid and support learning along the way. The more valued and emerging practice of assessing the processes of learning as opposed to the products of it seems to call for technologies that can meet these demands. At the moment, the attraction of many ICT devices (such as clickers) and online E-assessment frameworks is their potential for reduced and quick marking, class administration, and identifying weaker students (Sclater, Conole, Warburton, & Harvey, 2006). Proposing a method for a more engaging use of clicker technology, Duncan (2005) has devised a procedure he calls Peer-Instruction aimed at reducing some of the perceived limitations. Essentially, he proposes their use in a collaborative manner as opposed to responding individually. The focus on collaborating and having peer-to-peer discussions prior to submitting answers with clickers certainly fits with a vision and understanding of an inquiry-based and active learning model. It also demonstrates a use of a technology that goes beyond using “gadgets as traps for impoverished teaching and learning” (Wilhelm, 2010, p. 44).

Constructivism and Clickers: A Recipe for Active Learning?
The emphasis placed on the clickers allowing for a more active and less passive learning experience for students is a key pedagogical premise for their use. This emphasis represents a critical piece of the pedagogy pie that is missing many ingredients. Importantly, the focus on active learning is also shared with the epistemological assumptions that underpin constructivist perspectives on learning. Although Levy (2003) cautions there is no universally accepted form of educational constructivism, he does maintain the notion that learning is “essentially an active, situated and relational (or social) process that is widely shared” (p.93). The approaches to learning and teaching necessitated by this approach may be classified and understood as participatory and dialogic in nature. In light of this understanding, the creation of knowledge is the result of these social interactions and the accompanying activity (Vygotsky, 1978). In terms of learning, Vygotsky regards collaborative discourse as an essential mechanism for learning because it elevates and externalizes learners’ thoughts. Wenger (1999) also regards active discourse as a critical practice in order to be engaged within his notion of a community of practice. The result of these discussions is the opportunity for ideas to be collectively refined and negotiated. As such, ICT tools, such as the clickers, may have the ability to help nurture the key elements of a constructivist learning perspective in a classroom environment.
Instructional interventions developed from this perspective will place a greater emphasis on student-centered discourse than in a more traditional classroom setting.

**Methods**

*Procedures and Process*

This research investigation seeks to uncover and to confirm some of the existing *uncomfortable realities* of the Smart Response system (clickers) in teaching practice, while at the same time offering a collaborative and supportive approach to educators intending to use them to enhance the learning experience for their students. The starting point for this investigation was my feeling of professional disconnect. Utilizing a practice-based action research approach allows the opportunity for the type of dynamic involvement and *reflective practice* (Schön, 1983) that seemed necessary to address it.

*Guiding Lights: Research Questions*

The specific research questions that provided the foundation for this investigation were:

- What are some of the uncomfortable realities and barriers facing teachers’ effective and inspired use of the Smart Response System in teaching?
- Can this form of ICT enhance levels of student engagement at the elementary school level?
- Is this a technology worth investing in for an elementary public school?

*Beyond the Spiraling Image*

Action research is an approach grounded in a constructivist epistemology that assumes people actively construct meaning within very situated social contexts (Levy, 2003). As noted by Kemmis and McTaggart (2000), such an approach typically involves a range of qualitative interpretive modes. The process involves a spiraling, systematic, and problem-solving set of self-reflective cycles that results in the construction of practical knowledge (Levy). Sharing a similar conception of the process, Wisker (2007) and Delong, Black, and Wideman (2005) underscore the process as one that involves the continuous and flexible act of planning–acting–observing–reflecting–revising–sharing and repeating. However, Kemmis and McTaggart caution that a participatory action research (PAR) approach is more than the rather simplistic image of the *spiraling reflective phases* that is often depicted. While my investigation is not a pure example of a PAR design, it was influenced by the concept of it. With a PAR model there is a shared research agenda, whereas AR has the researcher at the helm. Kemmis and McTaggart would note the very social nature of my research that seeks to collaboratively bring teachers together to improve classroom practice. At its best, then, action research is a social process of collaborative learning realized by groups of people who willfully join together in changing practices (Kemmis & McTaggart). A further cautionary notice is served by Kemmis (2006), who warns that any research endeavour that is narrowly aimed at merely improving the techniques of teaching without any regard for the broader concern for the education of students for a better society is lacking.
The Action Research Framework: A Call for Creativity and Flexibility

In many cases, the cyclical research framework outlined necessitates a creative, systematic, yet flexible data collection process. The process for conducting this research investigation was constructed around six generally framed *action-oriented, collaborative, flexible, and reflective phases* (listed below) in a bid to complete one research cycle, understanding that more than one iteration of this cycle is necessary. The following is an outline of the research phases and the corresponding methods that were used within each:

**Phase 1: The invitation for reflection, collaboration, and action pre-planning.** This reflective phase involved identifying and meeting with a school administrator interested in advancing the effective use of the Smart Response System in order to enhance the learning experiences for students. The choice of an administrator for this project was influenced by the research relationship that had been established with the same administrator in module one. This administrator’s desire to have technology used in an inspired way within his school is well documented. The fact that the school was also a primary/junior (K-6) learning environment that was a focus for this investigation was key. At this stage a preliminary plan was collaboratively devised on how to get the required technology, have the software installed, effectively introduce it to the staff, and identify the participants for the investigation. At this time I also gained an informed understanding of my *field of action* (Levy, 2003) in terms of the trends and issues taking place within the context of the classroom.

**Phase 2: Courageous conversations and an experiential learning approach.** Based upon the planning in phase 1, a focus group was held for interested teachers willing to examine collaboratively the Smart Response System in use and the pedagogy that underscores it. The focus was not on the technical set-up of the system. At this time, I conducted an experiential, fun, and interactive exploration of the Smart Response software that is used with the clickers. Teachers responded anonymously using the devices to answer key questions specific to their understanding of the system and the pedagogy that underscores the effective use of it. The responses and accompanying visual data that were generated via the system were modeled and became the object of further discussion for the group exploration (see Figure 3 for an actual example of the type of data that can be generated by using these devices and the required Response software).

**Phase 3: The reflective practitioner: Building blocks.** Based upon the feedback from the focus group and the anonymous results gathered from this exercise, a further meeting was held with the principal to identify 3 teachers that might be interested in exploring clicker use in actual practice with their students. The 3 teachers identified, and that ultimately ended up agreeing to participate, had no prior experience with the response system. However, they did have some preconceived notions for its use and knowledge of its existence. The choice of the teachers was based partially upon the grade being taught, and the availability of the required hardware in their classroom. The result was 2 male grade 6 teachers and 1 female grade 2 teacher agreed to participate. Provisions were made to have three sets of clickers loaned on consignment from a vendor for an extended period without having to purchase them. In essence, this action research project represented the
pedagogical investigation of their use that would be pivotal in the decision as to whether they would be returned to the vendor or purchased.

Phase 4: Action: Not words. The teacher participants that agreed to explore the response system with their students were offered some further collaboration, pedagogy, and the technical support required to begin their investigation. This level of support was maintained throughout. During this time, the individual teachers and I made observations via frequent meetings and conversations about the impact of the response system on student learning, the challenges, and the benefits of its integration. All participants were encouraged to keep a log of their reflections related to levels of student engagement during their use, barriers impeding their effective use, and any general thoughts related to the integration of technology and learning that came to mind. During this time I had the opportunity to observe a total of 3 lessons taught. Following the lessons, we reflected upon them, identifying the ways which the system seemed to engage student learning. Importantly, ways to build upon and enhance future lessons were discussed.

Phase 5: Teacher interview: The active art of reflection. During this stage, the 3 teachers who used the response system for a period of 3 weeks were interviewed. The parameters dictating and constricting the clickers’ use during this period of time were few. In essence, the teachers were informed they could be used at any time it was believed they had the ability to enhance the learning process. The interviews were digitally recorded. Member checking was used in order to ensure a higher level of authenticity and validity. The interview schedule was largely open ended, with the reflective journal being the prime focus of the discussion and the starting point for our conversation. The following list is a summary of the broadly framed questions that were asked during the interview process:

- Based on your experiences using the clickers with your students what have you determined?
- Looking at the reflective journal that you kept is there anything that you would like to expand on?
- What are the barriers that you encountered using these devices?
- Have you noticed if these devices have had any impact on the learning experience for students with special needs or who may be regarded as “on the margins”?

Phase 6: Stakeholder dialogue and debrief: Should they stay or should they go? The results of the investigation were reported at a second focus group that aided in determining whether the school decides to purchase the three sets of consigned clickers.

The following diagram represents the constructivist action research process used for this investigation:
A Focus on Process, Not Product: Issues of Validity

The standards upon which the previous research process was built were those associated with a constructivist approach and epistemological understanding. As such, it is regarded as a working knowledge that is open to reinterpretation. However, sense-making constructed in this manner is not immune to standards of rigour and issues of validity. As noted by Guba and Lincoln, constructivist sense-making is problematic if it is “incomplete, simplistic, uninformed, internally inconsistent, or derived by an inadequate methodology” (1989, p. 98, cited in Levy, 2003). The same criteria for authenticity associated with the positivist tradition cannot effectively be used with the constructivist approach that was used for this project. Recent authenticity standards, in keeping with the assumptions of the constructivist paradigm, are outlined by Rodwell and Byers (1997). They include, and highlight, issues of fairness, the opportunity for reflexivity, sharing with stakeholders, linking evaluation to concrete actions, and thoroughness as hallmarks of authentic research. A key focus on process and not the final product is vital. In keeping with this, there is a call for a triangulated approach and procedures like member checking. These become matters of ethical and methodological accountability as opposed to seeking the one ultimate reality in interpretation more closely affiliated with the scientific approach and understanding (Levy). As such, a triangulation of qualitative data sources was used for this investigation, which included reflective journals, focus groups, interviews, classroom observations, and quantitative survey data gathered from actual use of the clickers. As noted by Delong et al. (2005), the committed act of reflective dialogue with critical friends who act as both supporters and pushers often calls for some version of a reflective research journal.
Data Analysis: Starting Points
The process for the data analysis of the interviews and reflective journals was inductive in nature. A traditional qualitative analysis approach (constant comparison) was utilized, with themes, associated words, thoughts, and connected concepts emerging from the divergent data sources. These were put into table format (see Table 1 & Table 2). This process seemed justified given the fact this approach was originally developed to analyze data that was collected over a series of rounds and in various formats, as was the case in this investigation. As noted, and supported by Leech and Onwuegbuzie (2007),

Constant comparative analysis can be used throughout a research study. One way of using codes is to go back out into the field and undertake member checking with the participants by asking if themes, arguments, or assertions developed from the codes are accurately describing their statements (p.565).

Findings
Research Question 1: What are some of the uncomfortable realities and barriers facing teachers’ effective and inspired use of the Smart Response System in teaching?

Teacher level: Finding imaginative and creative uses: Key barrier. One of the guiding research questions for this project was to uncover some of the uncomfortable realities of integrating clickers, and more generally ICT, in classrooms today. In the mind of Kemmis (2006), any AR investigation that is narrowly focused on only improving teaching techniques is lacking. The real focus must be on improving student learning. Based on the findings, many of the primary barriers cited by the teachers in this study are the same ones that have continued to exist for years: lack of time, lack of technical support, lack of motivation, lack of training (see Figure 3 and Table 2 Theme: Uncomfortable Realities). However, one novel barrier that emerged specific to the use of the clickers was the teachers’ lack of creativity in finding uses for them (see Table 1 Theme: Teachercentric). In this sense, the teacher participants noted that finding interactive and engaging uses for the devices, combined with the challenge of having to create higher level questions, was a primary obstacle. In one sense, Caldwell’s (2007) assertion that clickers are limited only by the imagination of the teacher is supported. However, what Caldwell may not have considered is that finding imaginative uses for them may not be as easy and as functional for educators as she has proposed it is.

Figure 3: Screen capture of the responses and graph generated by using the clickers and software during the focus group (N=10).
The following tables highlight the emergent codes, themes, and related thoughts that were generated by the constant comparative process. This data is the amalgamation and result of the interviews, focus group, classroom observations, and meetings that took place during the AR research cycle.

**Table 1.** Emergent Codes, Themes, and Related Thoughts From Constant Comparison Analysis: Interviews and Reflective Journals: Part 1

<table>
<thead>
<tr>
<th>Data chunks taken from interviews</th>
<th>Associated thoughts, related issues and key words</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kids enthusiastic&lt;br&gt;Good for IEP kids&lt;br&gt;Students quite fluent with this tool&lt;br&gt;Great buy-in by students&lt;br&gt;Students really liked seeing the visuals&lt;br&gt;Students largely enthusiastic&lt;br&gt;Enjoy the anonymity&lt;br&gt;One of the kids you least expected responded&lt;br&gt;More engaged&lt;br&gt;Kids have told me they are cool&lt;br&gt;Anonymous important to the kids</td>
<td>Anonymity has been a key phrase and concept that has come into the discussion on many levels throughout this investigation. One girl in grade 2 told her teacher, “I like that nobody knows it is me.”</td>
<td>Student-centered&lt;br&gt;*issue of anonymity</td>
</tr>
<tr>
<td>You have the ultimate ability to look at the data&lt;br&gt;You are tracking, but not visually&lt;br&gt;We need to be more prepared&lt;br&gt;It is easier than I thought it would be&lt;br&gt;Loss of control when these are in the kids’ hands&lt;br&gt;I really want to know the kids who know and don’t know&lt;br&gt;If my students aren’t engaged, what am I doing?&lt;br&gt;A challenge to find more interactive uses</td>
<td>One teacher told me she lacks the creativity to come up with good questions to use these devices. Some of these data confirm my suspicion that a key barrier in using technology is a lack of creativity. Another key finding is that giving students more control and flexibility in the learning environment will be a challenge for some educators. One teacher in this investigation sees this system as offering that.</td>
<td>Teacher-centered&lt;br&gt;*need for creativity&lt;br&gt;*need for control over teaching environment</td>
</tr>
<tr>
<td>Allows for more truthfulness&lt;br&gt;Main benefit is the anonymity&lt;br&gt;Promotes honesty&lt;br&gt;Gave an opportunity to share&lt;br&gt;You can put up the responses, but they remain anonymous&lt;br&gt;Kids can compare themselves: that can be good and bad&lt;br&gt;Records results for each student&lt;br&gt;It is bound to make it more enticing&lt;br&gt;Immediate feedback&lt;br&gt;Students with special needs are comfortable using&lt;br&gt;Immediate feedback, that was neat&lt;br&gt;Formative assessment, live on the go&lt;br&gt;Immediate feedback&lt;br&gt;I can help kids who never raise their hands</td>
<td>Many of the pedagogical benefits cited here are the same ones that are cited by other authors. One major difference is the focus by one of the teachers in this study on the formative assessment benefits as opposed to the often-referenced summative assessment benefits. This seems to confirm for me that what a technology affords a teacher is differential in nature. It has left me to wonder why and how some teachers are more resilient and some are more vulnerable in this respect.</td>
<td>Pedagogically Speaking&lt;br&gt;* (Resilience versus vulnerability model)&lt;br&gt;*Fear of failure (technologically speaking)</td>
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</tbody>
</table>
Table 2. Emergent Codes, Themes, and Related Thoughts From Constant Comparison Analysis: Interviews and Reflective Journals: Part 2

<table>
<thead>
<tr>
<th>Data chunks taken from interviews</th>
<th>Associated thoughts, related issues and key words</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trying to use it at a higher level</td>
<td>The same barriers that existed more than a decade ago are still being cited today.</td>
<td>Uncomfortable Realities *fear, finances, time, lack of resources</td>
</tr>
<tr>
<td>Fear of technology is higher with these</td>
<td></td>
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<tr>
<td>Many teachers technologically phobic</td>
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<td>Lack of inserviceing</td>
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<td>Have to develop Smart lessons: too much time</td>
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<td></td>
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<tr>
<td>Financial barriers</td>
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<tr>
<td>Boys seem to be more jazzed about them</td>
<td>This was an unexpected outcome of the investigation that offers some potential promise of hope for further investigation. The male teachers involved with this investigation seem convinced of the positive role that technology can play in this area.</td>
<td>Gender Differences</td>
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<td>Especially useful for boy-centric groups like mine</td>
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<td></td>
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<tr>
<td>Technology and boys go hand in hand</td>
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<td></td>
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<tr>
<td>A focus is to get boys more interested</td>
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<tr>
<td>Fairly useful</td>
<td>The participants of this investigation were quite skeptical during the preliminary exploration of these devices. Their endorsement of them in such a short period of time is an interesting finding.</td>
<td>Justification for purchase</td>
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<tr>
<td>I definitely think the Sentenos are worth it</td>
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<td></td>
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<tr>
<td>Don’t like when you pull it up, you lose the question</td>
<td>The insight that kids imagine these as being able to do more is a higher level insight that may carry weight for the developers of this product.</td>
<td>Interface/technological *redundancy</td>
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<td>The interface could be better</td>
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<td></td>
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<tr>
<td>Relatively easy to use</td>
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<tr>
<td>Didn’t save data correctly</td>
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<tr>
<td><strong>Kids imagine this can do more than it can</strong></td>
<td></td>
<td></td>
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<tr>
<td>They want more from the device</td>
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<td></td>
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<tr>
<td>Could not integrate with another file</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am surprised how easy they are to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We have had no problems so far</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will they still be cool in 5 months?</td>
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</table>

A notable discrepancy: Mind over matter. All 3 of the teacher users reported the technological aspects of the devices, including the software, were easy to negotiate when given the level of support and collaboration that was provided as a part of this AR project (see Table 2 Theme: Interface/technological). In her journal, Sarah noted, “Relatively easy to use system”, while Mark reported, “I was very surprised by how easy it was to set-up questions and to alter them as I typed”. Less optimistically, it was revealed the general lack of sustained support provided by the school system would be a barrier for teachers with “a phobia of technology” (Steve). This theme reemerged during the interview process. Based on these findings, it seems apparent that devising uses for the clickers in a manner that allows for an active and inquiry-based constructivist learning experience is not necessarily being limited by the technological interface, but more so by the mind. However, there was some incongruence between what was stated and what was observed in actual practice. While the teacher users reported this as a barrier, all 3 were observed using the devices in what I regarded as pedagogically engaging ways. In one lesson I observed, Sarah had opted to use the devices as a way to enhance discussion about a sensitive story she had read to the students by presenting questions that would provide a platform for further group
reflection. During it, students appeared very interested when Sarah revealed the graph of class responses to a particular question. As noted in my observations, “One student looking out the window during the time it took for others to enter their responses was quick to refocus and pay attention when Sarah presented the visual graph on the Smartboard of the class responses.” Following the lesson, when we debriefed about what had taken place, we both agreed that the learning process for the students may have been heightened if the peer-instruction procedure developed by Duncan (2005) had been used. In this case, the students would have responded in groups with one device after considering the question, as opposed to responding individually. Furthermore, it was agreed the opportunity for collaboration between the students that this process called for was an essential missing ingredient for this lesson. This creative adaptation of the clicker device represents the kind of inventiveness that is required to move their use beyond their becoming mere gadgets and tools for impoverished learning (Wilhelm, 2010). It also represents the type of pedagogical insight that is not naturally afforded by the technology and may not be without some enhanced collaboration and deeper level investigation of their use. This opportunity was provided as a part of the AR process and is essential. However, it was lamented that this community of practice (Wenger, 1999) like approach would not be sustained once I left. This realization had not been something I had considered at the onset of this investigation and resulted in what I have coined a form of ethical discontent. At this stage of my understanding, I would regard this as a key limitation of the AR process. In some way I had the feeling that I was going to be “pulling up stakes” after my investigation and leaving town.

Student level: Wanting more: A limited user interface. This investigation revealed an interesting juxtaposition when, during an interview, Mark (2011) stated it seemed that his students “wanted more from the devices” and that he felt his students “imagined the clickers doing more.” In this sense, it was his feeling that the tech-savvy nature of his grade 6 level students had already outgrown what Mark regarded as a “limited” clicker user interface. Interestingly, his belief that his students’ enhanced capacity to imagine greater uses for these devices was the very limitation that the teachers had reported as being a key obstacle: imagining uses for them.

Research Question 2: Can this Form of ICT Enhance Levels of Student Engagement at the Elementary School Level?

Much of the investigation in the area of clicker technology seems to be focused on higher education where the lecture format of instruction predominates. However, the instructional deficits that have been identified at this level also exist at other levels. The assertion by Duncan (2006) that the regular use of clickers can transform a class in very positive ways by adding an element of active engagement was largely based upon research within university-level environments. The data provided by his investigation suggests that the same power to actively engage student learning in earlier grades also exists, albeit with the previously recognized limitations. Most notable was the feeling by all 3 of the teacher participants that these devices have the capacity to engage students who would not normally be willing to share during class discussions (see Table 1 Theme: Studentcentric). As noted by Steve, “Great buy-in by the students. Students hugely excited.” These
reflections were confirmed by my observations of the lessons where there was an obvious “sense of fun and engagement” taking place during the teaching. A key observation during this investigation was the frequently made comment by all of the teacher participants that the “clickers are only as good as the questions that you ask” (Mark). Put another way by Sarah, “At times I felt it was difficult to design question sets for some of the lessons. The types of questions that I ask are really the key to using these devices”. These comments highlight the notion that clicker technology is merely a tool that requires a high level of creativity and pedagogic skill in order to maximize levels of engagement and inspiration in the classroom. They also point to the fact that a technology will not somehow magically afford itself to an educator without some willingness and desire on the part of the educator to make IT (information technology) happen. The types of questions that were asked and activities that took place during the lessons that I observed were diverse in nature. One notable lesson that took place was during a grade 6 language class. At the onset of the lesson Steve posted questions that based on Krathwohl’s (2002) review of Bloom’s taxonomy could be regarded as evaluation level queries. The manner in which he attained this level of inquiry by his students using clicker technology was notable. During the lesson students were challenged to defend and summarize one of four possible positions that were offered as choices on the clickers. These were in response to a chapter book that the class was studying together. After all students selected a position using the device, a visual of the results was immediately posted for all to see. I observed at this moment a high level of interest by the students as evidenced by the chatter and pointing to the graphic that followed. Steve then asked if any students would like to summarize their position at which time many hands were raised.

In the situations that I witnessed the use of these devices, I observed classroom management issues were limited and there was a “seamless” nature to their use within the teaching. This was a testament to the teacher participants who obviously took the time and extra effort prepare for their effective use and integration. A common theme that was attributed to some of the enhanced engagement and active involvement that was taking place was the aspect of “anonymity” that these devices afforded the students. As noted by Mark, “One of the kids you least expected responded”, and “Students seemed to enjoy the anonymity of response.” During one observed lesson, Sarah asked her grade 3 students what they enjoyed most about using the clickers. One young girl said, “I like that nobody knows what my answer is, but I can give one.” In this sense, one of the commonly cited pedagogical rationales for adopting these devices is the comfort that can be afforded students by being able to respond anonymously. The result is a higher overall level of classroom engagement and participation. Based on these findings, this seems real. Perhaps more important, for students existing on the margins, these devices have the potential to capture their attention and insights: “Good for students with individual education plans and those that struggle” (Sarah). Another key finding that provides the opportunity for further investigation is the assertion by both Mark and Steve that the clickers seemed to attract the attention of their young male students. As noted, “these are great for boycentric groups like mine” (Steve). At a time when school districts are struggling with ways to reduce dropout rates of male students and to attract the attention and imagination of them, this insight is timely and offers some hope. By providing this kind of awareness to teachers,
along with the tools and understanding to enhance the learning, the AR process used for this investigation has achieved some small level of success (Kemmis & McTaggart, 2000).

Research Question 3: Is This a Technology Worth Investing in for an Elementary Public School?
This AR project was partly based upon the understanding presented by Lin (2007), who observes the lack of critical performance and pedagogical analysis of a given technology, prior to its purchase, is all too common. Having the opportunity for an experiential and pedagogical exploration of this technology perhaps has modeled the Rolls-Royce version of what Lin has suggested should more regularly take place. At the onset of this investigation, many of the teachers were skeptical that these devices were worth investing in. Based on the cumulative data gathered via the collaborative research phases that took place, the participants were unanimously in favour of making the purchase due to the impact that they witnessed it had on the learning and level of classroom engagement, all in a very short period of time. As noted by Mark, “I definitively think the Senteos are worth it.” Importantly, this was with the proviso and understanding that there was a need for continued collaboration and pedagogical pushing by others in order to maximize their use. While the answer to the research question as it is posed seems to be a resounding yes, the highly contextualized nature of AR that is recognized by Levy (2003) would more accurately caution it should be stated, “For this elementary school the answer to this question is yes.”

Where Do We Go From Here?
This AR investigation was conducted over a very condensed period of time and represents one cycle of what should be a series of cycles. As such, the level of collaboration and depth of analysis that took place must be regarded as surface level. More important, this study was limited by the lack of the student voice that could not be heard due to stringent ethics procedures and time constraints. Future research in this area must include the student voice if it is going to tell the “unwelcome truths” (Kemmis, 2006, p. 459) and if it is to have the political and critical edge that more contemporary forms of AR call for. In spite of these limitations, the AR process that was utilized for this investigation provided me with the professional learning experience that I required to partly appease my professional disconnect that was a starting point for this investigation. It also seemed to offer the level of support required to have an impact on the teaching and learning landscape in a small elementary school. Sustaining this remains an unanticipated ethical issue that has resulted from the intimate and interpersonal AR process. Future research of this type may consider resolving this in advance of the project and put into place an exit support plan.
REFERENCES


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**Biographical note:**

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