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Calculator Usage in Secondary Level Classrooms: The Ongoing Debate

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Introduction

The use of calculators in secondary level mathematics classrooms has been a recurring and controversial subject for the last 40 years. With technology growing more and more prevalent in everyday life, it has become imperative, yet again, to examine the usage of technology, namely calculators in the classroom. There have been many opposing opinions on the subject among leading educators. It has been said that calculators will become a crutch for students and they will no longer need to remember basic facts, such as multiplication. It has also been said that calculator use leads to better student understanding. Both statements can be proven true; depending on how the calculator was introduced and used in the classroom. This thesis will explore these opinions regarding this matter and aim to provide a possible compromise to this issue. It will survey the past, investigate the present, and try to anticipate the future use of calculators. It will also reveal the disadvantages as well as the benefits to the students and to the teachers of using calculators in the secondary level classroom.

The History of the Calculator

Imagine a machine that could only add, subtract, multiply, and divide; cost over a thousand dollars, weighed more than 30 pounds, and was the size of a typewriter. Figure 1 shows the calculator in its early days. The only people that had this machine were offices and mathematicians; as they were the only people who had a need for such an expensive tool. On April 14, 1970, one of the first major transformations occurred in the world of calculators. Texas Instruments (whose main production is through integrated circuits, also known as microchips) introduced the Pocketronic (see Figure 1); a hand-held calculator which used less power because of its paper strip output

Figure 1: Pocketronic-Texas Instruments

instead of display lights. It was not comparatively "pocket-size" but it was small enough to carry around and much less expensive than the desk-top calculators of the time. The Pocketronic was about $400 in 1970 (equating to $2,400 today), while the desk-top calculator was $7,500 ($12,000 today) (Hamrick, 1996). In 1972, calculators used a liquid crystal display (LCD) and by the late 1970s, calculators operated on batteries, were pocket-size, and were programmable, with some costing less than $50 (Grinstein and Lipsey, 2001). Calculators continued to develop throughout the 1980s and 1990s, becoming smaller, cheaper, and less power consuming, yet still more powerful in their calculation abilities. Calculators, similar to technology as a whole, are becoming stronger and more dominant as years go on. Like all things, in order to understand the present and the future of calculator usage in the classroom, knowing the past is an important first step.

The History of the Calculator in the Classroom

The introduction of the calculator was ground-breaking to educators. As soon as they became affordable, the dynamic of classrooms began to change. In 1974, the National Council of Teachers of Mathematics (NCTM) released a "far-reaching" statement advocating that calculators should be used in the classrooms (Dessart & Hembree, 1986). Some educators began to worry about their place in the classroom while others welcomed the idea of having a new tool to use. With the calculator being more tangible, people who originally had no interest in mathematical concepts now found themselves exploring its capabilities (Maor, 1976). Educators began to see that there at least needed to be guidelines in place in order to regulate the usage of calculators in the classroom. However, by 1987, only 42% of the states had actually produced a policy at all; including two states that totally restricted calculator usage in grades 7-12 (Dessart & Hembree, 1992).

As time went on, calculators continued to be the friend of some teachers, and the enemy of others. Some educators soon began to question what the inclusion of calculators could mean for students while taking a test. Up to that point, calculators were simply prohibited on tests. Since no calculators were allowed, students began to think that the most important part of mathematics was to simply "execute computational procedures" (Heid, 1988) causing that thinking to affect the rest of their mathematical experience. This could have definitely been the beginning of the strong disposition that children have against math today; triggering the ever-present question from students: when will I ever use this? Mathematics is, of course, more than computation as one could apply it to literally any and every thing in productivity.

As calculators became more powerful, they also became less expensive (Heid, 1988). This caused more educators to speculate about its use in the classroom. What if students could purchase a calculator, bring it to school and use it in order to enhance their education? What if schools could purchase calculators and loan them (as they do with textbooks) to students for the school year? Finally, what if calculator use was allowed on tests? Think of how broad the curriculum could become; how much more real the numbers could be; and how much more content could be covered (Heid, 1988). These questions were imperative to begin to at least consider. The calculator's power was just beginning. Its role in the classroom is just becoming apparent; and its existence will not be leaving any time soon.

In 1997, a study was conducted by Elaine Simmt with six 11th and 12th grade teachers who planned to use the graphing calculator for the unit on the quadratic function. Five out of the six teachers gave each student a calculator while the other teacher used an overhead projector of a calculator. While all of the teachers used the graphing calculators to show the transformations, they all did this in different ways. This could suggest the amount of trust that they had in the

calculator's capability. Four of the teachers provided discovery time; stretching a lesson across two days, while the other two ran a very structured class, allowing little time for discovery before presenting the point of the lesson. Two teachers used the calculators to investigate solutions to max/min word problems while one teacher asked the students to explore the changes to the graph as one of the parameters (or coefficients) got closer and closer to zero (previewing the concept of limits). After the study, Simmt states that no new methods were used while the teachers used the calculators; and that the teachers simply used the calculators as an extension to how they already taught the course (Simmt, 1997). This showed, even then, that the calculator does not replace the teacher, but rather enhances their activities and instruction. It also shows that there is not only one "correct" method to incorporate calculators into the classroom. Teachers can decide the best method that matches their teaching style and choose to include calculators in that way. Simmt states that technology (such as calculators) "will not have an impact on mathematics instruction if teachers do not use it differently," (Simmt, 1997) so it is time for educators to embrace each other's differences and improve the education of secondary school students.

The Concern of Calculators in the Classroom

Calculators have numerous benefits in the classroom. However, there are also certain disadvantages that can come from having them available. Incorporating calculators into the traditional classroom is nearly impossible. This calls for a curriculum change in order to properly integrate calculators without losing their value. Teachers will have to use more time for preparation, seek training, and may spend more money to ensure that the students can ultimately benefit from the usage of calculators. Simply put, there is a lack of incentives, such as paid-time, money, and support (both technical and moral) and, in order to convince teachers that more technology in the classroom is worth the work that will be necessary for a successful integration

(Dick, 1997). Before teachers can motivate their students to use calculators, teachers must first motivate themselves. Teaching is a sometimes thank-less and unappreciated profession; it is understandable why some would stray from additional, unsupported work.

It is imperative to understand that too much of anything can do harm. When introducing calculators, one of the first concepts that teachers need to teach is that students need to be able to recognize what an answer *should* look like. It is very common that students will trust the calculator's answer over their own work (McCulloch, Kenney, and Keene, 2012). This could cause major mistakes and confusion as students could have simply pressed the incorrect key or not used parenthesis where they were needed. As a result, it is again up to the teacher to make sure that students are prepared to use the calculator as a tool and not solely as an answer machine.

Another major concern that teachers have expressed is the logistical difficulty of trying to explain to 35 students how to operate the calculator. A lesson can either be absolutely successful or totally catastrophic, depending on the students' familiarity of the device being used. This means that the teacher may have to stop a lesson entirely so that everyone is together or move on, possibly leaving some students confused for the rest of the lesson. This is, of course, assuming that all of the students were provided a calculator by the school or that they were all able to purchase the calculator that the teacher would like for them to use. For example, the teacher may ask the students to have the TI-Nspire; but not every family can afford that, so they bought the TI-89 Plus instead. Although useful, and beneficial to have, if the teacher has a lesson prepared for the students to use an Nspire, that is what every students must have. Otherwise the teacher must be prepared to spend even more time instructing usage (for more than one model), rather than the lesson itself.

As part of the debate of calculators in the classroom, educators have expressed concerns of when calculators should be introduced. According to an article by Joy Rogers, psychologists have argued that giving calculators to students too early can introduce mathematical concepts that they are not cognitively prepared for (1976). However, giving calculators to students in later years is also risky, as by then, they have already formed their own opinions as to how calculators should be used. [This, once again, reiterates that the way that calculators are introduced to students, will define how they will use them. When calculators are used incorrectly, it will become a crutch to its users, and students will not derive all of the potential benefits that calculators offer.

Research has confirmed that the teacher's beliefs about teaching and learning, for example, deciding the appropriate methods and materials for a lesson or unit, directly affect the students' learning (Özgün-Koca, 2009). So a teacher's beliefs about calculators and their use can affect their use in the classroom. This means that the longer teachers are opposed to calculators, the longer students will be deprived of an educational tool that can be extremely beneficial to their learning.

The Advantages of Calculator Usage in the Classroom

With every disadvantage of the calculator in the classroom, there is an advantage to counter it. Calculators can help to simplify tasks. Calculators may compute an answer, but they will only give the answer for which the user asked. Calculators are processors of entered information. Therefore, they can only be used as tool. They do not do all of the work for the students, just the tedious part (such as graphing a complicated equation, where many points would be needed to get an accurate picture). They can, however, speed up the learning process. Students who learn the appropriate use of calculators can spend more time discovering

challenging and more interesting mathematics, and less time trying to complete tedious calculations that could hold back the process (Waits, 1997).

When introducing calculators into the classroom, a concern is that classroom management could be disrupted and no one will be able to learn. This is a great time for teachers to use a Cooperative Group Learning strategy and allow students to work together. Since nearly all current students have literally grown up with technology, there is a high likelihood that some, if not most, of the students already have an idea of how to use the calculator provided. Many teachers become nervous when they hear about group work, as it seems like it will be more work for the teacher regarding the management of the class. According to a study conducted in 2012 on cooperative learning, it was discovered that students were satisfied with cooperative learning when it had the following elements: Positive independence (requiring everyone to participate), individual and group accountability, promotive interaction (for example, having the teacher close by in case he/she is needed), communication, and group processing (for example, allowing students to decide their group member's roles) (Dietz-Uhler and Lanter, 2012). When students are enjoying their task, the less likelihood of there being any behavioral problems, meaning the teacher need not be concerned with discipline. The more rich and worthwhile tasks are for the students, the less energy that the teacher will need to put towards classroom management.

One of the main questions that a mathematics teacher hears from students is "when am I ever going to use this?" The answer that a teacher could give is simple: every day. Mathematics helps students (and everyone else) think logically. The addition of calculators helps with that process. Students are undeniably familiar with technology. Calculators will allow students to be familiar with more technology, but from a different standpoint. In the classroom, calculators help students have a "multiple representational approach to teaching and learning" (Demana and

Waits, 2008) which will help students be able to effectively and fluidly move between representations. As students are introduced to these representations and gain a deeper understanding for them, they can expand the capacity to think mathematically (Representation Standard, 2000). With students seeing more representations, they now have the chance to actually "visualize mathematical concepts more effectively" (Özgün-Koca, 2009), thus taking mathematics away from the abstract world that it is known for and giving students greater hope of understanding both basic and more advanced mathematics.

The problem that students face is simple: test results such as the ACT and Michigan Merit Examination (MME) show that after 11 to 12 years of "learning" a curriculum, students are "ill-prepared to apply mathematics sensibly to the world around them" (Heid, 1988). With the implementation of calculators (and other technological tools), teachers can not only provide more rich lessons that can be more interesting to students, but also provide more real-world problems "instead of executing routine manipulations" in fabricated problem settings (Heid, 1988).

Although it may take a longer time to prepare activities and lessons that involve calculators as compared to those which do not, it will save instructional time in the long run. Once the lessons are done, they will only need to be updated or edited; all of the hard work is done after the first go-round; and the ultimate benefit is for the students (which is why teachers work so hard in the first place). One of the concerns for calculators in the classroom is curriculum changes. This is an unavoidable situation whether teachers decide to fully incorporate calculators into the classroom or not. An effective teacher is constantly reviewing and updating lessons and activities; continuously trying to improve instruction. With each new

generation, students are changing and teachers must be able to accommodate those changes with up-to-date activities and instruction, and a curriculum which supports it.

Calculators as Tools

As previously stated, calculators can be used in the classroom in multiple ways. The method chosen ultimately depends on the teacher's preference and beliefs about them. According to Joy Rogers, calculators can be used as a teaching aid (1976). She then lists four characteristics that a specific teaching aid (in our case, the calculator) must have in order to be usable in a classroom. First, the calculator must be inexpensive or durable enough that teachers would allow students to use them while being fairly unsupervised. Secondly, the calculator must be controllable by the learner. Rogers compared this feature to using a book. The student can read it at any rate, in any comfortable position and can stop and start at will. The same can be said about the calculator. This is exceptionally useful in the classroom, as the teacher may need for the students' attention to be elsewhere for a moment. The students can easily place the calculators on the desk until it is time to work with them again. The third characteristic needed in a teaching aid is that it must do what the learner wants it to; i.e., solve problems. This does not, however, negate the fact that a calculator will only give an output that is based on the input.

Calculators are a great tool to explore ideas such as "forbidden" operations, for instance dividing by zero, and watching the "violent flash of the display" or an error sign; reminding students that such operations are undefined or indeterminate (Maor, 1976). A comprehension of mathematics means that the students first understand what the problem is asking; then they know how to set it up, what operation to use, and know that the answer makes sense. Calculators are a tool that students can use in order to help them solve those problems (Waits, 1997). The final characteristic that a teaching aid should have is flexible usability. Specific, specialized materials

should not be needed in order to operate the teaching aid. For example, the chalkboard would not be as useful or versatile if specific boards required specific chalk; or if there was only one type or brand of dry erase markers for specific boards. They are much more useful because any type of chalk or any dry erase markers will work.

Not only can calculators assist in showing students relationships in mathematical concepts, such as the effects of the coefficients of a quadratic equation on its graph, but they can support the students' computations more efficiently and precisely than their paper-and-pencil efforts (Tajuddin, Tarmizi, Konting and Ali, 2009).

In order to effectively use calculators as tools, teachers must have "specialized" knowledge known as TPACK: "the interconnection and intersection of technology, pedagogy, and content knowledge" (Browning and Garza-King, 2010). Figure 2 shows a diagram of TPACK. This means that simply being an expert in your content area, the technology, and the pedagogy separately will not help. The teacher must be able to interconnect those skills in order to best serve the students when integrating not just calculators, but any form of technology. Just as no teacher should walk into a classroom unprepared to teach a lesson, no

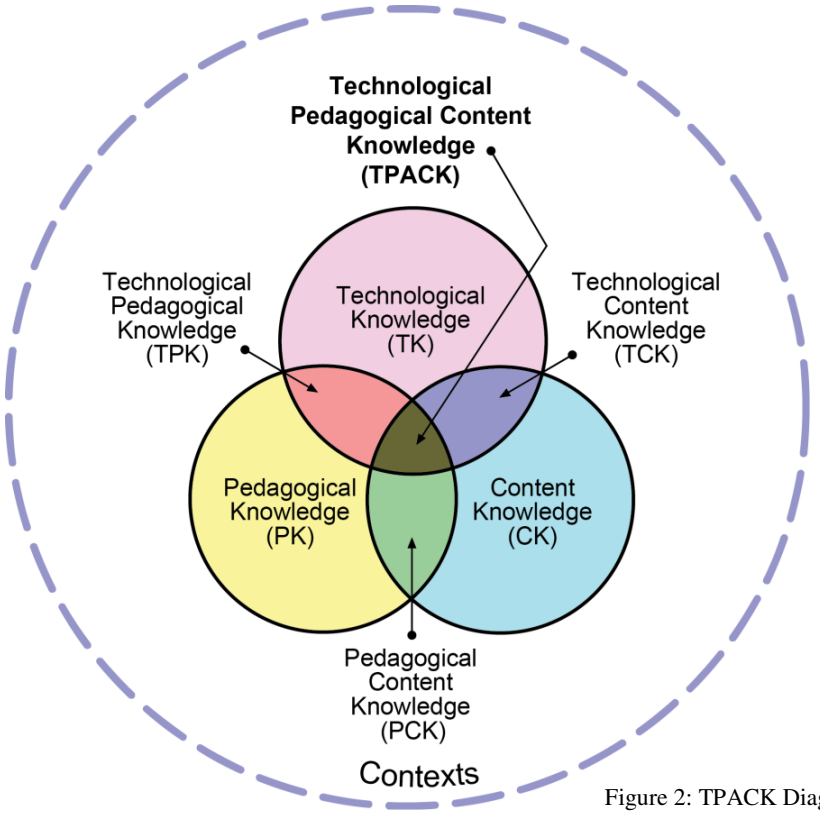

Figure 2: TPACK Diagram

teacher should walk into a lesson blinded on how the lesson and the desired technology will piece together into a successful demonstration. In the article *Graphing Calculators as Tools*, a lesson was created so that students could explore and analyze the nature of change in linear relationships and other functions (Author(s), 2010). Students in pairs were each given a portable motion detector that used stand-alone data collection. These devices linked to their graphing calculators through a cable. The calculator is able to take the information from the motion detector and create a graph to show the data. The students were asked to simply walk or run to see the affect it had on the graph on the calculator when comparing distance and time. Through this activity, students identified that if they wanted a straight line, they had to walk at a constant speed or the calculator would generate a curve. They also realized that their speed would affect the slope of their line. During their experiments, the students began to wonder if they could create a vertical line. As students tried running as fast as they could, they noticed their lines getting steeper but never vertical. They soon noticed that in order to produce a vertical line at a certain time, the person needed to be walking or running from all distances at the same time; which they knew was impossible. This would later be correlated to having a line with an undefined slope.

In the example above, by using calculators as a tool, students were able to collect and examine data that they created as well as explore numerous cases in just one to two class periods. The graphs from the calculators provided immediate and individual feedback to the students and also allowed the teacher to ask questions to increase the students' understanding and teach them to think critically. Since the calculators were used a "discovery tool", students were provided feedback that they could understand and that was useful to the activity and learning process (Özgün-Koca, 2009).

This lesson could also serve as an introductory lesson to problems involving distance, time, and rate; and how they relate to linear equations and their graphs. The activity also serves as a way that calculators can assist in solving real-world problems (the students were solving an actual problem that they were creating) and observing how these problems could be applied to different situations.

In the above activity, calculators were used as the main source. Students can also use calculators as a way to simply check their hypothesis about the data, without spending too much time performing computations for a guess that led them to the incorrect answer (Heid, 1988). The next activity described will show calculators being used to simply aid the students with computation. The activity was created by three Wayne State University professors for a seventh-grade class for students to explore ratios, rates, and proportions in a real world situation. The activity called for the students to look up nutritional information about McDonald's Big Mac and calculating how long it would take to exercise away the calories (Chelst, Edwards, and Özgün-Koca, 2013). The students were given calculators so that they would not have to calculate large percentages by hand. This helped to simply keep the lesson going so that students were not stuck doing computation rather than the actual activity. Along with the activity sheet, the students also participated in discussion and group work. This is necessary to ensure full understanding of the math that occurred while the students were working. Although the calculators did not have the major role in this activity, they were still a necessary component in presenting a successful lesson to the students. Calculators cannot be used in the same way for every lesson. Their incorporation must be well thought-out and planned and their place in the lesson must make sense. Activities such as these are always a great way to start that integration. There is no urgent need to reinvent the wheel at this time.

Having calculators in the classroom also supports Problem-Based Learning. Problem-based learning is an instructional approach to the way students learn. It supports students learning through discovery and experience while the teacher facilitates and guides student-learning through discussion and by using the student's prior knowledge (Schettino, 2012). Problem-based learning recognizes that students learn differently and have different ability levels. It is, therefore, the teachers' duty to ensure that the class time is filled with different ways for the students to come to an understanding about a topic; this includes discussion, asking questions that will allow the students to think deeper about the topic, well thought-out homework and using instructional tools (such as calculators).

Calculators are being upgraded every few years with more capabilities. The TI-Nspire CX, for example, has a color screen, a keypad that allows easy navigation, and the ability to see multiple representations of a problem. For example, a student can input data and see that data as a table, a graph, or a box and whiskers plot; and a student can see two of those representations at once if they desire to. This also gives students the opportunity to compare and contrast their data representations with one another in order to gain their own understanding of what they are looking at. Most graphing calculators have the ability to download applications on them in order to enhance their use. The TI-84 Plus, for example, allows a person to download apps such as Cabri Jr. (shown in Figure 3) which is an interactive geometry app; the Guess My Coefficient App which is a fun way for students to both study and learn how coefficients affect the graph of a function; and Solve It! Which allows students to practice solving equations in the form of a game. If every student owned, or was given a calculator and one of these apps was downloaded

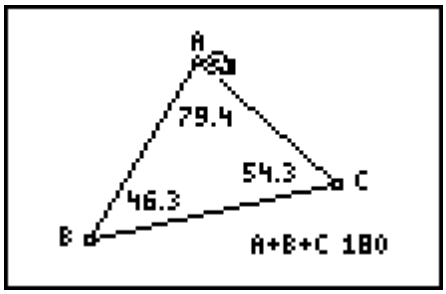

Figure 3-Cabri Jr. – Interactive Geometry

on them, they could be used as an activity where the teacher shows the students (in groups) the different functions of the app and then provides a worksheet to lead them through the lesson. An interesting twist to this activity could be allowing room for the students to get different answers. For example, in the Cabri Jr. app, students can discover that similar triangles only change in proportions and those proportions could be different depending on how students manipulate their shapes. Afterwards, there could be a discussion of what each group discovered while completing their worksheet.

Every teacher, no matter where they find an activity or lesson will put their own "flare" into the lesson. No lesson, even if it is followed exactly, will turn out exactly the same. When activities and lessons are planned properly (using research, providing the correct background information, having proper content knowledge, and choosing assessments), it is relatively easy to incorporate calculators as tools to students for the purpose of enhancing what they are learning in the classroom.

The Future of Calculators in the Classroom

When looking towards the future of calculators, it should be understood that the idea of what the calculator is (in terms of its form and usage) should be considered. As technology changes, so does the calculator. It is already apparent that the calculator can come in all types of forms, such as an online version and in applications on Apple and Android devices. Soon, students and parents could begin to question why they need to buy a $150 TI-NSpire calculator, when they can get the NSpire app on their iPads for around $80; and with all of calculator's features included. Therefore, along with educators thinking about how to implement calculators, it is safe to say that the form of calculators should be considered as well.

In addition to this, teachers should also consider the usage that students can have for their

calculators outside of their high school classroom. For example, part of the main focus of teachers is to prepare their students for Standardized State Tests such as the Michigan Merit Examination (MME) and the national college admission exam, the ACT. These tests have very specific requirements on what can and cannot be used by the students. One of those specific requirements includes the types of calculators permitted while taking the test. This affects the calculators used in the classroom, because one of the tips given for the ACT and MME is to be familiar with the calculator that will be used. If teachers are spending all of their time to incorporate a calculator, it is important to have the students practicing with calculators that can be used on the one of the most important tests that they will take. For example, the TI-Nspire CAS is not permitted for use on the ACT. The TI-Nspire non-CAS, however, is permitted. Students need to be comfortable with "executing calculator routines (of the calculator they will use later) but more importantly making decisions (on when it is appropriate to use)" (Heid, 1988).

It is acceptable for students to have experience with all kinds of calculators, however, it is more beneficial when they can explore and discover the wonders of a calculator that will also help them be successful on tests that will affect their future. It is the duty of the teacher to be sure that students have enough practice with calculators that they can use outside of the classroom in order to be successful outside of that classroom. So, when looking to incorporate calculators or technology in general, there are more things than just curriculum that will need to be considered.

Moving Forward

It has been shown that there is a strong relationship between the teachers' beliefs and the instructional decisions made in their classrooms (Crutch or Catalyst, 2007). This could very well

be a deciding factor on whether or not students are introduced to calculators while in school. This screams that "calculator believers" must keep advocating its usage.

Teachers must remember that they are not alone. There are plenty of resources for teachers to use if they are considering implementing calculators into their classroom. For example, calculator websites, textbooks, journal articles, conference workshops, and fellow teachers (Campe, 2011). Simply put, there is really no absolute need to reinvent the wheel. Teachers have been sharing their lesson plans and activities for years. There are multiple sites and blogs that are open to teachers for that exact purpose. Texas Instruments, for example, has a site dedicated to using their calculators in the classroom. It is possible to choose the model, subject, and class that the teacher needs. All of the activities are free to download, and they can all be compared to the state standards on the website or through the Common Core State Standards website.

Technology has taken huge steps in the last 10 years. Consequently, teachers have not had too much experience with the mathematical freedom of having the calculator (Rogers, 1976). One of the main concerns of implementing the calculator into the classroom is the teacher's lack of knowledge about them. When a person has never experienced something and they "survived without it", it can be difficult to then persuade them that a change is needed. This suggests that before calculators can be used properly in the classroom, teachers must first be convinced that they are important. Once enough teachers and administrators believe that this change is necessary, more teachers can be trained in their usage. In a utopian educational system, there would be district-wide training seminars involving technology in the classroom. This training could come in different forms, both collaboratively or individually, and through workshops, professional conferences, reading journal articles, and observing well-experienced teachers.

Bringing up the topic of training teachers begs the questions of when this "training" should actually begin. A good place to start would be for students who are attending universities to become professional teachers. Universities could begin to incorporate technology, particularly calculators, into the Education curriculum. This means to make technological classes required throughout the career for pre-service teachers in universities in order to provide a certain experience with technology that is useful in a classroom. This exposure allows for the future teachers to be comfortable with technology in itself and eventually comfortable with it in their classrooms. Making this change to the university education curriculum would not only advocate for technology in mathematics classrooms but in every classroom in each subject; thus giving students to ultimate experience of becoming technologically ready for the world that is ever changing. The more comfortable teachers become with the usage of calculators (and other technological tools), the more comfortable they will be when using them later within their classroom. This is exceptionally useful to pre-service teachers as they reflect on how they would like their classrooms to be; they will now be able to answer their use of calculators from two different perspectives: that of a students as well as that of a teacher. This skill of looking at a situation or lesson from those two perspectives makes for a very well-versed teacher.

Not only has technology changed but the overall curriculum has changed as well. There are multiple concepts that were previously not taught until upper high school that are now introduced to middle students (Demana and Waits, 2008). For example, the global use of the function concept is a relatively recent development in being introduced in school mathematics. Although calculators did not cause the curriculum change to include functions, they enhanced it via the ease with which multiple representations of a function that can be studied and compared within the classroom and without using too much time. This can also be said about Algebra as

an entire course. The once somewhat abstract class can now be elevated simply by using forms of technology such as calculators to show *why* or *how* certain things happen within the mathematics realm. An example of that could be data analysis. Having the freedom of being able to show students at least 4 different ways of evaluating at one piece of data (such as a line or bar graph, a table, or a box and whiskers chart) is a substantial stepping stone in the students understanding of concepts needed in order to move on to more advanced topics. Figure 4 shows the screen of a TI-84 Plus Silver Edition representing data in the form of a box and whiskers plot and a histogram. When students are able to see a long list of data simplified into a picture, it is easier for students to grasp a concept. In any representation, there are features that are both emphasized and features that are hidden. Showing students more than one representation of data assists students in seeing those connections and understanding why one representation may be more useful than another (Özgün-Koca and Edwards, 2013).

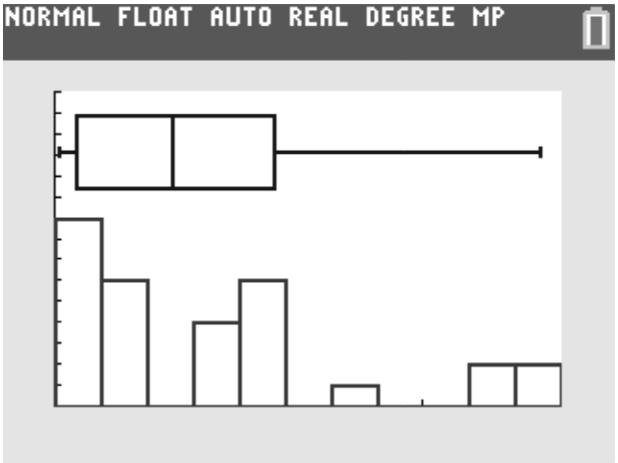

Figure 4-Multiple Representations of Data

Technology has altered everyday tasks for every person in one way or another. Telling students that they may not use their calculator in the classroom is the same as telling them that cannot use the computer to type their paper, or that they cannot use the internet to do research. Technology has evolved and will continue to progress. More importantly, technology is changing classrooms. Whiteboards are replacing chalkboards; tables are replacing desks; and multiple computers can be found in classrooms. "The implementation of calculators into mathematics curricula…is vital to the advancement of mathematical teaching and learning

(Waits, 1997). The duty of educators is to motivate their students, provide assistance, serve as a role model and coach, facilitate learning and most importantly to produce real-world ready adults who can be successful in their own individual dreams. No matter what career students decide to pursue, they must be technology-literate.

This thesis is not suggesting that calculators should replace the learning of basic skills. In reality, "basics skills" have changed over time. Fifty years ago, basic skills were considered to be sewing and cooking for women and fixing what needed to be repaired for men. Now, in the 21st Century, where students will soon be living and working in, it would be unreasonable to say that proficient, appropriate use of technology is not a basic skill which students will need in order to be successful in any chosen career. Furthermore, this thesis is not suggesting that calculators are the best solution to helping students understand mathematics. As Waits stated in *The Role of Calculators in Math Education,* "despite all of their capabilities, calculators will never be able to replace he human mind…" (1997). Rather, calculators should be used to simply enhance what students learn and serve as an instrument to better provide a mathematics education that is worthwhile to every student. Lastly, this thesis is not saying that calculators and technology should be used in every single lesson of the year. What is being said is that incorporating tools such as calculators through a well-thought out lesson will be immensely beneficial to the students in which they are introduced. Now is the time to plan for a change; now is the time to give students the ultimate preparation for the real world.

This debate will continue for many more years to come. The fact of the matter is that in order for calculators to be accepted into most classrooms (with a goal of incorporating them into all classrooms), all teachers must first be able to acknowledge the impact on students'

understanding of mathematics (Crutch or Catalyst, 2007) and second, take the necessary steps to guarantee the successful implementation of calculators.

With calculators and technology making such a huge impact on a daily basis in every person's life, it only makes sense for the education system to join the movement. Not doing so will not only impair the success of future students but also impair the development of education in its entirety.

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