Effective 21\textsuperscript{st} Century Education: Direct vs. Indirect Instruction

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Introduction and Historical Context of the Problem

Determining the best way to educate students has been highly debated by mathematics educators. The two most widely accepted instruction methods, which most other methods can be classified under, are direct instruction and indirect instruction. Both sides of the dispute make quality, valid points, but which method should be used over the other? Throughout this analysis, proposals from both sides of the argument will be brought into focus through historical context, a reformed solution, implementation of that solution, and a collaborative action. Through credible debate, a clear solution will be reached on the topic of direct versus indirect instruction in the 21st century.

Direct instruction is the most commonly known and used method of instruction and defined by Nancy Marchand-Martella, Ronald C. Martella, and Kristy Ausdemore (2005) in An Overview of Direct Instruction as, “An explicit, scientifically-based model of effective instruction… with focus on curriculum design and effective instructional delivery” (pg 1). In other words, learning by the student is put on the shoulders of the teacher with less responsibility put on the shoulders of the students. A teacher who uses direct instruction might start his or her class by saying “please open your books to page 63.” Some other learning styles cited by Castellano, Davis, and Lahache in Approaches to Education are lecture, work books and handouts (2000). The term direct instruction is said to have coined by Siegfried Engelmann in the 1960’s (Marchand- Martella, and Martella, and Ausdemore, 2003), but as David Klein (2003) points out in A Brief History of American K-12 Mathematics Education in the 20th Century, direct instruction has been around much longer. He acknowledges, “In the 1930s the education journals, textbooks, and courses for administrators and teachers advocated the major themes of
progressivism” (Pg. 4). The use of textbooks and education journals to push progressivism demonstrates that mathematics in America has long been a “do more in less time” society.

Indirect instruction, on the other hand, presses responsibility for learning on the student. Born in 1989, the National Council for Teaching Mathematics (NCTM) called for a reorganization of content standards developed nine years prior:

In many respects, the 1989 NCTM standards promoted the views of An Agenda for Action, but with greater elaboration. The grade level bands included lists of topics that were to receive "increased attention" and lists of topics that should receive "decreased attention." For example, in the K-4 band, the Standards called for greater attention to "Meanings of operations," "Use of calculators for complex computation," "Use of manipulative materials," and "Cooperative work." Included on the list for decreased attention in the grades K-4 were "Complex paper-and-pencil computations," "Paper and pencil fraction computation," "Rote memorization of rules," and "Teaching by telling." (Klein, 2003).

With 21st Century technology, indirect instruction has come even farther into light. Student discovery and guided inquiry have become more important. Technology has made it easier to perform tedious tasks. In the 21st century, technology has given a new, faster, and more efficient ways to make computations.

With these two immodest contradictory methods of instruction, it is easy to see where a problem occurs in the classroom. Critics of indirect instruction claim that discovery learning is impossible without teacher-centered basic facts. Opposed to direct instruction, advocates for indirect instruction claim that “do more in less time” teaching is easily forgotten and less useful
with development of 21st century technology. Much to the dislike of functionalists, evolving technology will have the ability to let students learn at their highest ability. Functionalism is defined by Dr. Wysocki in *EFRT 459* as, “A transformative function by establishing norms for learners in an evolving, democratic society” (N. Wysocki, lecture, January 19, 2011). The norms which have been established in the past that allows students to be characterized by socialization, training, and role selection may be altered by 21st century technology and discovery based learning that puts all students on a level playing field. Our society has functioned at a high level because employers know what they were looking for from students entering the work force. Functionalism has helped push this along by making school systems act as a capitalist society through organization, routines, and social relationships (Wysocki, 2011). Now, in a changing society, employers are looking for more out of the people they hire. They no longer are looking for employees who can practice and drill as direct instruction implies. Instead, industries are looking for who can problem solve and make fast-paced decisions as indirect instruction implies (Klein, 2003). Educators in the 21st century must encourage student centered development in order to encourage the growth of our society and its new generations.

**Reform Solution**

Perhaps the best way to educate students in mathematics education is exclusively through direct instruction. It has shown fast results, especially in high poverty schools. Students would listen to the teacher instruct throughout class, and then be assessed on what they learned through test, quiz, and homework problems. Through lecture, students quickly comprehend what strategy is used to solve a problem in the same way the teacher has taught them. However, using only the direct instruction method would turn students into human calculators and not allow for students to think for themselves and come to conclusions by themselves.
Advocates of conflict theory would have no problem permitting the direct instruction method into each and every classroom in America. As defined by Dr. Nicholas Wysocki of Winona State University in his lecture *Conflict Theory*, Conflict theory is a theoretical orientation that argues that the driving force in complex, capitalist societies is the unending struggle between different groups to hold power and status (Wysocki, 2011). Through direct instruction alone, students can learn how to perform tasks in a way that their instructor asks them to. This form of schooling is performed much like a business or corporation operates. The lower level laborers are asked to do what they are told, not what they think. Higher level employees of the company are asked to do all of the decision making and problem solving. If our education system truly wants all students to succeed, the students need to be taught how to solve problems with their own thoughts, something that cannot be done solely through direct instruction.

With direct instruction and its downfalls in mind, indirect instruction should be the easy choice for preferred method of instruction. Indirect instruction stresses the importance of student involvement and student centered learning to promote complex problem solving. In study done by Richard Lehrer and Lee Shumow in *Cognition and Instruction*, indirect instruction works vastly better than direct instruction when gauging student understanding of mathematics. Their research found that homeschooled students whose parents taught with an indirect method out performed those whose parents focused more on defining problems and managing goals on independent measures of problem solving (Lehrer and Shumow, 1997).

So why not teach all students using only the indirect instruction strategy? Each and every student would be given the tools needed to learn by themselves with the teacher being used as a facilitator. No favorites could be played and all students would be given equal opportunity to learn for themselves. On the other hand, not all students learn the same way. Some students
need to be taught unequally to maintain equity. They need to be taught in a way that benefits them specifically. In addition, there are very few students who would be able to learn completely on their own without being trained in basic comprehension strategies and skills. For instance, a middle school student learning the Pythagorean Theorem would obviously first need to know how to add A + B. Therefore, student discovery alone would not work in the mathematics classroom.

The best way to teach mathematics in the classroom is using a mixture of both direct and indirect instruction. Direct instruction is used to master the skills needed to solve a problem and indirect instruction is used to comprehend how and why the direct instruction strategies work. Using a combination approach to instruction also allows for students to learn in the best way that works for him or her. This can be implanted in many ways as Saskia Kistner, K. Rakoczy, B. Otto, C.D. Ewijk, G. Büttner, & E. Klieme, (2010) of Metacognition and Learning, acknowledges, “Teachers can promote self-regulated learning either directly by teaching learning strategies or indirectly by arranging a learning environment that enables students to practice self-regulation” (Saskia, et al., 2010). For example, the teacher can introduce a new idea or theorem and spend 1-2 class lectures explaining where it came from and what strategies can be used to prove its existence using examples. Then, students are given the opportunity to work through a real-world problem by themselves or in small groups expand on comprehension of the topic.

The direct instruction method has its place in the classroom because it allows for students to observe and scaffold ideas building off of each other. Students are given the strategies needed by the teacher to become masters of solving equations. Indirect instruction also has its room in the classroom. It takes students from masters of solving equations to masters of solving problems. There is no reason why they can’t, and shouldn’t both be used in the classroom. In
fact, the two methods complement each other well as Susan Goldman of *Learning Disability Quarterly* points out:

Empirical efforts have focused on teaching both task specific and more general types of strategies. To address issues of transfer and generalization of what is taught, the goals of strategy instruction in mathematics must extend beyond the task-specific and provide children with general problem-solving tools (Goldman, 1989).

Students who are at risk of falling behind benefit the most from a combination of direct and indirect instruction. In most cases, these are the students of minority or low socio-economic background who are taught from the very beginning that they will fail because they are too poor or not as smart. The idea of functionalism gives the illusion that these public school students are on an even playing field with high socio-economic students. In reality, the hidden curriculum, that is the curriculum that prepares them for the work force, is what is taught to them. This is why direct instruction is implemented and works well in high poverty schools. It emphasizes following orders, punishes students who do not pay attention, and doesn’t equip students with critical-thinking skills necessary for post-secondary schooling. The combination of direct and indirect instruction complimented by adequate resources and technology will break through socio-economic barriers and narrow the achievement gap.

**Implementation of Solution**

Creating a solution on paper is much easier than applying it and implementing a solution. Based on the facts and sources cited previously, the best way to establish a connection from mathematics to 21st century skills is through a combination approach of direct and indirect instruction. This presents a case of implementation of teaching skills into the teaching
curriculum. However, a change in curriculum reform means a change style of teaching. Teachers must accommodate for new technology practices, turning student inquiry into knowledge, differentiated instruction to account for equity amongst all students, and new approaches to teaching. Practicing teachers may not always be ready for the change.

Implementation of a good solution to curriculum reform will not be successful without teacher acceptance. The traditional teaching style in mathematics emphasizes knowledge of facts rather than mathematical skills needed to answer problem solving explorations, thus leading to a lack of student innovation. Teachers unfamiliar with the content change may find it too hard to adapt to a new teaching style. Worse yet, they may use the new 21st century constructive teaching style and technologies without actually believing in its success. Stated by Boris Handal and Anthony Herrington in the article “Mathematics Teachers’ Beliefs and Curriculum” of Mathematics Education Research Journal, “teachers’ feelings, beliefs, and values that are opposite to constructivism are a barrier to reform in mathematics education” (Pg. 63). Looking at a change in curriculum and teaching style through a functionalist’s lens, there may not be a problem with the current teaching pedagogy. Students could learn the basic skills and facts needed to graduate and be ready to enter into the workforce in a place that was already chosen for them. Consequently, opposing student inquiry only deepens the achievement gap. In a 2003 case study done by Handal and Herrington, a lack of change in the curriculum proved to be everyone but the students’ fault. In an interview with three New Zealand primary mathematics teachers, teachers had trouble implementing a constructivist (building off prior knowledge into inquiry) approach. One teacher even stated, teachers had “difficulties in maintaining control over what was happening if children were left to explore an idea for themselves,” and standards are “not as practical as they were made out to be, especially in dealing with the structure of
most schools — short periods, no collaboration, no team teaching”” (Handal and Herrington, 2003). Standards and curriculum reform remedies can be proposed, but the teachers are the facilitators of the content. In order to narrow the achievement gap and push for student exploration, teachers must be willing and able to implement change in the classroom.

In order to narrow the achievement gap teachers must fulfill their obligation to differentiate instruction. Not all students learn in the same way and therefore should not be taught in the same way. The overwhelming majority of current teachers would say that all their students are treated equally. They learn from the same text books, listen to the same lectures, and fill out the same work sheets, but this does not necessarily mean that all students obtain equity. For instance, take a look at the story of Calvin observed in a case study done by L. Mathews (2003) of High School Journal. In the article “Towards Design of Clarifying Equity Messages in Mathematics Reform,” a high achieving African-American 5th grade boy, Calvin, who was not allowed into the 6th grade pre-algebra course. Calvin was an outstanding academic student who consistently brought home A’s and B’s on his report card and was known to be “good at math” by his teacher. He passed all the criteria to be admitted into the course accept one, classroom behavior. Even Calvin admitted that he can be a nuisance during class, but he, nor his mother, believed that it should be enough to hold him back. His teacher took a consequentialist’s point of view while being a pillar for Calvin’s barrier. She thought of how Calvin’s behavior might disrupt other students in the rigorous pre-algebra class and didn’t think that Calvin would pass. She may have looked at Calvin as a typical self fulfilling prophecy because, as Mathews states, African American and Latino students are often confronted with lowered expectations even when they have proven they are capable of achieving” (Mathews, 2005). Luckily, Calvin’s principle took a non-consequentialist’s view and required that Calvin
be treated respectfully and that he was entitled to equal rights and opportunities as the code of ethics points out. Calvin was then enrolled in the pre-algebra class during the second week of school. Calvin’s story highlights the need for leadership amongst teachers to advance a strategy to eliminate inequities in policies and practices.

Teacher change in educational practice and equity in the classroom are important, but teaching students to be independent thinkers is the reason they are all in school in the first place. Students need to know how to turn formal instruction into solving real life problems. In order to produce successful student thinking, teachers need to know how students think. In the article “Cognitively Guided Instruction: A Knowledge Base for Reform in Primary Mathematics Instruction,” Thomas Carpenter, Elizabeth Fennema, and Megan Franke of The Elementary School Journal recognize two key models for teachers to gain knowledge of student thinking; students need to be taught concepts rather than rote and recall, and abstract thinking needs to be connected to experience (1996). In order to implement this in the classroom, they advocate for the cognitively guided instruction approach to teaching (CGI). CGI focuses on children’s understanding of mathematics and provides a basis for teachers to develop knowledge of students. In the same way that direct instruction can relay application of algorithms through rote and recall, indirect instruction can be used in a problem solving manner for students to learn the algorithm on their own through inquiry. As Carpenter, Fennema, and Franke state:

Our major thesis is that children bring to school informal or intuitive knowledge of mathematics that can serve as the basis for developing much of the formal mathematics of the primary school curriculum. Without formal instruction on specific algorithms or procedures, children can construct viable solutions to a variety of problems (1996).
In other words, direct and indirect instruction complement each other well in the classroom. Indirect instruction can be used for students to determine a working algorithm. Once that algorithm is clearly understood by the student, it can be used in the next step of indirect problem solving. Through CGI, students are taught to use their ability to construct knowledge rather than assimilate what they already know.

One other approach to implementing 21st century skills into the classroom is through constructive representation instruction. Here, the teacher acts as a guide for the students. It is based on the assumption that students will inevitably construct the correct internal representation through mathematical relationships. Of course, it would be impossible for students to progress using only their internal knowledge to enhance relationships. Therefore, Paul Cobb, Erna Yackel, and Terry Wood of *Journal for Research in Mathematics Education* point out in their article, “A Constructivist Alternative to the Representational View of Mind in Mathematics Education (1992),” that:

This would clearly seem to be an impossibility if students are simply left to their own devices to explore the materials without guidance. As a consequence, it would seem necessary to consider the teacher's role in helping students construct replicas of the mathematical relationships presented to them in an easily apprehensible form (1992).

In order for students to develop higher knowledge mathematical representation, the teacher must give students the tools needed evolve inquiry into the next step of knowledge. However, if the teacher offers too much help, they become lecture based, explicit educators whom base their teaching on memorization and recall of algorithms which leads to a lack of conceptual meaning. In conclusion, the instructional representational approach is based on three concepts; the goal of
instruction is to mirror mathematical relationships outside the mind in instructional relationships, the method for achieving this instructional goal is to develop transparent instructional representations that make it possible for students to construct correct internal representations, and external instructional materials presented to students are the primary basis from which they build their mathematical knowledge (Cobb, Yackel, and Wood, 1992). If all three of these characteristics can be implemented by the educator, it will activate constructive learning, increase detail, and lead to student interaction.

Conclusion

Direct and indirect instruction have proven to be the most commonly accepted and best approaches to teaching mathematics. Both have their benefits and downfalls, but when combined as one in the classroom, students have the best chance of understanding the mathematics curriculum. Historically, direct instruction has been used for much longer. With its use, educators have been able to promote organization, routines and build social relationships. However, this is part of the process that has led to a wide achievement gap between high and low socio-economic students. Functionalists have found that direct instruction helps the classroom work as a business by building socialization, training, and role selection. More recently, a push for indirect instruction has worked as a conflict theorists’ resolution to narrowing the achievement gap. Through indirect instruction, students learn to problem solve, promote inquiry, and develop real-life resolutions to real life problems. Instead of letting the curriculum determine role selection, students are given the tools needed to choose how far they want to go into furthering their education.
It can be perceived that direct instruction is encouraged by functionalists, and indirect instruction is encouraged by conflict theorists. Direct instruction encourages the “hidden curriculum,” that is, following the rules and solving mathematical problems given the techniques given to do so much like a company expects its workers to show up and do as their work as they were taught. Indirect instruction pushes for competition by using 21st century skills such as problem solving, collaboration, and discussions. Although both parties know what methods benefit their approach to education, they acknowledge that both techniques need to be used in the classroom. Allowing for both direct and indirect instruction to be used collaboratively is the key to determining the difference between equal education and equity in education.

Not all students learn in the same way. Therefore, students need to be taught in different ways. Many veteran teachers have adopted their own technique to teaching. This could prove to be a future downfall for students who have come so comfortable with new technology. Teachers must be willing to accept and implement a new teaching regimen in order to narrow the achievement gap. Obviously, all students in a particular classroom are given equal education because they listen to the same lecture, but some students may not be gaining the same knowledge from that lecture. In order to gain equity in education, teachers need to differentiate their instruction. Teaching by telling works great for some students, especially those who are high achieving students. However, low achieving students do not seem to gain higher order thinking from the direct instruction approach. In order to gain higher thinking, students need to use their ability to construct knowledge rather than assimilate and recall what they already know.

In order for students to develop higher learning, teachers must give them the tools they need to become an inquiry based learner. This means that the teacher needs to find the technique that works for each individual student to support equity in education. For instance, the teacher
could use a consequencialist technique that allows for 80% (the majority) of the class to pass to the next grade. However, the remaining 20% are left to fall behind and widen the achievement gap between those who understand the material and those who don’t. If a teacher uses a non-consequencialist technique, every student is reached in a manner benefits their learning. On the other hand, if the teacher spends too much time reaching every student, the students who are ready to move on may not be pushed far enough into higher order thinking. This would narrow the achievement gap, but doesn’t push all students to their highest potential. In order to narrow the achievement gap there must be a happy medium between consequentialist and non-consequentialist views on ethics and a overlap between functionalist and conflict theorist approaches to education in order to have an equal and equitable education for all students. The best way to implement a resolution to these conflicting approaches in the mathematics classroom is combining their views through direct and indirect instruction within the math curriculum.
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