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CONSTRUCTIVISM IN TEACHING AND LEARNING AT ELEMENTARY LEVEL

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Abstract

Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in. in this paper researcher highlights about the role of constrctivisim at elementary level. In constructivist classrooms, students create organizing principles that they can take with them to other learning settings. Constructivism gives students ownership of what they learn, since learning is based on students' questions and explorations, and often the students have a hand in designing the assessments as well. Constructivist assessment engages the students' initiatives and personal investments in their journals, research reports, physical models, and artistic representations. Engaging the creative instincts develops students' abilities to express knowledge through a variety of ways. The students are also more likely to retain and transfer the new knowledge to real life.

Keywords- constructivism, Elementary School , Teacher, Students

"Students need to construct their own understanding of each mathematical concept, so that the primary role of teaching is not to lecture, explain, or otherwise attempt to 'transfer' mathematical knowledge, but to create situations for students that will foster their making the necessary mental constructions. A critical aspect of the approach is a decomposition of each mathematical concept into developmental steps following a Piagetian theory of knowledge based on observation of, and interviews with, students as they attempt to learn a concept." It's not surprising that constructivism has a strong voice in the current dialogue on math education. Many are concerned about the success - or lack of success - of math education. Constructivism cuts a nice path between the main ideas that have influenced how math has been taught: the concept of math as facts to be transmitted to the student, and the view that some people have it and some people don't, where the educator's task is to figure out how "smart" students are and choose the right tasks for them to perform.

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Questions remain, however, about whether these offer rich information for developing different ways of teaching. And what's to be done for the students who aren't succeeding?

In contrast, constructivism focuses our attention on how people learn. It suggests that math knowledge results from people forming models in response to the questions and challenges that come from actively engaging math problems and environments - not from simply taking in information, nor as merely the blossoming of an innate gift. The challenge in teaching is to create experiences that engage the student and support his or her own explanation, evaluation, communication, and application of the mathematical models needed to make sense of these experiences. Given this view, there are many approaches to improving teaching: look for different ways to engage individual students, develop rich environments for exploration, prepare coherent problem sets and challenges that focus the model building effort, elicit and communicate student perceptions and interpretations, and so on. We'd like to explore here the theory and applications of constructivism in math education. We invite you to submit your favorite readings, projects, and classroom materials that either point out the pitfalls or demonstrate the opportunities of this theoretical framework.

The concept of constructivism has roots in classical antiquity, going back to Socrates's dialogues with his followers, in which he asked directed questions that led his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences.

In this century, **Jean Piaget** and **John Dewey** developed theories of childhood development and education, what we now call Progressive Education, that led to the evolution of constructivism.

Piaget believed that humans learn through the construction of one logical structure after another. He also concluded that the logic of children and their modes of thinking are initially entirely different from those of adults. The implications of this theory and how he applied them have shaped the foundation for constructivist education.

Dewey called for education to be grounded in real experience. He wrote, "If you have doubts about how learning happens, engage in sustained inquiry: study, ponder, consider alternative possibilities and arrive at your belief grounded in evidence." Inquiry is a key part of constructivist learning.

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Vygotsky introduced the social aspect of learning into constructivism. He defined the "zone of proximal learning," according to which students solve problems beyond their actual developmental level (but within their level of potential development) under adult guidance or in collaboration with more capable peers.

Bruner initiated curriculum change based on the notion that learning is an active, social process in which students construct new ideas or concepts based on their current knowledge. **Seymour Papert's** ground breaking work in using computers to teach children has led to the widespread use of computer and information technology in constructivist environments.

Principles

There are several guiding principles of constructivism:

1. Learning is a search for meaning. Therefore, learning must start with the issues around which students are actively trying to construct meaning.
2. Meaning requires understanding **wholes** as well as parts. And parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not isolated facts.
3. In order to teach well, we must understand the mental models that students use to perceive the world and the assumptions they make to support those models.
4. The purpose of learning is for an individual to construct his or her own meaning, not just memorize the “right” answers and regurgitate someone else’s meaning. Since education is inherently interdisciplinary, the only valuable way to measure learning is to make the assessment part of the learning process, ensuring it provides students with information on the quality of their learning.

Seven Basic Principles of Constructivist Education

Teachers must see themselves as playing a crucial role in children’s learning and development. To accomplish this as a constructivist teacher, DeVries et al. (2002) identified seven principles of constructivist teaching. They are:

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1). **Establishment of a cooperative, socio moral atmosphere**

A cooperative, sociomoral atmosphere is one in which mutual respect is continually practiced. Every classroom has a sociomoral atmosphere that may be viewed along a continuum of coercive to cooperative. Cooperation occurs between students and their peers, as well as the students and the adults. Opportunities to work together in groups, share thoughts and feelings, discuss issues, and contribute to the workings of the classroom on an equal footing are some of the characteristics of a cooperative, sociomoral atmosphere. A constructivist teacher must create a community of learners in which autonomy rather than obedience is encouraged. All other principles rest on this first principle.

2). **Appeal to children's interests**

Curriculum that responds to the interests of children is one that will provide meaningful opportunities for construction of knowledge. A constructivist teacher must be able to recognize, as well as stimulate,

children's interests. This can be done in several ways – observe what

children do spontaneously, solicit children's ideas about what they want to learn, propose enticing activities, and provide ample opportunities for children to make choices.

3). **Teach in terms of the kind of knowledge involved**

Piaget's distinction among three kinds of knowledge is helpful to constructivist teachers. These types of knowledge are physical knowledge, logico-mathematical knowledge and conventional, or social, knowledge. Different strategies of teaching are applied for the different types of knowledge. For example, conventional knowledge is arbitrary and children must be told or shown the information usually delivered through direct instruction, which is considered didactic. With physical knowledge, one assists children in finding opportunities to act on objects and find out their reactions. If the knowledge is logico-mathematical,one provides experiences through which children can reorganize their own knowledge.

4). **Choose content that challenges children**

Constructivist teachers create a culture of inquiry and develop curriculum that 1) focuses on "big ideas" that allow in-depth study, 2) provide activities and materials appropriate to a

wide range of developmenta levels, and 3) analyze activities in terms of regularities and relationships.

5). **Promote children's reasoning**

An important part of the role of a constructivist teacher is to use questions and other interventions that will move children's thinking forward. Sharing ideas and encouraging children to provide explanations are means for enhancing children's reasoning.

6). **Provide adequate time for children's investigation and in-depth**

Engagement "Adequate time" refers to the amount of time during the day that is provided for children's investigations, as well as time over weeks and even months. Children cannot be expected to construct complex relations when their exploration is limited to fifteen or thirty minutes a day.

7). **Link ongoing documentation and assessment with curriculum**

Activities Assessment should be a part of teaching and not separate from it. In constructivist classrooms assessment has two forms – assessing children's performance and assessing the curriculum. Constructivist teachers strive to understand children's thinking by identifying the relationships they are constructing. In the primary grades, academic content must be addressed. Constructivist teachers must consider how to teach academics in ways that do not impede sociomoral development and that promotes both learning and intellectual development. (DeVries & Edmiaston, 1998). "The challenge for the constructivist teacher in approaching any academic content is to distinguish what must be constructed and what must be instructed".

How Constructivism Impacts Learning Mathematics

Curriculum–Constructivism calls for the elimination of a standardized curriculum. Instead, it promotes using curricula customized to the students' prior knowledge. Also, it emphasizes hands-on problem solving.

Instruction–Under the theory of constructivism, educators focus on making connections between facts and fostering new understanding in students. Instructors tailor their teaching strategies to

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student responses and encourage students to analyze, interpret, and predict information. Teachers also rely heavily on open-ended questions and promote extensive dialogue among students.

Assessment–Constructivism calls for the elimination of grades and standardized testing. Instead, assessment becomes part of the learning process so that students play a larger role in judging their own progress

In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure she understands the students' preexisting conceptions, and guides the activity to address them and then build on them.

Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students learn HOW TO LEARN.

You might look at it as a spiral. When they continuously reflect on their experiences, students find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information. One of the teacher's main roles becomes to encourage this learning and reflection process.

For example: Groups of students in a science class are discussing a problem in physics. Though the teacher knows the "answer" to the problem, she focuses on helping students restate their questions in useful ways. She prompts each student to reflect on and examine his or her current knowledge. When one of the students comes up with the relevant concept, the teacher seizes upon it, and indicates to the group that this might be a fruitful avenue for them to explore. They design and perform relevant experiments. Afterward, the students and teacher talk about what they have learned, and how their observations and experiments helped (or did not help) them to better understand the concept.

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Contrary to criticisms by some (conservative/traditional) educators, constructivism does not dismiss the active role of the teacher or the value of expert knowledge. Constructivism modifies that role, so that teachers help students to construct knowledge rather than to reproduce a series of facts. The constructivist teacher provides tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment. Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. Always guided by the teacher, students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook. Constructivism is also often misconstrued as a learning theory that compels students to "reinvent the wheel." In fact, constructivism taps into and triggers the student's innate curiosity about the world and how things work. Students do not reinvent the wheel but, rather, attempt to understand how it turns, how it functions. They become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings

Benefits

1. Children learn more, and enjoy learning more when they are actively involved, rather than passive listeners.

2. Education works best when it concentrates on thinking and understanding, rather than on rote memorization. Constructivism concentrates on learning how to think and understand.

3. Constructivist learning is transferable. In constructivist classrooms, students create organizing principles that they can take with them to other learning settings.

4. Constructivism gives students ownership of what they learn, since learning is based on students' questions and explorations, and often the students have a hand in designing the assessments as well. Constructivist assessment engages the students' initiatives and personal investments in their journals, research reports, physical models, and artistic representations. Engaging the creative instincts develops students' abilities to express knowledge through a variety of ways. The students are also more likely to retain and transfer the new knowledge to real life.

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5. By grounding learning activities in an authentic, real-world context, constructivism stimulates and engages students. Students in constructivist classrooms learn to question things and to apply their natural curiosity to the world.

6. Constructivism promotes social and communication skills by creating a classroom environment that emphasizes collaboration and exchange of ideas. Students must learn how to articulate their ideas clearly as well as to collaborate on tasks effectively by sharing in group projects. Students must therefore exchange ideas and so must learn to "negotiate" with others and to evaluate their contributions in a socially acceptable manner. This is essential to success in the real world, since they will always be exposed to a variety of experiences in which they will have to cooperate and navigate among the ideas of others.

Role of a constructivist mathematics teacher

. Constructivist teachers pose questions and problems, then guide students to help them find their own answers. They use many techniques in the teaching process. For example, they may:

- prompt students to formulate their own questions (inquiry)
- allow multiple interpretations and expressions of learning (multiple intelligences)
- encourage group work and the use of peers as resources (collaborative learning)

More information on the above processes is covered in other workshops in this series. For now, it's important to realize that the constructivist approach borrows from many other practices in the pursuit of its primary goal: helping students learn HOW TO LEARN.

In a constructivist classroom, learning is . . .

1.**constucted**

Students are not blank slates upon which knowledge is etched. They come to learning situations with already formulated knowledge, ideas, and understandings. This previous knowledge is the raw material for the new knowledge they will create.

Example: An elementary school teacher presents a class problem to measure the length of the

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"Mayflower." Rather than starting the problem by introducing the ruler, the teacher allows students to reflect and to construct their own methods of measurement. One student offers the knowledge that a doctor said he is four feet tall. Another says she knows horses are measured in "hands." The students discuss these and other methods they have heard about, and decide on one to apply to the problem.

2.active

The student is the person who creates new understanding for him/herself. The teacher coaches, moderates, suggest, but allows the students room to experiment, ask questions, try things that don't work. Learning activities require the students' full participation (like hands-on experiments). An important part of the learning process is that students reflect on, and talk about, their activities. Students also help set their own goals and means of assessment.

Examples: A middle-school language arts teacher sets aside time each week for a writing lab. The emphasis is on content and getting ideas down rather than memorizing grammatical rules, though one of the teacher's concerns is the ability of his students to express themselves well through written language. The teacher provides opportunities for students to examine the finished and earlier drafts of various authors. He allows students to select and create projects within the general requirement of building a **portfolio** [1]. Students serve as peer editors who value originality and uniqueness rather than the best way to fulfill an assignment.

in a history class, asking students to read and think about different versions of and perspectives on "history" can lead to interesting discussions. Is history as taught in textbooks accurate? Are there different versions of the same history? Whose version of history is most accurate? How do we know? From there, students can make their own judgments.

3.reflective

Students control their own learning process, and they lead the way by reflecting on their experiences. This process makes them experts of their own learning. The teacher helps create situations where the students feel safe questioning and reflecting on their own processes, either privately or in group discussions. The teacher should also create activities that lead the student to reflect on his or her prior knowledge and experiences. Talking about what was learned and how it was learned is really important.

Example: Students keep journals in a writing class where they record how they felt about the class projects, the visual and verbal reactions of others to the project, and how they felt their own writing had changed. Periodically the teacher reads these journals and holds a conference with the student where the two assess (1) what new knowledge the student has created, (2) how the student learns best, and (3) the learning environment and the teacher's role in it.

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4.collaborative

The constructivist classroom relies heavily on collaboration among students. There are many reasons why collaboration contributes to learning. The main reason it is used so much in constructivism is that students learn about learning not only from themselves, but also from their peers. When students review and reflect on their learning processes together, they can pick up strategies and methods from one another.

Example: In the course of studying ancient civilizations, students undertake an archaeological dig. This may be something constructed in a large sandbox, or, as in the Dalton School's "Archaeotype" software simulation, on a computer. As the students find different objects, the teacher introduces classifying techniques. The students are encouraged to (1) set up a group museum by developing criteria and choosing which objects should belong, and (2) collaborate with other students who worked in different quadrants of the dig. Each group is then asked to develop theories about the civilizations that inhabited the area.

5.inquirybased

The main activity in a constructivist classroom is solving problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and, as exploration continues, they revisit those conclusions. Exploration of questions leads to more questions'

example: Sixth graders figuring out how to purify water investigate solutions ranging from coffee-filter paper, to a stove-top distillation apparatus, to piles of charcoal, to an abstract mathematical solution based on the size of a water molecule. Depending upon students' responses, the teacher encourages abstract as well as concrete, poetic as well as practical, creations of new knowledge.

6.evolving

Students have ideas that they may later see were invalid, incorrect, or insufficient to explain new experiences. These ideas are temporary steps in the integration of knowledge. For instance, a child may believe that all trees lose their leaves in the fall, until she visits an evergreen forest. Constructivist teaching takes into account students' current conceptions and builds from there.

What happens when a student gets a new piece of information? The constructivist model says that the student compares the information to the knowledge and understanding he/she already has, and one of three things can occur:

- The new information matches up with his previous knowledge pretty well (it's **consonant** with the previous knowledge), so the student adds it to his understanding. It may take some work, but it's just a matter of finding the right fit, as with a puzzle piece.
- The information doesn't match previous knowledge (it's **dissonant**). The student has to change her previous understanding to find a fit for the information. This can be harder work.
- The information doesn't match previous knowledge, and it is **ignored**. Rejected bits of information may just not be absorbed by the student. Or they may float around, waiting for the day when the student's understanding has developed and permits a fit.

Example: An elementary teacher believes her students are ready to study gravity. She creates an environment of discovery with objects of varying kinds. Students explore the differences in weight among similarly sized blocks of Styrofoam, wood, and lead. Some students hold the notion that heavier objects fall faster than light ones. The teacher provides materials (stories, posters, and videos) about Galileo, Newton, etc. She leads a discussion on theories about falling. The students then replicate Galileo's experiment by dropping objects of different weights and measuring how fast they fall. They see that objects of different weights actually usually fall at the same speed, although surface area and aerodynamic properties can affect the rate of fall.

A new approach

If the current constructivist teaching techniques leave some mathematics students anxious and floundering, do not produce any better outcomes in achievement than traditional methods, and do not necessarily work for low-achieving students, one might question the value of using these techniques in the classroom. Although the studies reported here did not prove the superiority of constructivist methods over any other, many of the researchers still expressed their confidence in using constructivist methods over traditional transmissive techniques.

A criticism of constructivism as it is used presently is that it has strayed too far from its roots. Socio-historical constructivism was proposed by Lev Vygotsky, the Russian psychologist, in the early 1930s, and his ideas, along with other theories, provide the basis for the constructivism that is used today. According to Vygotsky's theories, socio-historical constructivism anchors instruction within the social and cultural milieu within which the students learn, and language is one of the tools by which children internalise the body of knowledge that has been created by their culture (Driscoll, 2005).

In contrast, the constructivist techniques currently in use reflect a more radical constructivist view. This philosophy is epitomized in the words of von Glasersfeld: "It starts from the assumption that knowledge, no matter how it be defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience" (1996, p.1). To this end, teachers use concrete materials and manipulatives in the math classroom, but may fail to connect students' constructions and algorithms with those developed through many years of mathematical work in the students' own culture. Kroesbergen, Van Luit & Maas note, "… if students do not discover a strategy on their own, it is not discussed within the group" (2004, p. 240), and this would also apply to the traditionally used, or standard, algorithms as well. Schmittau (2004) notes, "constructivists highly value children's actions with concrete materials, and since it is often difficult to establish connections between children's actions and standard algorithms, they assume that if algorithms are taught they must of necessity be learned by rote" (p. 25). This often leads teachers to deliberately not teach the standard algorithms, fearing, perhaps, that to do so will lead them back to transmissive teaching techniques. In contrast to this, Schmittau (2004) claims that students must be able to connect their actions with the standard algorithms: "In abandoning

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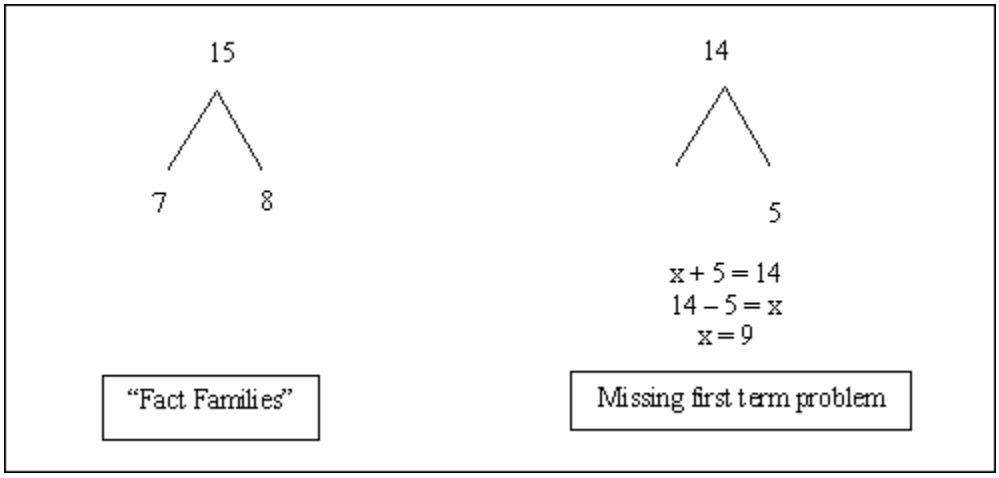
the teaching of algorithms or failing to connect them to the meaningful mathematical actions that gave rise to them, we fail to pursue the development of a concept through to its complete historical fruition, and consequently to its full mathematical power" (p. 25).

An alternative for the constructivism presently in use is a mathematics curriculum developed by V.V. Davydov (Schmittau, 2004), which is based on Vygotsky's work. In this program, developed for children in grades 1 – 3, students start by learning about quantity instead of number, the concept of which is not even introduced for the first three months. Using materials such as liquid in jugs and measuring devices such as cups, students develop the ideas of equality and definitions of addition and subtraction. Once the concept of "number" is introduced, students use "^" notation to develop several other ideas: "fact families"; the decomposition of numbers in base 10 or other bases; measurement using multiple units; and missing addend or missing first term problems (Schmittau, 2004). (See figure 1).



Once students master the basic ideas, the distributive property becomes important in helping students develop algorithms for multiplication and division. The result of Davydov's program is that students in grade 3 are able to solve problems that are troublesome for high school students using the regular curriculum.

This curriculum is in use in about 10% of the schools in Russia (CRDG, 2006) and in selected schools in the United States. In one instance, an innovative program called "Measure Up", which is an updated version of Davydov's curriculum, has been in place since 2001 in Hilo, Hawai'i, sponsored by the University of Hawai'i Education Laboratory School, and research is being carried out on selected students in the program who were chosen to represent the diversity of the area. Researchers in the program expect that students will have taken a rigorous algebra course by the end of grade 6 (CRDG, 2006), something that would be impossible using the standard North American curriculum.

Conclusion

The current constructivist approach to teaching and learning, however flawed, is better than the transmissive teaching techniques that were promoted in teacher education until the 1980s. However, we must recognize that these techniques may not necessarily be adequately addressing issues such as math anxiety, better achievement or assistance with low achieving learners. An alternative curriculum, such as the one proposed by Davydov, may hold some hope for helping our learners make connections between their actions and the rich cultural heritage of mathematics.

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