HOW CAN I IMPROVE JUNIOR LEVEL MATHEMATICS ACHIEVEMENT USING CONSTRUCTIVISM?

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Abstract

This is a description of an educator using a non-traditional teaching method to improve Mathematics achievement in a split-grade junior classroom. The supplemental impact of this action research project guided students to engage in independent investigation across the curriculum. Mathematics test scores to determine grade level, provincial test scores, and teacher observations supply evidence of enhanced pupil achievement in Mathematics.

Introduction

> "Action research is a values-based process which thrives in a culture of inquiry and reflection" (Delong, Black, and Wideman, 2005, p. 5).

Auger and Rich (2007, p. 42) classify Constructivism as an approach that focuses on how people learn (e.g. discovery or uncovering) rather than just merely covering material, as teacher candidates are taught in Ontario through detailed lesson planning requirements. Constructivism makes use of concepts such as learning plans (Marlowe and Page 1999) which are designed to help students assimilate new information and process novel learning experiences through accommodation. As Ricci suggests:

> At the faculty, candidates are asked to create endless detailed lesson plans and to stick to their plans as closely as possible. Instead, it would be best to have candidates practice reacting to spontaneity and the unexpected. By having them do things and then revealing to them that most teachers do not teach in this way, but yet, it is essential for beginning teachers to do it, we are preparing them for the task of doing what you are told even if it does not contribute to making them a more successful teacher. (Ricci, 2005, p.8)

I am sure if you asked a random sample of teachers in a mainstream school staffroom "where does curriculum come from?" they would answer with a response such as "from the Ministry" or "from a Provincial curriculum writing team" rather than acknowledging that curriculum is part of daily planning involving learners, subject/content, and the teacher.

Since the early twentieth century not much has changed in our current education system, we still rely too heavily on expectations (objectives or aims), delivering curriculum content, and summative assessment strategies. We continually separate the instructional delivery of the lesson from the needs of children.

Our purpose as educators is to create a meaningful learning experience for our students. One of the most important elements required for student achievement is the creation of an environment which supports investigation and problem solving through constructivist learning.

> "Learners control their learning. This simple truth lies at the heart of the constructivist approach to education...Students must be permitted the freedom to think, to question, to reflect, and to interact with ideas, objects, and others – in other words, to construct meaning" (Brooks & Grennon Brooks, as cited in Auger & Rich (2007) pp. 40-43).

Human beings are remarkable at learning from and adjusting to the physical environment. We are constantly acquiring new skills without the use of didactic memorization teaching techniques. Everyday children actively come together and socially construct their own knowledge and understanding using a natural constructivist style. As Willinsky indicates:

> When I was younger and time was long on a school afternoon, I would find myself playing with a paper clip or whatever odd object lay on my desk. I would take the thing through a hundred different variations, apart from its designated function. I was no Picasso with a bicycle seat, but I would make the paper clip into a stickman, a bridge across the inkwell, and the first letter of my last name. I would align it with the pencil grove. What even the most acute of my teachers failed to recognize was that I was actually, I can see now, in training for work that now stands me in good stead; I was apprenticing methodologically in a form of critical inquiry (Willinsky, as cited in Carson and Sumara (1997) p. 329).

Methodology

According to Sagor, action research is "a disciplined process of inquiry conducted by and for those taking action. The primary reason for engaging in action research is to assist the actor in improving or refining his or her actions" (Sagor, 2005, p. 1).

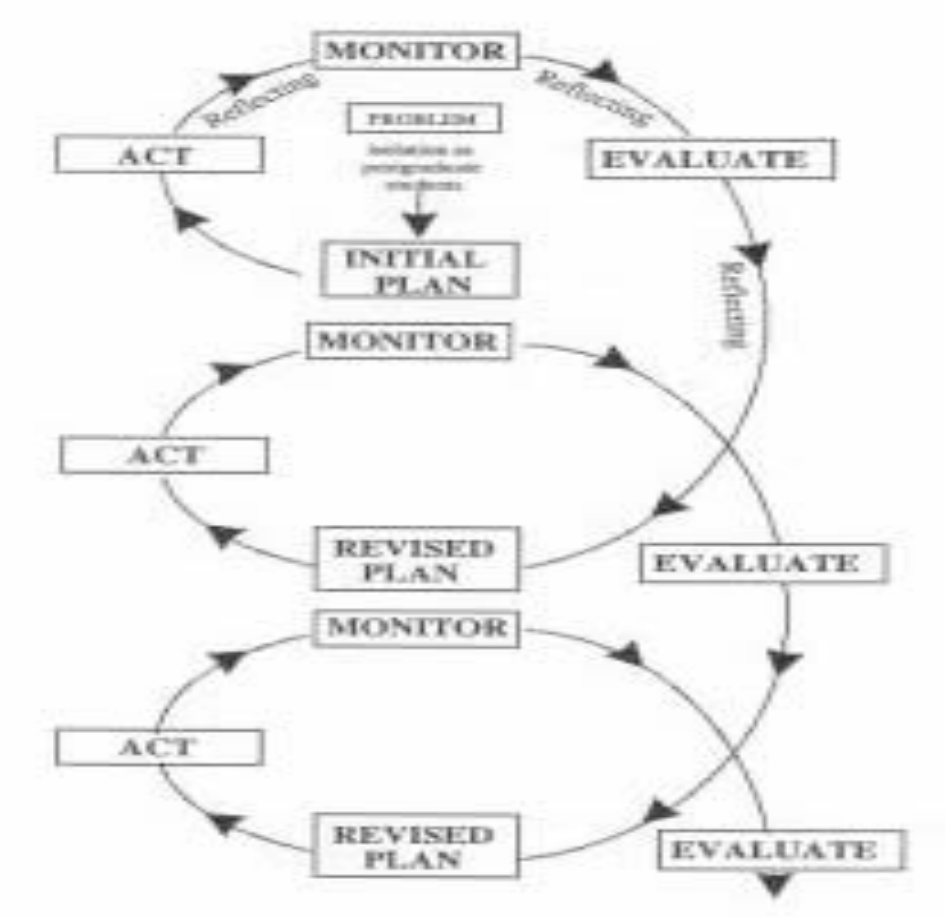
To investigate whether or not a constructivist approach would improve learner achievement we developed the following research questions:

1. Would a Constructivist classroom improve junior learner achievement in Mathematics?
2. What is the impact of Constructivism on learner motivation?

When I first came to the grade 5/6 junior division classroom as a result of a mid-year opportunity to teach Mathematics, Science, and Physical Education, it became clear the existing institutional structures in place did not support a constructivist approach to learning. To answer the first research question quantitative data was gathered. The students were administered a sample grade equivalency test to determine the instructional level in Mathematics with results well below grade level. The grade 5 learner achievement average was 3.2 GE, while the grade 6 learner achievement average was 4.3 GE.

It is significant that 41% of the students in the class had learning exceptionalities and 28% of the students had transferred into the school within the last 12 months. The latter made the grade 3 Provincial testing information unreliable as baseline data. In addition, many of the students who had achieved level 4 scores in grade 3 testing had left the school at the end of grade 4 in favour of attending a late-entry French immersion school.

The figure below outlines a spiral action research approach developed by Kemmis, as cited in Fisher, Bennet-Levy, and Irwin (2003):



(Source: http://ultibase.rmit.edu.au/Articles/nov03/fisher1.htm)

For the purpose of this study a spiral model adapted from Kemmis and McTaggart as cited in Koshy (2005) was used, although not implemented in an inflexible manner of "planning, acting, and observing" as action research may not always be easily separated during the activity. As Koshy suggests:

> I find the spiral model appealing because it offers opportunity to visit phenomenon at a higher level each time, and so to progress towards a greater overall understanding. By carrying out action research using this model, one can understand a particular issue within an educational context and make informed decisions through enhanced understanding. It is about empowerment (Koshy, 2005, p. 5).

Against the backdrop of the cyclical process of shifting from thematic units to inquiry, the researcher employed the process as outlined by Short and Burke (1996, p. 97-103).

Step 1 - The first step to improving student achievement through constructivism was to listen to what the children found interesting about Mathematics in mainstream schooling. Until this point, the students had not been provided with the level of choice necessary for student interest to develop as a starting point to address their learning needs. The students engaged in roundtable discussions around what they found interesting or enjoyable regarding Mathematics. This process was not easy, as many students had never had a question such as this posed during their schooling. This was challenging for many learners, who frequently responded with statements such as "I'm not sure" or "I've never thought about it" and "Well, I'm good at addition, so I guess that's my favourite."

Step 2 - The second step for improving learner success in Mathematics was to enhance the classroom environment towards a constructivist approach. For example, improving the existing physical

arrangement (layout) away from idle rows used for the copying notes and lessening the use of pencil and paper towards a more active classroom. The new classroom layout specifically allowed for workspace and socialization. By approaching the curriculum constructively, the learners were provided with the general Mathematics content cornerstones (strands) and supplied with opportunities for further investigation of their own interests.

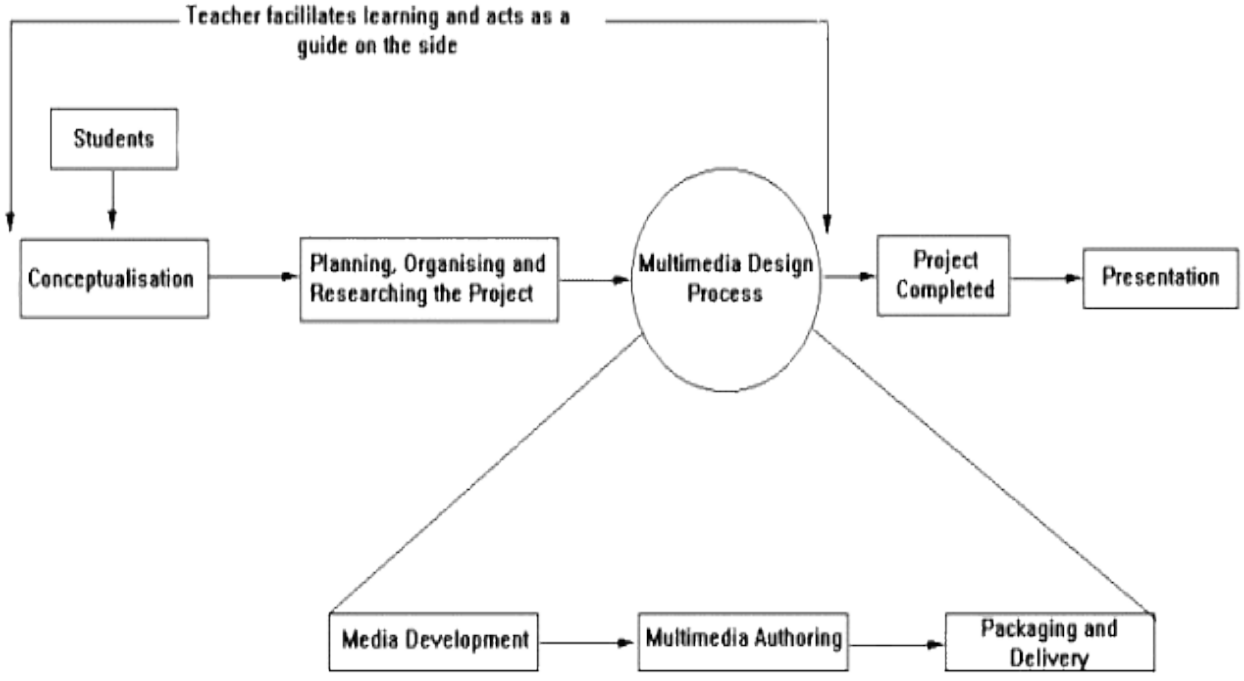
> "Hands-on materials are used instead of textbooks, and students are encouraged to think and explain their reasoning instead of memorizing and reciting facts. Education is centred on themes and concepts and the connections between them, rather than isolated information" (McBrien & Brandt, as cited in Auger & Rich (2007, p. 45).

Step 3 - The third step was to develop a completely new approach to teaching. A constructivist classroom required a great deal of effort. Constructivism required more than merely the addition of some Mathematics manipulatives or hands-on activity centres, instead it meant a new way of establishing the learning. My teacher behaviour became more and more interactive although I was still the master of subject-based content. Initially, I did not abandon all of my previous traditional thematic units, instead how I employed these resources changed. As Anderson, Herr, and Nihlen indicate:

> Teachers in particular, live in a fishbowl. Their professional competence is constantly vulnerable to questions from parents, students, principals, and fellow teachers. They are understandably defensive about what they may perceive as attacks on their professional competence" (Anderson, Herr, and Nihlen, 2007, p. 51).

Step 4 - The fourth step involved a paradigm shift away from a reliance on the use of pre-fabricated content. When we began a content theme, I would ask the students what they knew about the topic and what they wanted to learn about the topic. For example, using the popular KWL Model facilitated this process. This method acknowledged that the students already had knowledge and encouraged them to research and solve problems. In Mathematics, this allowed for the learners to create presentations (projects) to share with their classmates. At this stage, I had made the shift away from teaching thematic content units to students. I was no longer teaching the memorization of facts and figures related to a topic or theme.

The figure below indicates a project-based constructivist learning approach with a multimedia focus as developed by Neo (2003):



(Source: http://www.ascilite.org.au/ajet/ajet19/neo.html)

Step 5 - The fifth step involved the questioning of my beliefs about my teaching practice (Brookfield, 1995). I became conscious that I was still simply having the learners cover material, although they were having more fun in the process. I came to understand that I was only guiding the students from one knowledge 'jamboree' activity to another, rather than engaging in higher-level thinking skills necessary for true constructivism. The value of this process is that "action research signifies individual, reflective practice" (Ontario Action Researcher Homepage, 2007). If I wanted my students to improve their achievement in Mathematics, I could not be the 'sage on the stage' in the classroom; I needed to be the 'guide on the side.' This new approach was similar to Freire's Participatory Action Research (PAR). Until now, I had only been teaching content knowledge rather than allowing for my students to actively construct their own understanding about what they were interested in.

Through teacher observation, I was able to grasp that my students could identify problems and find solutions without artificial teacher intervention. The learners were now the ones asking and answering the questions in the classroom. This was not an easy process and many teachers may not choose to follow such a path, however, if real and lasting learning is to occur in mainstream schools then teachers must stop dictating how, when, and what our children learn.

Findings

When we ask ourselves "What do we know" we often think about the lasting learning experiences we have had, often not from our formal schooling or pencil and paper tests. It is important for not only teachers to provide resources in the classroom, but also for students to bring items to the classroom which they take interest in.

Question 1 – *Would a Constructivist classroom improve junior learner achievement in Mathematics?*
After 3.5 months of using a Constructivist approach the students were administered a similar grade equivalency test in Mathematics. The results had improved significantly in the grade 6 learners from 4.3 GE to an average level of 5.8 GE (a total GE increase of 1.5). While the grade 5 learners improved from 3.2 GE to an average level of 4.6 GE (a total GE increase of 1.4). The Provincial Testing data corresponded with the grade 6 figures in Mathematics. Although no learners scored at level 4, there were no learners who scored below level 1 (including the students with exceptionalities). Further, 19% scored at level 3, 50% at level 2, and 31% at level 1.

According to Delong, Black, and Wideman "Sometimes the changes in student achievement are minuscule over the course of a year, but these changes are always of benefit" (2005, p. 28). The emphasis of this project was to help learners improve their achievement in Mathematics, rather than to use summative assessment for ranking, therefore only group data is presented.

Question 2 - *What is the impact of Constructivism on learner motivation?*
Teacher observations indicated that students are more interested in learning and excited about Mathematics. Specific evidence was observed in the form of positive telephone calls and thank you letters from parents regarding their child's enhanced interest in Mathematics. In addition, student absenteeism decreased by approximately 60% by the end of the 3.5 month period, which may be a response to increased student interest in Mathematics and schooling. By providing students with an alternative way to learn, they were no longer learning Mathematics in isolation, which is one of the major factors impeding growth in mainstream schools. Although there is no single recipe for motivating students, it was observed that when students are self-assured and interested in authentic (useful) tasks in Mathematics they will achieve.

Conclusion

The success of this action research project using a constructivist medium reveals that classroom teachers should be including constructivism within the learning environment. The ability of the teacher to move away from the conformist teaching style is connected to the success of this study. The road to lasting and sustained school improvement is through teacher development. Teacher-growth must form a link between professional development and enhancing learner capacity. True school

transformation requires an authentic commitment to developing an investigative environment for both students and teachers.

From this study a series of recommendations for teaching junior level Mathematics using constructivism was developed. Here are 7 practical guidelines to using constructivism:

1. Emphasize the enduring Mathematical understandings or big ideas beginning with the end result in mind.
2. Mathematics should be focused on the interests of the learner as the bases for developing student questions.
3. Learning should be established based upon the prior knowledge and experience of the student.
4. Encourage discussion with learners by guiding students to actively construct new knowledge.
5. Make the role of the teacher the 'guide on the side' the priority in the classroom.
6. Remember that learning is a social process and students should not learn in isolation. Be sure to facilitate the exchange of student ideas.
7. Constructivism is not expensive and can be done on a shoestring. Recyclable materials are budget friendly.

This study illustrates that when a teacher is commited to improving student success, that he or she can transform the learning climate through the use of constructivism. It should be noted that although this study was a success, it may not be a template for every teaching/learning environment.

> Be careful not to generalize the conclusions of action research. Just because something worked for one teacher in a classroom does not mean it will occur the same way for all teachers and students in all classrooms. In action research, the context of the learning is the individual (Delong, Black, and Wideman, 2005, p. 35).

Since this study was done, this project continues to have a positive impact on the students. Many learners and parents have credited their renewed interest in Mathematics in mainstream schooling to the investigative approach used by the teacher. Other students have extended their interests outside the walls of the classroom to participate in open-learning across the curriculum.

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