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STIMULATING creativity

STIMULATING CREATIVITY THROUGH INCOPORATING SYSTEMS THINKING IN FIRST AND THIRD GRADE CLASSROOMS

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Recieved: May 24th, 2012
Approved: June 24th, 2012

SUMMARY

This action research was developed in order to identify the effects of Systems Thinking tools on creativity competencies among students ages seven to ten years old. Teachers' observations showed low levels of flexibility, connectivity, curiosity and fluency in the creativity competency in various subjects. The purpose of this study was to determine if the use of specific Systems Thinking tools and strategies geared for K-12 could improve students' creativity competencies. The results of this case study showed an increase in connectivity, flexibility, fluency and curiosity among the students using Systems Thinking strategies in the classroom compared to students in the control group.

Key words: Creativity, flexibility, connectivity, curiosity, fluency, Systems Thinking

RESUMEN

Esta investigación se desarrolló con el fin de identificar los efectos de las herramientas de Pensamiento Sistémico en la creatividad de los estudiantes en edades entre los siete y diez años de edad. Observaciones de los profesores mostraron bajos niveles de flexibilidad, conectividad, curiosidad y fluidez en la creatividad aplicada a diversos temas. El propósito de este estudio fue determinar si el uso de algunas herramientas específicas del Pensamiento Sistémico y de las estrategias orientadas a K-12, podrían mejorar la competencia creatividad en los estudiantes. Los resultados de este estudio mostraron un aumento en la conectividad, flexibilidad, fluidez y curiosidad entre los estudiantes que utilizan Estrategias de Pensamiento Sistémico en el aula, en comparación con los estudiantes del grupo de control.

Palabras clave: creatividad, flexibilidad, conectividad, curiosidad, fluidez, Pensamiento Sistémico.

INTRODUCTION

"Students, please place this exercise in your math folder," the teacher told the class. A student immediately responded, "This is English, not Math. You can't connect them!" The Systems Thinking teacher exclaimed, "Everything is connected! We used this vocabulary exercise to work on fractions. How many did you get correct? I see, you got 9 out of 10 correct, and you learned some new vocabulary along the way."

Why did this student believe that Math and English could not be linked? Education is still departmentalized into separate subjects and every once in a while there is a glimpse of interaction. How can students realize that their world is intertwined on many levels, not continuously departmentalized? How can students be awakened to the world's complexities and be given the tools to access creative solutions?

As teachers, we always hear that students will learn better if subjects are more accessible and personally meaningful to them. At present, if students need to solve an equation, they have been taught the tools or strategies about how to solve for x. But what if students are asked to find a solution to the traffic problems in Bogotá, Colombia, given the opportunity to find ways to improve international relationships or create a plan for conservation of fresh water? Would they have the tools and strategies to find creative solutions or to visualize what actions would give positive results or give negative precursors to those results? In the end, we work and live in systems whether complex or simple, one thing or many things affect other things, from history to politics, from politics to the economic state of a country, from current road construction to an increase in road rage; they are all systems and they are dynamic.

This is where a concept like Systems Thinking can be introduced at an early age and developed all the way through college. When working in social, economic, environmental systems, we often assume that *one* action has *one* result and that it will happen relatively soon. However, experience has shown us that we are tightly interconnected, delayed, complex systems where *one* action can produce multiple results (Sustainability Institute, 2004).

The need for Systems Thinking in education and the learning process has grown exponentially and to date there are many organizations and resources available; according to Professors Kira S. King, Ph.D (University of Central Florida) and Theodore Frick, Ph. D (Indiana University Bloomington) in a paper entitled, "Transforming Education: Case Studies in Systems Thinking" presented at the annual meeting of the American Educational Research Association on April 19,1999 in Montreal Canada:

"As the amount of information increases exponentially, our educational system can no longer focus primarily on memorizing a core body of knowledge. There is no way any single individual can master all of the information available. Rather, our schools must help children become skillful manipulators, synthesizers and creators of knowledge... Society no longer relies primarily on factory workers, but on lifelong learners who can think critically, solve problems and work collaboratively. These

are the skills of tomorrow's "knowledge workers" (Drucker, 1994)... we need entirely new concepts in learning and teaching- rather than more efficient industrial age schools" (King, Frick,1999, pp. 2).

According to teachers' experiences and observations, specific aspects of creativity need to be directly taught to improve students' fluency, connectivity, curiosity and mental flexibility. The urgent need to find tools and strategies to holistically increase creativity has brought the idea of incorporating Systems Thinking to the classroom. This study intends to investigate if students will be receptive to experimenting with Systems Thinking in the classroom and if Systems Thinking practices are effective in increasing the creativity competence of the students. This action research took place in a private school in Bogota, Colombia. The students' ages ranged between seven and ten years. Systems Thinking tools and strategies were applied in English, math and science classes. The intervention took place within the months of March and April in 2012.

If the results render positive, students' creativity competencies will improve and students will transfer the tools and strategies learned to higher grades and other subjects. As a result, students will have a different perspective for solving problems and will practice this mindset throughout their student careers. Therefore, students will be better prepared for the ever changing dynamic systems of the world.

RESEARCH QUESTIONS

Do students ages seven to ten years old show improvements in creativity, with respect to fluency, connectivity, curiosity, and flexibility competencies after explicitly having been taught Systems Thinking strategies and tools?

What were students' perceptions when considering which tool and strategy had the most impact on their creativity development?

LITERATURE REVIEW

Considerations for Second Language Learners

The students in this study are all English language learners with various levels of English proficiency. This is a component that cannot be overlooked in this study. Students are currently gaining English proficiency in subject areas, in social context, and with respect to Systems Thinking in English without the instructor using the students' native language. Students will not only be challenged linguistically in the new language, but also cognitively and socially as Systems Thinking is applied to the classes.

System Thinking Tools and Strategies for K-12

Systems Thinking research offers a new perspective on the way we address problems and approach everyday situations. It is essentially a set of tools and a specialized language that we can use to understand the relationships among the parts of any given system. The idea is that instead of looking at the individual parts of any given system and isolating them, one instead looks at the system as a whole and takes into account all the interactions that occur in it, in order to understand how it works (Aronson, 1996-8). Focusing on how the parts within the

whole work we can sharpen our comprehension, and develop a unique perspective on the reality of the relationships in any situation.

Using the tools of Systems Thinking, whether they be simulation models, connection circles, stock and flow diagrams, causal loop diagrams or any type of design that allows the thinker to view and understand the connectivity of the given system, these tools allow us to explore and identify dynamic complexity and relationships within any system. Creating, for example, a causal loop diagram for a specific inquiry can encourage learners to examine the way we look at situations and problems including our current assumptions that often influence the way we think and react. By defining the root of a problem and examining potential solutions, we can learn to anticipate possible solutions that pre-empt more difficulties. The tools of Systems Thinking provide different ways to look at a given system as a whole (Waters Foundation 2012).

Systems Thinking

The concept of Systems Thinking has been in existence for many decades. It originated in the 1920's within areas such as ecology, biology and engineering. An American computer engineer and systems scientist, Jay Wright Forrester, created the concept of Systems Dynamics, during the mid 1950's, while he was a Professor at the Massachusetts Institute of Technology (Systems Dynamic Society, 2012). Systems Thinking has a deep foundation in the area of Systems Dynamics, which is an approach to understanding complex systems over time. The tools, associated with this approach to thinking, enable teachers to explore how to help students understand the world around them and how it works. According to the Waters Foundation, an American based organization, dedicated to promoting Systems Thinking in education at schools, Systems Thinking aims to, "...deliver academic and lifetime benefits to students through the effective application of Systems Thinking concepts and habits and tools in classroom instruction and school improvement"(www.iseesytems.com, Waters Foundation, 2012). Systems Thinking tools and strategies will help students develop a comprehensive world view by taking pieces of the problem or situation, chunking it together, and finally developing patterns that make sense about the world and its' issues to find plausible and effective solutions. This type of thinking requires practice and a distinct change in mindset in order to realize that subjects cannot and should not remain isolated.

While this action research will be based on the educational habits that can be developed through Systems Thinking in understanding the flexibility of this approach to thinking, it might be worthwhile to note that the process of Systems Thinking has been used by different companies around the world to solve some of their dilemmas and reinvent their way of thinking. "The company also brought in Peter Senge, the pioneer of Systems Thinking, as a moderator" (Triple Pundit, 2011), so in 2009, after much controversy and criticism about its' non-recyclable cups and other environmental practices, Starbucks, an international coffee company based in the United States, began to use Systems Thinking to ensure that their new recy-

clable cup was sustainable; according to an article posted on a website called the Triple Pundit.

Reflecting the need to prepare graduates with a different desire to confront daily complex systems, aspects of Systems Thinking are also offered at the university level in many countries. The Cambridge, Massachusetts based Harvard University offers various programs that incorporate Systems Thinking into their curriculum. The Harvard Graduate School of Education offers a program called, "Leading Education Systems at the National Level: Effective Policy and Practice for Improving Outcomes." A key part of the program's objectives is to actively practice Systems Thinking and go beyond the step-by-step strategies already practiced worldwide and instead make improvements by taking a "holistic view" of the world.

Creativity

In the particular school setting for this action-research, one competence that is developed in the educational plan is creativity. According to the Academic Council and concept bases from November 2011, the definition of creativity is "a group of knowledge, abilities and attitudes that a student should put into practice to use theories and knowledge in different contexts, to deduce non evident results, recognize non-evident conclusions; to establish the value of the ideas and authorship; to demonstrate originality and ownership in design, productions and achievements." Taking into consideration that creativity is also, "a special attitude towards life that is expressed in a manner that is cognitive, affective, deliberate, and experimental and that reflects achievement. It is characterized by four conditions: fluency, flexibility, connectivity, and curiosity."

Seeks to understand the "big picture"

A Systems Thinker focuses on the forest rather than on the details of any one tree.

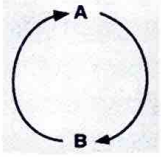
Questions to ask...

"How can I maintain balance between the big picture and important details?"

"What time frame should be considered as I view the system?"

"Am I keeping my focus on areas of influence, rather than on areas of concern that I cannot influence?"

Identifies the circular nature of complex cause and effect relationships



A Systems Thinker sees the interdependencies in a system and uncovers circular causal connections.

Questions to ask...

"How do parts affect one another?"

"Where does circular causality/feedback emerge?"

"Is one feedback loop more influential over time than another? If yes, how?"

K-12 Habits of a System Thinker (Waters Foundation 2012)

In this study, the focus was to increase these four conditions systematically in order to improve creativity in general.

There are four conditions that complement creativity and can be developed. *Fluency* can be described as generating ideas, using resources to avoid mind blocks, and finding alternate ways to overcome obstacles. In conjunction with fluency it is necessary to be mentally *flexible* which permits valuing different perspectives, and using them to reach specifics goals. *Connectivity* plays an important role to establish relationships or to identify patterns that go beyond the obvious to detect possible solutions. *Curiosity* is the collective act of exploring, questioning, inquiring, and imagining possible solutions or problems when faced with uncertainty (Gimnasio Campestre, 2011).

Methodology

Both qualitative and quantitative research methods were used in this study. The main sources were student work and teacher observations. A post survey was applied in order to examine students' experiences after the intervention. A teacher survey has been included in this study. Specific rubrics were designed to measure aspects of the students' competency levels in the four conditions of Creativity.

Rubric: In specific activities the students were scored on creativity using the following criteria: flexibility, connectivity, curiosity and fluency. Students were scored using the rubric before and after the intervention. The pre and post intervention rubrics were compared.

Observational notes: Observational notes were important to the study in order to capture how students were interpreting the strategies and tools in their second language. With the expectation of continuing the full immersion model, teachers and students used minimal native language, only when necessary to clarify any misconceptions.

Surveys: Teachers were invited to answer a survey to share their perceptions about any increase or decrease in students' creativity competencies. Students were surveyed and specifically asked which tool and strategy had the most impact on them for future use.

During the months of March and April of 2012 students were introduced to System Thinking habits, then, they practiced the strategies, and finally used Systems Thinking and its tools in various subjects. Students received information with definitions and practice exercises on a weekly basis for 5 weeks using System Thinking theory and tools with various posters displayed in the classroom. One first grade class and one third grade class were used to apply System Thinking in the English, math and science. The principles and tools of System Thinking were scaffolded by varying the degree of difficulty in the practice exercises. First, students were introduced to the concepts, the teacher modeled a strategy or tool, then students worked in small groups, and finally in pairs or individually using the tools learned for that week. During the second week in April, students and teachers completed the surveys.

In this particular investigation, students have been explicitly taught the following

concepts and strategies of Systems Thinkers: seeing and understanding the big picture, accepting that change happens over time, knowing that things depend on each other, finding that cycles persist and exist, willingness to change perspective, and recognizing that systems have structure (Waters Foundation, 2012). The students learned to use the tools of behavior-over-time graphs and connection circles. Although there are many more tools and strategies, this study led to the use of the ones mentioned above due to students' ages and second language development.

Analysis

The following information resulted from analyzing surveys, observational notes, and comparing student work with a rubric.

Four Conditions of Creativity

A specific rubric was developed to quantify the increase or decrease of the four conditions of creativity and to compare students' results in the intervention group and the control group. Work samples from different subject areas were compared to the rubric and rated by the criteria for each of the four conditions. Thirty-six of the forty-nine students that were introduced to Systems Thinking received scores that demonstrated mastery by receiving Excellent or Superior in all four conditions of creativity. Fifteen of the forty-seven students in the control group showed Excellent or Superior in all the conditions of creativity. Below is a breakdown of each condition in which students received Excellent or Superior in the work samples scored. Overall more students in the intervention group scored Excellent and Superior than in the control group in each of the competencies.

Confidence in Creativity

The responses found in the surveys given to the students after applying System Thinking to the intervention groups were taken into consideration when analyzing perceptions of various levels of creativity. Students also rated the tool they believed was the most beneficial for them when working with Systems Thinking. In addition, they selected which strategy helped them feel more confident when working and thinking creatively. Likewise a similar survey was given to the control groups. The surveys in the control group demonstrated that students were not as confident about creativity as the students in the intervention group. In the survey, we found that students preferred the connections circles as a tool to for creativity and the strategy that had the most impact was seeing and understanding the big picture.

The results from the teacher survey of the control groups indicate the number of students did not significantly improve in creativity in the last semester. On the other hand, the intervention group's teachers noticed an increase especially in connectivity and flexibility among the students after applying Systems Thinking.

In this study, we checked to see if students would naturally make connections in their writing. Random English, math and science work samples were taken to see if there are any connections made in students' writing. Transference of the ideas and tools were evident in their work samples.

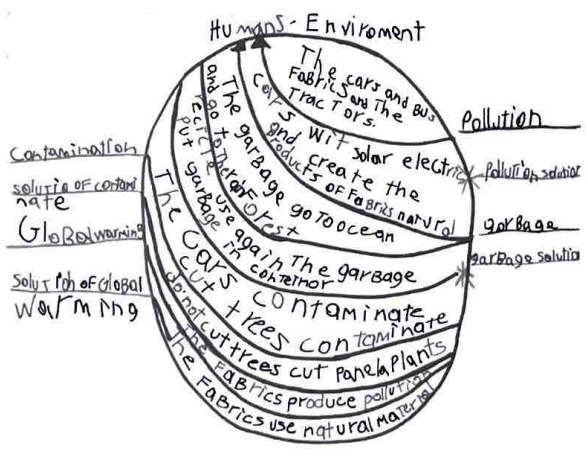
Language Learning and Creativity

The observational notes for the intervention group indicate the ease with which the students were using the tools and gaining the language necessary to express their ideas when using Systems Thinking in the classroom. In one of the lessons, students gave many examples of systems that they were familiar with and there were "a-ha" moments in several lessons where the students were fully engaged and making out of the ordinary connections verbally and in their written work. Very rarely the teacher needed to use the students' L1.

Based on the information gathered in the study: Students in the intervention group showed an increase in the four conditions of creativity more than in the control group.

Students in the intervention groups felt more confident about their own creativity than students in the control group. Students that learned how to use the System Thinking tools said they could apply the tools to other subjects.

Seeing and understanding the big picture



First Grader's Connection Circle: Human Impact on the Environment

and using the connections circles were the preferred strategies and tools from Systems Thinking selected by the intervention group.

CONCLUSIONS

Systems Thinking has evolved into a key tool for educators particularly in primary grades. Schools and educators alike have realized the importance of helping children to see beyond each particular assignment and instead, develop higher level thinking skills. Organizations like, The Waters Foundation, an Educational Partnership whose network of educators examine and research the impact of systems thinking and dynamic modeling in elementary and secondary schools, are dedicated to furthering the benefits of Systems Thinking in all students' educations. The Waters Foundation aims to "develop the capacity of K-12 educators to apply Systems Thinking and Dynamic Modeling (ST/DM) effectively in classroom instruction and organizational planning..."(Pegasus Communications, 2011). Among all the evidence gathered, and research currently being reviewed, it has become apparent that children learn Systems Thinking through understanding relationships, whether it be relationships between characters in literature, between events, numbers, symbols, natural resources or more - this relationship provides a basis for deeper exploration. In conclusion, this study demonstrates how explicitly teaching the tools and strategies of Systems Thinking increases the four conditions of creativity in first graders and third graders at this private school in Bogotá, Colombia. Students were challenged to think outside of the box and practiced using thinking skills

that will benefit them in their future classes and careers. This is a small stepping stone for the students learning to use Systems Thinking; however this study shows how young children in first and in third grade can begin to master the world of systems for solving problems with creative solutions. There are many other aspects in continuing to work with Systems Thinking, but for this study these initial steps showed an increased effect in flexibility, connectivity, curiosity, and fluency, the elements necessary for creativity in learning.

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