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THE IMPLEMENTATION OF *MICROWORLD LOGO* IN CLASSROOMS

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Abstract

The idea of Microworld Logo brought new perspectives in education. It gives inspiration to develop and look deeply into the powerful ways in which computers and educational software might improve teaching-learning processes. However, the implementation of this Logo seems to be unsuccessful. This paper discusses and evaluates the implementation of Logo in classrooms' context and discusses some obstacles in its implementation in classrooms so that teachers could get lesson from that. It considers the notion of Logo's history and its preceding implementation to identify the problems on Logo's implementation. This study shows that the failure of Logo implementation might be comes from the limitations of Logo itself, human and technical resources, and learning environments that are related with curriculum and schools policies.

***Keywords**: Microworld Logo.*

INTRODUCTION

Nowadays, computer use in classroom activities is a common thing. Most people believe that computers will provide meaningful experiences and interactive learning. According to diSessa (1986) computers allow students to build their own ways of thinking and formalising the geometry objects. This is one of the most thoughtful experiences of mathematics: "mathematics can be made" (p.17). But the use of computers in education has raised some issues in terms of the contents of material, teaching methods, learning process, and also the program that is used.

The spread in the use of computers in schools since about 1980, has led to the vast development of educational software. *Microworld*, as one of educational software which is based on invention, play and discovery principle, allows younger students to understand highly significant and applicable concepts and principles underlying all complex systems (Rieber, 2004). There are many examples of *Microworld* programs such as *Logo*, *Boxer*, *ThinkerTools*, *SimCalc*, *StarLogo*, *Geometer's Sketchpad*, and so on.

Microworld Logo which was created by Seymour Papert and his team since 1967 has had serious issues in its implementation. It is almost three decades since it began, yet Logo seems to have been unsuccessful in gaining its original aims. This paper evaluates the implementation of Logo in classrooms' context and discusses some obstacles in its implementation in classrooms. Therefore, we can learn from its previous implementation in order to gain more advantages from the use of *Microworld Logo* in classroom.

HISTORY OF *MICROWORLD LOGO*

Most educational software is based on the paradigm of "explain, practice and test" (Rieber, 2004). But *Microwolrd* offers a different philosophy, which is that students study through invention, play, and discovery. Papert in 1980 defined a *microworld* as a

> …subset of reality or the constructed reality whose structure matches that of given cognitive mechanism so as to provide an environment where the latter can operate effectively. The concept leads to the project of inventing *microwolrds* so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills. (Rieber, 2004, p. 585)

The simple definition of *Microworld* comes from Clements (1989), who describes *Microworld* as "a small playground of the mind" (p.86). Andy diSessa (2000, p.47), described a *Microworld* as "a genre of computational document aimed at embedding important ideas in a form that students can readily explore". He also mentioned some criteria of a good *Microworld* such as that the set of operation be easy to understand, the task be valuable and able to engage the children so they can gain meaningful learning.

The first version of *Microworld Logo* was introduced in 1967. It became spread widely throughout the world from in the early 1980s because of the advent of personal computers. It is also as an impact of publication of *Mindstorms*, a controversial book by Seymour Papert. He offered new ideas of integrating technology in education. His vision focused on turning the power of computers over to students through computer programming with *Logo*. He believed that learning through computer programming in Logo will give meaningful experiences and in the next step it will change the way children learn everything else. His ideas and his controversial book brought such a "fresh wind" in education. Thousands of teachers over the world became excited and enthusiastic to apply the powerful *Logo* in their classroom.

Logo takes from the Greek word that means "thought" or "idea" (Rieber, 2004, p. 584). It also can be seen as an education philosophy because its design was influenced by a particular educational philosophy. Abelson (1982 in Web Logo Foundation) state that *Logo* is the name for a philosophy of education and for a continually evolving family of computer languages that aid its realization. The philosophy is constructivist learning theory which is emphasizes on students construct their own knowledge based on their own experiences. *Logo* was designed to support this constructive learning.

Logo was designed as a tool for learning that was based on *Lisp* procedural language (Solomon, 1978). It used simple basic commands such as *Forward, Back, TurnLeft, TurnRight, PenUp, and PenDown*, so the children can learn and master it easily. It is different from other programming languages because its environment involved the Turtle (diSessa, 1986). The turtle is used as a robotic creature that could be directed to move around the floor by typing an instruction on the computer screen but now it is a computer graphic feature as a tool to draw shapes, designs, and pictures on the computer screen.

There are three ideas that underpin the design of *Logo* for young children. They are that *Logo* is: "procedural" such as giving words meaning, naming process, making descriptions for how to do things; "anthropomorphic" that is ascribing human characteristics to non-human things through the turtle; and "debugging" that is what we learn from our mistakes (Solomon, 1978, p. 21-22).

Papert's ideas and dream through *Logo* are very wonderful but it is quite difficult to realize them due to the limitation of *Logo* itself and the resources, both human and technical resources. Some people in *Logo*'s team realized that this condition has to be changed and then they try to make other *Microworld* such as Boxer by Andy diSessa and StarLogo by Resnick (Rieber, 2004). Nowadays, many kinds of *Microworld* have been developed which are more interactive and flexible.

IMPLEMENTATION *LOGO* IN CLASSROOM

As a tool for learning, *Logo* has been used in mathematics, science, language, music, and other fields of education. In learning mathematics, the Turtle is use as a transitional object that connects what students already know and the mathematical ideas or as a bridge to move from concrete to abstract ideas (Solomon, 1978). It is very helpful for children in abstraction processes and also for teachers to teach abstract concepts especially to young children but it seems to be quite difficult to identify whether children have been able to catch the mathematical ideas properly. The issue is how we can assess the children's achievement? How should teachers report students' progress on *Logo* learning?

Papert's theory is wonderful in giving a coherent and wide ranging vision about what education and learning process in computer era look like. In his book, *Mindstorms*, he tries to create an ideal learning process in ideal conditions. But Leron (1986) states that Papert's vision can be realized only with an ideal learner who is a bright and intellectually alert child; an ideal teacher who is knowledgeable, caring and sensitive; and ideal interaction. He states ideal interaction as including enough computers, which is one or two children to one computer to one teacher, or at least very supportive and constructive group work. Moreover, Hoyles (1986) believes that *Microworld Logo* only helps some bright students in constructing their mathematical knowledge and others end up stuck on the programming language. So it can be seen that *Microworld Logo* is not useful for all level of children's ability. Moreover, implementation of logo in classrooms requires an ideal condition (ideal teachers, ideal students and ideal partners) which seems to be unrealistic.

Since *Logo* is an instrument to help children in the learning process, it is important to evaluate the ideas underpinning it. The idea of developing *Logo* is based on constructivist learning theory where children construct their own knowledge based on their experiences. But then Papert preferred to use the term *constructionism* insted of constructivism, because he believe that *constructionism* place greater emphasize on the learning environment, which is an important aspect in *Logo* implementation (Leron, 1986; Rieber, 2004). The Implementation of *Microworld Logo* is based on an *exploratory* learning approach which has four basic principles: (1) learners can and should take control their own learning; (2) knowledge is rich and multidimensional; (3) Learners approach the learning task in very diverse ways; (4) It is possible for learning to feel natural and uncoaxed (Rieber, 2004, p. 587). In classroom activities children and teachers discuss and solve the problems together. Teachers should give more opportunities to the students to explore and construct their own knowledge. But on the other hand teachers and schools have to follow the curriculum which usually has a limited time for teaching certain topics. This is one challenge of *Logo* implementation in classroom, but Papert (in Rieber, 2004) states that schools need to change the curriculum and give adequate time to students to explore the materials. But who will guarantee that by giving students a longer time to explore and construct their knowledge, they will gain the purpose of the learning process and construct their knowledge properly. Balacheff and Kaput (1996) argue that although *Microworld Logo* offers to students to open worlds in which they can freely explore problem situations, the interaction with the machine is insufficient; the free exploration offers rich experiences but does not guarantee that learning process occurs.

There are some benefits in implementing *Logo* in classroom activities, such as that learning with *Logo* could make the images more vivid and certain ideas more concrete (Solomon, 1978). Rieber (2004), states that the turtle helps students in abstraction easily because the turtle acts as a bridge for students to move from concrete things to the abstract concept. Clements and Meredith (1992) believe that children can develop their problem solving skills through *Logo* programming; children also develop their communication skills trough discussion during programming.

Indeed, van Hieles (in Rieber, 2004) concluded that *Logo* can help children learn higher levels of geometric thinking. He believes that students develop their thinking through the visual level, descriptive level and analytical level. If students learn with expository methods, they might be in the visual level which is when they see a geometrical shape as a “whole” only. For example, rectangle looks like door. In contrast, if using *Logo*, students have to describe and analyse the rectangles in order to be able to give instructions to the turtle to draw the rectangle. In this stage they learn at the descriptive level and analytical level. For example, they have to be able to analyse the characteristics of rectangles which are have four square corners and opposite sides that are equal and parallel.

All of the benefits mentioned above are based on research literature and observations in classroom on certain topics in mathematics. It can not be generalized for all topics which have different level of difficulty and even for others subject in education. Hoyles (1986), state that *Logo* only works in some topics, particularly on simple shapes in geometry for elementary and middle schools. Moreover, Kelly, Kelly, and Miller in Clements and Meredith (1992) argue that the benefits of *Logo* might not be emerging until children have *Logo* experience for more than a year. So the benefits of *Logo* do not automatically emerge on the students' performance; it needs time to observe and to assess it.

Logo is quite old compared with other *Microworld* version. This also might be the reason why some school decide to use other versions of microworld instead of *Logo*. This paper tries to compare two *Microworld* versions that are *Logo* and *Cabri-geometre*. In logo students or users draw static geometry objects. They can modify them by modifying the *Logo* code that produces them. In *Cabri-geometre*, students or users can directly manipulate the drawing by simply dragging it. If they drag a certain point, at the same time they can see the position of this point changes. *Cabri-geometre* is more interactive and flexible. Balacheff and Kaput (1996, p. 472) mention other significant differences between them that have implication on a cognitive level. They state that in *Cabri-geometre* intrinsic drawings are everything that can be drawn with ruler-and-compass whereas *Logo* only can draw any arbitrary set of points by numerating them or by generating them with functions defined on number segments (p. 472).

Based on some literature and research on the implementation of *Microworld Logo*, it can be conclude that it is quite difficult to see whether students engaged with *Logo* and learnt in meaningful ways because some children do work in *Logo* programming but they do not always know what they are programming or even they get stuck on language program. And it is quite hard to see whether students transfer the way they think in programming with *Logo* into other contexts, other subjects and other activities.

RESEARCH ON LOGO ACHIEVEMENT

Some researchers report significant gains and even dramatic learning changes in terms of students' learning. But others report mixed results or no significant differences between *Logo* and control groups. Clements and Meredith (1992) claim that these ”unsatisfactory” results may be because *Logo* provides practice only with limited topics so achievement tests assess only limited areas of mathematical knowledge or it perhaps because the hypothesis is not fully adequate.

Research conduct by Feurzeig, Papert, Bloom, Grant and Solomon in 1970 concluded that teaching mathematics with a suitable programming language has several benefits such as it facilitates to learn and develop rigorous “thinking and expression”, it allows students to define a number of concepts, and it helps students to develop problem solving skills (Feurzeig, Papert, Bloom, Grant & Solomon, 1970). This result was very meaningful. But it did not give clear evidence whether children learning in the meaningful ways and whether they can use their “achievement on thinking and expression” in others contexts and other subjects. And one things we should know that this research are conduct in elementary school where *Logo* gain its success in term of engaging the students (Hoyles, 1986).

Jong and van Jooligen (in Rieber, 2004) believe that students who learn from simulation have deeper cognitive process than learn from expository methods. But it is not guarantee that they can apply the knowledge to other contexts. Even though their research did not focus on the relationship between *Logo* and non-*Logo* activities, they believe that students who successfully manipulate the simulation may not have acquired “the general conceptual knowledge” to success at other task. They conclude it based on their observation.

Clements (in Rieber, 2004) conduct a research on the effects of *Logo* programming on students' cognition. He found that students working with *Logo* think differently about mathematics in deep and interesting ways. But this research did not provide enough evidence to say that the way students thinking affect on other context and other subjects. Indeed, the sample of this research was limited, he just investigate nine students who was learning with *Logo* and nine students who was not (as a control group). It is quite difficult to make generalization.

Another research conducted by White. She designs game in *Microworld Logo* and she used it in classroom to teach force and motion concepts. She found that students who played the game improved their understanding of force and motion concepts than those who did not (White in Rieber, 2004). But again, this research did not investigate the transfer process between *Logo* activities and non-*Logo* activities and the impact of *Logo* activities on others activities. And White's research did not identify whether this favour result is because they learn with *Logo* programming or because the students engaged with the games so they have high motivation to study.

Papert criticize many research on *Logo*, he said that some research in *Logo* programming more focus on the technology rather than on the students and learning environments. So Papert and his team conduct a field study to investigate the *Logo* works in some schools. He use a new research methodology called a *design experiment*. Since the researchers are *Logo'* team, the design have a tendency to see the success of the innovation itself instead of the failure or the limitation of their innovation (Collins in Rieber, 2004). This design experiment use vary research methodology and without a strong theoretical framework (Collins, 1992; Brown, 1992; in Rieber, 2004). Thus the result of this field study was difficult to interpret.

To sum up, some research studies had conducted in *Microworld Logo*. The results of these studies are giving positive responds to *Logo* programming. But we still can not get enough evidence to conclude that Papert's dream has become a reality.

DISCUSSION

Despite the result of some research on *Logo* and also its achievements in classroom implementation, teachers have to be concerned about the limitations of *Logo* and give more attention to the purpose of the learning process. This part discusses some issues that might be the causes of its "failure".

The first issue is the limitation of *Logo* based on its limited capability to cover all topics in education. Not all topics can be taught with *Logo* so it is quite difficult to see the influence of *Logo* on the ways students learn in other topics or context. *Logo* in some topics or subjects may have success in helping the learning process but it is not helpful in particular topics or subjects. Hoyles (1986) states that considerable work still needs to be done to determine which particular topics are suitable and enriched by learning through *Logo*. Moreover, Hoyles mentions that the other limitation of *Logo* is that it just helps to solve some problems in mathematics education. She suggests we need to be aware of *Logo*'s limitation in the future because it might be certainly not solve all of mathematics problems.

The second reason is the limitation of language that *Logo* used. Even though *Logo* used simple and basic language, it was still difficult to master. Children learn about how to draw simple shapes quickly but it is quite "difficult to move to advanced features of language" such as combining procedures and using variables (Rieber, 2004, p.590). *Logo* built a specific bridge between geometry and graphical phenomena. But the students were still obliged to operate through a symbolic language which carried its own complexity in its syntax or procedure (Balacheff & Kaput, 1996).

The third reason is the learning process using *Logo*. *Microworld Logo* offers to students to "open worlds" which means they can freely explore problem situations. But the interaction with the machine is insufficient; the free exploration offers rich experiences but does not guarantee that the learning process occurs (Balacheff & Kaput, 1996). Some children do work in *Logo* programming but they do not always know what they are programming. In this case, the role of the teacher is important. The teacher is a mediator in planning and facilitating the learning process (Clements & Meredith, 1992). They also have to motivate students to gain the learning purpose. Moreover, Reiber (2004) states that the benefits of *Logo* come with serious risks: students will end up with misconceptions if they fail using appropriate analogy.

The fourth issue is students. For example in learning mathematics using *Logo*, students do not always think mathematically although Logo environment requires this. Some students rely on visual shapes and do not work analytically (Hillel & Keiran, in Clements & Meredith, 1992). Moreover, Clements and Meredith (1992) believe that if they continue to rely on a visual approach and work in *Logo* on the basis of seeing whether objects look "about right" rather than using a more analysis, they do not progress their mathematical thought.

Another issue is the transfer process from *Logo* activity to material that teacher wants to teach (e.g. mathematical ideas). The idea of *Logo* is simple, as a bridge between abstract concepts and concrete things, but the implementation is not as simple as its idea. The teachers as a mediator in this process have to:

> (1)make sure that students are explicitly aware of the strategies and processes that they are to learn (2) discuss and provide examples of how the skills used in *Logo* could be applied in other contexts (3) provide individualized feedback regarding students' problem-solving efforts (4) ensure that a sufficient proportion of instruction occurs in small groups or in one-to-one situations (5) promote both child-teacher and child-child interaction (6) discuss errors and common misunderstandings (Clements & Meredith, 1992, p.1).

Again, the role of the teachers is very crucial here. Teachers needed to create explicit links between the *Logo* activities and other mathematical activities. Moreover, the transfer process takes time. So transfer process is one of the important parts in learning with *Logo* because if this process did not conduct properly, it will lead students into misconception. But this process is not a simple process. We need “a master teacher” who is master on both software and learning theory, in this case is constructivist theory. And also we need teachers who master on transferring process. Since the philosophy of *Microworld Logo* is constructivism which is mean give greater opportunities for student to construct their own knowledge based on their own experiences; it will raise an issue: how much teacher’ intervention in this transfer process?

The last issue is the school curriculum. Most school’s curricula are still based on getting all students through all topics at the same time (Rieber, 2004). This means that the same amount of time given to all of the children to learn, in this case with *Logo* programming, regardless the differences of students’ abilities in programming. Another problem in the curriculum is the time limit; this means teachers have to finish certain topics in a certain limitation of time. On the other hand, teachers and students need a longer time to transfer from *Logo* activities to mathematical concepts because it involves doing something special and extra. Thus the extra time used for the *Logo* activities does not meet the requirements of teaching and learning in such curricula.

CONCLUSION

Even though there is some research about *Logo* achievement and its positive impact on students learning, it is still hard to see the realization of Papert's dream in learning with *Logo*. This might be because of the limitations of *Logo* itself, the resources (human and/or technical resources), and the learning environments that are related with curriculum and schools policies.

Despite the lack of success in gaining the aims, Papert's ideas brought new perspectives in education. He gives inspiration to develop and look deeply into the powerful ways in which computers and educational software might improve teaching-learning processes.

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