

# **Fostering Pre-Service Teachers' Mathematical Thinking and Reasoning by Using TI-Nspire CX Graphing Calculator- A Review of Literature**

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## **Abstract**

This article provides information on the literature review on fostering pre-service teachers' mathematical thinking and reasoning by using TI-Nspire CX graphing calculator. Fundamental of mathematical thinking and mathematical reasoning are discussed in terms of definition and ways that can be done to foster these skills. A few studies were highlighted and suggestions from their studies were also discussed. Previous researches showed that technology helps to improve knowledge and skills and as such, TI-Nspire CX graphing calculator helps students to develop and enhance their mathematical thinking and mathematical reasoning.

## **Introduction**

The ability to think mathematically and to use mathematical thinking to solve problems is one of the important goals in producing skillful future teachers in Mathematics education. Fostering mathematical thinking among pre-service teachers is a new phenomenon in teaching institutions. This is because conventionally, mathematical thinking is fostered theoretically through lectures and practically through calculation write-up during their training. However, it is quite rare when mathematical thinking is nurtured using equipment such as a scientific calculator. 21st century education is geared toward holistic education in which in the context of mathematical education, it is not just about producing those who know how to count but also know how to reason and solve mathematical problems at a difficult level. Hence, it is crucial to foster both mathematical thinking and reasoning in order to produce quality mathematic teachers in the 21st century education.

## **Mathematical Thinking**

Mathematical thinking is a fundamental skill that must be mastered in solving math-related problems. Being able to use mathematical thinking in solving problems is one of the main goals of mathematical teaching (Razzouk & Shute, 2012). Mathematical thinking as defined by (Marcut, 2005), has two main components. The first component includes a set of

skills to process and produce information and beliefs. The second component include habits that are based on intellectual commitment and to use these skills to guide behavior. Mathematical thinking has evolved from the era of Socrates to the era of 21st Century whereby traditional way of learning mathematics has changed to experimental class of learning mathematics to help develop mathematical thinking among the students. Mathematical thinking requires students' efforts to collect, interpret, analyse and evaluate information for the purpose of reaching a credible and valid conclusion (Chukwuyenum, 2013). Chukwuyenum (2013) also suggested the importance of providing more courses which are related to mathematical thinking in teacher education program so that prospective teachers would become models of thinking strategies who in turn will make the subject easier to be understood by the students.

Mathematical thinking is a skill that requires instruction and training. In practicing mathematical thinking in the educational environment, it is important for educators to develop thinking skills among their students. This is because those with critical thinking skills will be able to understanding logical connections between ideas, construct and evaluate issues and identify common errors in reasoning and problem solving systematically. Instruction which supports mathematical thinking uses enquiry techniques that need the students to analyze, synthesize and assess information in order solve math-related problems and to make decision rather than memorizing or repeating information (Ebiendele, 2012). Teaching techniques that lead to memorization provide temporary knowledge that does not support mathematical thinking in terms of content application. Based on Ebiendele (2012), there are several ways that can be done to improve mathematical thinking. One of the ways is to involve students actively in the learning process rather than just relying on lecture notes. As such, mathematical thinking can also be enhanced by focusing on the learning process rather than simply concentrating on the content.

Mathematical thinking skills should be part of student's learning and it should be developed and evaluated by educators through teaching and learning process (Firdaus, Kailani, Bakar, & Bakry, 2015). Using appropriate techniques that can provide students with intellectual experience rather than memory recall could also enhance students' mathematical thinking (Ebiendele, 2012). A study on Developing Critical Thinking Skills of Students in Mathematics Learning which was carried out by (Firdaus et al., 2015) found positive effects on the respondents when they use mathematical learning module based on PBL to enhance the ability of critical thinking skills. The positive effects were seen in three components which involved identification and interpretation of information, information analysis, and evaluation of evidence and argument. The result proved that learning module based on PBL is one of effective methods to develop mathematical thinking skills on those three components. Marcut, (2005) suggest the importance of encouraging critical thinking and solving problems in mathematical education for the development of successful students. Improving student learning through problem solving and mathematical thinking skills and using technology tools to support conceptual understanding and problem-solving methods are now considered to be more appropriate (Kashefi, Ismail, Yusof, & Rahman, 2012). It allows them to overcome mathematical problems needed to solve problems in their field of study.

### **Mathematical Reasoning**

According to Mayer and Wittrock, (2006), reasoning skills are related to problem solving. Solving math-related problems involves the process of reasoning in order to understand conceptual knowledge required. Reasoning allows one to understand

mathematically in an effective way and create meaningful learning (Johnny, Salleh, Halim, Azean, & Mahani, 2015). To solve mathematical problems, including problems that are not routinely used in the classroom, one needs to be able to reason about the problem and calculate the solution to gain a correct answer (Nunes, Bryant, Evans, Gottardis, & Terlektsi, 2015). Based on (Sidenvall, Lithner, & Jäder, 2015) in their study on Students' reasoning in mathematics textbook task-solving, mathematical reasoning exist in all levels of mathematical understanding, assuming that it can be used at all levels of difficulty in solving math-related problems.

It was found that collaboration and discussion among students did not nurture mathematical reasoning among the students since some of them were just copying their friends' answers while doing the textbook task without asking for further mathematical justification. The result proved that textbook task does not help the students to nurture their mathematical reasoning in solving mathematical problems. Kuo, Hull, Gupta, & Elby, (2013) claimed that most studies done by researchers did not focused on how to emphasize the initial conceptual thinking to choose relevant equations and to process mathematic equations to obtain mathematical solutions. It was found that graphing calculator helps to increase the ability of participants to focus on their reasoning and to look back at their answers (Ann, Parrot, & Leong, 2018). In an experimental study involving a graphing calculator in learning probability, it forms a "thinking tool" that allows students to develop their understanding of concepts and ability to solve problems in mathematics (Tan, Harji, & Lau, 2011).

### **Fostering Pre-Service Teachers' Mathematical Thinking and Reasoning using TI-Nspire CX Graphing Calculator**

Many excellent software programs are built for the purpose of education such as Cabri Geometry, Geometer's Sketchpad and Fathom. Graphing calculator has been widely used as a technology tool in mathematical teaching and learning (Leng, Chuen, & Nancy, 2009). The ability of teachers to inculcate students' mathematical thinking and reasoning is an issue of strategic interest (Beverley & Bronwen, n.d.). The use of Graphing Calculator in learning mathematics has become popular as it facilitates in solving mathematical problems. It is small and portable, battery-powered and has multiple line displays where graphing objects can be drawn. It has the ability to plot graphs, solve simultaneous equations, and perform operations with variables (Karadeniz, 2016). Texas Instrument has developed a new model of graphing calculator namely TI-Nspire CX and a few models had been developed. TI-Nspire CX graphing calculator can be considered as one of the latest technology in mathematics area. Among the advantages of using TI-Nspire CX Graphing calculator is its geometry space enabled learners to develop a more intuitive understanding approach which is less algorithmic and this exploration was memorable for teachers and learners (Texas, 2008). Many studies had demonstrated the potential of TI-Nspire CX graphing calculator as a tool in the process of teaching and learning which promotes conceptual understanding and constructivist learning environment. Teachers' findings and research reports which are related to the use of graphing calculator in learning process have shown that it helps to develop and enhance student's conceptual understanding. TI-Nspire CX graphing calculator can help stimulate students mathematical thinking in order for them to engage in mathematical and conceptual structures which is hard to do with traditional approaches (Nor'ain, Rohani, Zah, & Majid, 2011).

Understanding the nature of mathematical thinking gives an idea of what content, skills, and cognitive processes should be fostered in educational settings and how to best promote these competencies (Fisher, Hirsh-Pasek, & Golinkoff, 2012). Topics such as algebra, geometry and calculus can be used as platforms in fostering reasoning skills as well as mathematical thinking (Johnny et al., 2015). As such, the use of TI-Nspire CX graphing calculator in these topics is very helpful to foster pre-service teachers' mathematical thinking and reasoning skills. Active learning in using this handheld device helps teachers to engage students in exploration, focusing on conceptual understanding, and deepening student work with mathematical and scientific models. This will develop students' confidence and encourage them to explore through a variety of problem-solving approaches (Leng et al., 2009). To ensure that mathematics teachers are able to deliver their teaching more effectively and meaningfully, teachers should be prepared with mathematical thinking and reasoning skills and this should be fostered during their teacher training. 21st century education which requires a holistic approaches in teaching and learning process requires pre-service teachers to be equipped with technology that could help them to nurture mathematical thinking and reasoning by providing them with the use of TI-Nspire CX graphing calculator.

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