2016 cohort

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Mathematics Laboratory: Every School Needs One

Students displeasure towards learning maths is on the rise (Nickerson, S.D. et al., 2017) and following reforms in GCSE maths, students achieving a pass grade of 4 have dropped nationally (BBC News, 2017). While some suggest a shortage of Mathematic teachers across the UK is partly responsible (Busby, E., 2018), others call for a nationwide adoption of teaching strategies like the Singapore-style to boost standards (Warrell, H., 2018). One thing is clear, new reforms at GCSE level now require student's mastery of problem solve techniques together with proficiencies in mathematical reasoning. There are currently increased calls for developing mathematical reasoning and problem solving competences in students and experts suggest that teaching mathematics in a meaningful context could be the solution (Sanchal, A. & Sharma, S., 2017). Discussions with colleagues in sciences, suggest that students learn effectively from practical activities and therefore, laboratory lessons are common place. My research investigates the effectiveness of adopting a math laboratory approach as a teaching intervention in developing "mathematics reasoning" and "problem solving" skillsets in students at secondary level.

All three GCSE examination boards have highlighted the increasing number of problem solving questions since the revised new examinations specifications were conducted in 2017 and this is because reasoning is an important tool for everyday life. Tamalene, H. (2010) suggested that reasoning skills of mathematics is a mental process that must be built continuously through the various contexts. Sumarmo, U. (2010) further highlighted that one of the characteristics of mathematics is its emphasis on deductive process that requires logical reasoning and axiomatic, that begins with the inductive process which includes the preparation of a conjecture, a mathematical model, analogy or generalization, through the observation of a number of data. Hence, to building mathematical reasoning in students, this study adopted a number of laboratory style classes instead of the conventional classroom learning style. Students are given a laboratory manual with contain the experimental objectives for the lesson. Students through inductive reasoning work through the tasks, making conjectures and developing data which they reflect on to determine facts from their observations.

Research methods and findings

The study commenced with a pre-intervention session designed to set measurement benchmarks such as, what is measured, how it is measured and in addition, defines the desired outcome for which all results are assessed. In the pre-intervention session, test subjects were shown a series of problem solving questions and asked to grade questions from levels 4 to levels 9 with 9 being the most challenging. A measurement criteria was therefore agreed where student agreed on which graded questions signified improvement in their problem solving and mathematical reasoning skillsets. Once a measurement criteria was defined, students were asked to attempt self-selected graded questions to obtain data on their pre-intervention competencies. With data on their math reasoning pre-intervention competences collected, students attended the math laboratory sessions over a two-week period.

The designed intervention initiated a number of steps to make teaching and learning of math activity-based and experimentation oriented. With a little reorganisation, the classroom and designated learning space was reorganised to engage learning. This lessons demonstrated physical experimental setups like the Pythagoras wheel, probability experiments and geometry experiments on Geogebra where students witnessed mathematical concepts first hand, understanding the mathematical concepts via hands-on or visual activities. Post intervention data were compiled from a compilation of graded questions students could subsequently solve accurately. Follow-up sessions conducted following the completion of laboratory sessions allowed the opportunity to interview all participants and obtained their reflective thought. As a control, 6 students followed the conventional lesson format, completing both pre and post intervention assessments. All ethical considerations for this research were duly considered and all guidelines in accordance with the BERA's ethical guidelines for educational research were adhered to. In compliance, written consents were obtained from all participants.

Findings and Analysis

Pre and post intervention test results was compiled and analyzed using mean, standard deviation and t-test. From the findings, it was observed that the use of math laboratory sessions enhanced the capability of the students to successfully answer higher order self-graded problem solving questions requiring a substantial degree of mathematical reasoning. The result showed that there was significant difference between the effectiveness of conventional teaching method and math laboratory method in teaching mathematics at secondary level. The study recommended that math laboratories are effective initiatives capable of improving mathematical reasoning and problem solving competencies in student. This methodology should be encouraged in schools and adapted to teaching mathematical concepts.

Table 1: Results For Pre & Post Intervention Assessment For Both Experimental And Control Groups

	Groups	N	M	SD	SE_D	*t*-value
Pre-Test	Experimental	11	31.39	9.31	2.14	0.03[1]
	Control	11	31.32	9.20		
Post - Test	Experimental	11	54.93	13.86	3.2	3.44[2]
	Control	11	43.95	14.30		

[1] Not Significant with *df* = 20 & t-value at 0.05 level= 1.99

[2] Significant with *df* = 20 & t-value at 0.05 level= 1.99

The result showed that there was significant difference between the effectiveness of conventional teaching method and math laboratory method in teaching mathematics at secondary level. The study recommended that math laboratories are effective initiatives capable of improving mathematical reasoning and problem solving competencies in student. This methodology should be encouraged in schools and adapted to teaching mathematical concepts.

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