The Impact of the Mathletes Training Program on the Math Achievement and Self – Concept of Students

Asia Pacific Journal of Multidisciplinary Research
Vol. 5 No.2, 131-138
May 2017
P-ISSN 2350-7756
E-ISSN 2350-8442
www.apjmr.com

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Date Received: January 18, 2017; Date Revised: April 27, 2017

Abstract - *An intervention program for the academically at risk students is usually given by every school. However, little attention is given to the talented and gifted students. Hence, a Mathletes Training Program was initiated by the University of San Carlos, Basic Education Department – South Campus, Cebu City, Philippines during school year 2015-2016, to expose the students to advance Mathematics and to bring their mathematical knowledge alive through participating in inter-school competitions. This descriptive study sought to evaluate the program's effectiveness after a year of implementation using 100 randomly selected Mathlete respondents. The findings revealed that the Mathletes considered the program highly effective ($\bar{X}$ = 3.85); there was a significant increase on their grades in Mathematics (t (99) = 2.828, p<.05) and an increase in their self-concept (t (99) = 8.156, p<.05).The studyprovides evidence that meaningful learning activities that engage the learners in interactions, collaborations, critical thinking and problem solving bring students' achievement to a higher level. The Mathletes also were transformed to become more confident, and interested and had fun learning Math.*

Keywords: *Mathletes Training program, Mathletes, grades, self-concept, impact, descriptive study*

INTRODUCTION

An educational institution is considered "good" if it follows the standards of quality education in terms of curriculum and instruction, assessment, facilities, community extension services and extra and co-curricular activities. Part of the activities that develop students academically are the intervention programs such as coaching, tutorial or remedial programs; or enhancement programs such as the Mathletes Training Program for the bright and the gifted students. Research evidences showed that these programs elevate students' success. Lubinski [1] mentioned that longitudinal studies of students with gifts and talents indicate that accelerated students who participate in talent search activities or other outside of school competitions achieve exceptional success and report high career and life satisfaction. In the same manner, Gavin Casa [2] - [3] also stressed that students who received a challenging math curriculum that focused on problem solving outperformed a comparison group of students of like ability from the same school.

In Susan's [4] article, the author articulated that students with gifts and talents are different in their strengths and needs. For instance, talented students in mathematics may exhibit a set of characteristics that may be different from those of students who have talents in English language arts. Moreover, Miller [5], "mathematical talent refers to unusually high ability to understand mathematical ideas and to reason mathematically, rather than just a high ability to do arithmetic computations or get top grades in mathematics."

It is important to note that students who achieve the highest test scores or receive the highest grades in mathematics class may NOT necessarily be highly talented in mathematics. As observed by the researchers, some of the mathematics programs in schools are too procedural; it focuses more on the development of computational skills and provides little opportunity for students to demonstrate the complex types of reasoning skills. This poses then a challenge to educators to spot students who are truly mathematically talented to help them hone develop it and not to waste such gift. Once these students are correctly identified, then it is good to provide them with an enrichment program that develop their potential and at the same time cater to their needs as students.

However, some schools focus more on the intervention programs for academically at risk or low performers rather than on the enhancement programs of the mathematically gifted. According to Glenda Lappan [6], the 2000 President of National Council of Teachers of Mathematics (NCTM) in her article "'Mathematics for All' Must Include High-Ability and Highly Motivated Students":

> "Our primary goal must be mathematical power for all students. We speak often about providing rich opportunities for disadvantaged students. But among the students we have in our mathematics programs are some that have either high abilities or high interest, or both. Our programs must include opportunities for these students as well. These students are likely to become significant users of mathematics as our future scientists, mathematicians, statisticians, engineers, technologists, and researchers. They deserve programmatic attention just as students with other kinds of special needs do."

Hence, the University of San Carlos, South Campus, Cebu City, during school year 2015-2016, had initiated a Mathletes Training Program for the talented and gifted students in Mathematics who wanted to hone their skills in Mathematics and join outside-school competitions. This exposes the students to a variety of topics beyond the general education curriculum.

Moreover, they were given small group activities in areas of cognitive and affective training; how-to-learn skills; imparted advanced research skills and provided reference materials; developed written, oral, listening and visual communication skills. They were also exposed to quiz bowl or team competitions to gain experience on the set of problems and on techniques and time management.

The training program culminates in a 2-day Math Camp where they do hands-on and minds-on activities that aimed to engage them to think mathematically while applying real – life Mathematics. This activity provided them the 'beyond the standard' curriculum. Exposure to more complicated situations in the form of collaborative games were given. The idea of camping following some of its routine activities were performed to train and develop the lifelong learning skills of the students. These exposures to challenging activities supported what Rusczyk [7] have said about the gifted students:

"…avid students are better off learning how to take tools they have and apply them to complex problems. Then later, when they learn the more advanced tools of curricular education, applying them to even more complicated problems will come more easily to them"[7].

The other factors considered in this study are the self-concept and math performance of the Mathletes referring to the students of this training program. Self-concept refers to the belief, general notion or idea of oneself relative to mathematics learning [8].

Marsh and Craven [9] maintained that "enhancing a child's academic self-concept is not only a desirable goal but is likely to result in improved academic achievement as well" (p. 155). The anticipated improvement of student performance is based on the existence of a reciprocal relationship between self-concept and academic achievement [10]. Self-concept is an important construct in education because of its relationship to academic achievement [11]-[12]. Nonetheless, a general self-concept might not be solely confined in the academic orientation [13] "Recent research has shown that better student achievement leads to improvement of self-concept, and that positive self-concept can also help increase student achievement [14]- [15].

Meanwhile, empirical investigations in comparative education did not produce conclusive findings in a multicultural context. Wilkins, Zembylas, and Travers [16] analyzed international data from the Third International Mathematics and Science Study (TIMSS), and reported a positive relationship between self-concept and mathematics achievement for 16 different countries.

Hence, the researchers considered it important to know the level of self-concept of Mathletes on their math abilities before and after the training. The result can help them grow in self-knowledge as they face the challenges of the new enhanced K to12 Basic Education Curriculum especially in choosing their different career tracks.

OBJECTIVES OF THE STUDY

The main aim of this study is to evaluate the impact of the Mathletes Training Program of the University of San Carlos, Basic Education Department – South Campus, Cebu City, Philippines, during the school year 2015 – 2016. Specifically, this study aims to determine the level of effectiveness of the program

from the point of view of the student mathletes; to test the significant difference of the mathletes' grades during the grading periods with and without mathletes training and to test the significant mean difference of the self-concept of the Mathletes before and after the training program.

Hypotheses

This study hypothesized that the level of effectiveness of the Mathletes training program is high. Moreover, there is a significant increase in the academic performance of the Mathletes in terms of their Grade Point Average (GPA) during the grading periods with training; and a significant increase in their self-concept after the training program. It further hypothesized that students who are given the opportunity to participate in the Mathletes program benefit from the program.

Theoretical Framework

This study is anchored on the theories of Constructivism, Vygotsky's Zone of Proximal Development and Bandura's Social Learning Theory.

Constructivist theory and Lev Vygotsky's Zone of Proximal Development

Jean Piaget's constructivism articulates a mechanism by which knowledge is constructed and internalized by learners. He explained this through the process of accommodation and assimilation where learners construct their own knowledge from their experiences. Constructivism describes how learning should happen and that it is so much related to John Dewey's learning by doing.

As students experienced the Mathletes training, it is presumed that they would have acquired specific skills such as creativity, collaboration, computing, and critical thinking which are crucial in constructing new knowledge. During the training they were engaged and challenged through performing differentiated activities. This is in congruence to the principles of the constructivism.

According to Brownstein [17], "learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their current level of mastery. This will motivate them to build on previous successes in order to enhance their confidence."

This is in line with Vygotsky's [18] zone of proximal development (ZPD) which refers to the difference between the actual developmental level (as determined by independent problem-solving) and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers).

In the training conducted, the Mathletes were engaged to challenging and more complex tasks that they don't normally do inside the classroom such as the inter-level and interschool quiz bowls. They were guided by an adult like the teacher-trainer. In this way, they feelownership of their own learning in the end.

Vygotsky[18] is strongly supported by many theorists who advocates that social interaction plays a fundamental role in the development of cognition. Bandura [19] states that "full cognitive development requires social interaction."To support Bandura's idea, the conversation theory of G. Pasks as cited by Scott [20] explains that learning occurs through conversations about a subject matter that serves to make knowledge explicit. The critical method of learning according to conversation theory is "**teach-back**" in which a person teaches another what he has learned. It applies to the learning of any subject matter.

Albert Bandura's Social Learning Theory

Albert Banduras' [19] social cognitive theory has a bearing in this study especially on social efficacy. According to him, "Social efficacy is the sum of all personal judgments that humans make about how well they will perform in situations that are ambiguous, unpredictable, and/or stressful. In other words, self-efficacy is a person's belief in his or her ability to perform."

Bets and Hackett [21] define Mathematics self-efficacy as beliefs about one's ability to perform mathematical tasks. Positive belief on oneself towards mathematical tasks lessen the idea that math is a difficult and complicated. The more interested students are in math, the higher the achievement they may possibly attain.

This theory has bearing to the present study since this theory viewed learning a social activity in which people should connect to other people such as teachers, peers and family. This means that in any training program like the Mathletes, interactions with others and collaborations are an integral aspect of learning which eventually led to students' social and cognitive development.

Limitations of the study

The study is limited to the student Mathletes of the University of San Carlos, Basic Education Department – South Campus in Cebu City,

Philippines, who were enrolled in the academic year 2015 – 2016. There were 120 Grade school Mathletes and 91 Junior High school Mathletes for a total of 211. From the total respondents, only 50 students were selected from the Grade school and another 50 students from High school through random sampling. The respondents' grades in Mathematics ranged from 80 to 94 from first to fourth grading. The impact of the training program, the self-concept and the Math academic performance of the Mathletes were the only variables considered in the study.

METHODS

The researchers utilized the descriptive method to determine the impact of the Mathletes Training Program in terms of the program implementation, the self-concept and the grades in Math of the 100 randomly selected grade school and junior high school Mathletes undergoing the training.

Table 1. The Respondents of the Study

Level	Mathletes Population	No. of Respondents	(%)
Elementary (Grades 1 - 6)	120	50	41.67
Junior High School (Grades 7-10)	91	50	54.95
Total	211	100	47.39

The study was conducted at the University of San Carlos, Basic Education Department –South Campus, Cebu, Philippines, during school year 2015-2016. The school is a private sectarian institution managed by the Society of the Divine Word (SVD) priests. It is the only level 3 institution in Cebu City accredited by Philippine Accrediting Association of Schools, Colleges and Universities (PAASCU).

Research instrument

In the conduct of the study, the researchers designed an evaluation instrument for the Mathletes Training Program to measure the level of effectiveness of the Training Program from the Mathletes perspective. This research instrument was pilot-tested previously for fine-tuning and to ensure its validity and reliability. Gagani and Bonotan [22] details the processes in designing and validating the instrument in a separate research article.

The Mathletes Training program Evaluation Tool consists of two (3) parts:

Part I - It evaluates the program implementation in terms of (a) program objectives (b) processes of selection of Mathletes, (c) resources, (d) time schedule and venue, (e) training fee, (f) activities and (g) the characteristics of the trainers of the enhancement program using a 25-item Likert-type 5-point scale. The weighted scale labels are as follows: very high impact (4.21 – 5.00); high impact (3.41 – 4.20); average impact (2.61 – 3.40); low impact (1.81 – 2.60); very low impact (1 – 1.80).

Part II– It measures the self-concept of the Mathletes through a 12-item semantic differential scale. Self-concept of Mathletes refers to the perceptions of the student Mathletes toward self and others before and after joining the training program.

The tool allows the respondents to rate their feelings from greatest to least (5 to 1) that corresponds to positive or negative feelings towards self and others. The total scores were collected, encoded and then analyzed using Statistical Package for the Social Sciences (SPSS) software version 16.0.

The weighted scale labels are as follows: very high self-concept (4.21 – 5.00); high self-concept (3.41 – 4.20); moderate self-concept (2.61 – 3.40); low self-concept (1.81 – 2.60); very low self-concept (1 – 1.80).

Aside from this instrument, the grades of the Mathletes were also taken from the class record of the teacher-trainers. The grades from first to fourth grading were analyzed by separating the grades of the grading periods with and without Mathletes training. The first and fourth grading grades were considered without Mathlete Training Program while the second and third grading have Mathletes training.

The researchers wrote a letter to the principal, explaining the study and asking permission to access the Math grades of elementary and Junior High School students for the use of the evaluation study. After obtaining the approval, the data taken were kept under lock and key at the coordinators' office for safety and confidentiality.

RESULT AND DISCUSSION

Based on the findings**,** the **objectives** of the program were all met with high ratings and that, through the Mathletes Training Program, the students get to consider mathematics as enjoyable and fun ($\bar{X}$ = 4.36).

Table 2. Impact of the Mathletes Training Program

Mathlete Training Program	**Mean**	**Description**
1. The training program provides the basic knowledge in mathematics.	4.59	High Impact
2. The program offers opportunities to master the basic competencies.	4.11	High Impact
3. The training sessions helps me to explain mathematics to others.	4.11	High Impact
4. The training sessions makes me realize that mathematics is enjoyable for all.	4.36	**Very High Impact**
5. There is a need for orientation in the training program.	3.69	High Impact
6. The qualifying exam is the best way to select the members for the program.	3.63	High Impact
7. The number of training sessions (10 sessions) is enough for the training.	3.00	Average Impact
8. The allotted time of 2 hours is enough to learn advanced math skills.	3.24	Average Impact
9. The second quarter to third quarter schedule of the training is sufficient.	3.39	Average Impact
10. The classroom is the right venue for the training.	3.74	High Impact
11. There is a maximum participation of the members during the 10-session training.	3.57	High Impact
12. The inter-level Quiz Bowl is an effective mental activity.	3.70	High Impact
13. The inter-School Quiz Bowl is one of the most memorable experiences.	3.97	High Impact
14. Joining the training program opens opportunities for outside competition/participation.	4.27	**Very High Impact**
15. The Math Camp is the most awaited event of the training program.	4.46	**Very High Impact**
16. The Math Camp is the appropriate way of culminating the training program.	4.11	High Impact
17. The venue of the Math Camp is suitable to the grade school and high school.	3.82	High Impact
18. There is nothing wrong with the time schedule of the culminating activity.	3.86	High Impact
19. The activities of the Math Camp are well thought of.	3.97	High Impact
20. The materials used in the Math Camp are good enough.	2.33	**Low Impact**
21. There is a **maximum** participation of the members during the Math Camp.	3.46	High Impact
22. The training fee is worth it for the 10-session training program.	3.62	High Impact
23. The teacher demonstrates a genuine interest in teaching/training the student.	4.32	**Very High Impact**
24. The teacher provides materials (worksheets, photocopies of sample problems) to students during the training sessions.	4.20	High Impact
25. Overall, the training program is effective.	4.44	**Very High Impact**
Over-all Mean Rating	**3.85**	High Impact

With regards to the selection processes, the qualifying exam and orientations were also rated high. That is, Mathletes agree that as Mathletes of the University, there is a need for them to pass an entrance exam since this is an enhancement program intended for outside school competitions. As to the time schedule, they were all neutral and rated 2 hours, 10 training sessions and second to third quarter implementation as enough enhancement schedule. With respect to the venue, the classroom was rated high ($\bar{X}$ = 3.74).

As to the activities of the training, the Mathletes rated them as high. This means that they agree that inter-school, inter-level quiz bowls and other activities of the program are really an effective mental activity and thus motivate them to give their maximum participation in every Mathletes sessions. The culminating activity which was the Math Camp was rated high too. They all agreed that Math Camp is the most appropriate way to culminate the training program and that the venue was just suited to the Grade school and Junior High School Mathletes. However, it can be seen that the only item that was rated low ($\bar{X}$ = 2.33) was the provision of materials during the Math Camp.

With regards to the training fee and the provision of the materials from the teacher-trainers, it was rated high impact which means that it's just enough.

Lastly, the thing that really contributed to the impact of the program was the attitude shown by the teacher-trainers. The teacher demonstrated a genuine interest in teaching/training the students for them to learn and to enjoy Mathematics. The performance of the teacher-trainers was Very High Impact ($\bar{X}$ = 4.32) which contributed to an Over-all Highly Impact ($\bar{X}$ = 3.85) of the Mathletes Training program.

Table 3 presents the impact of the Mathletes training program to the academic performance of the 100 randomly selected students' mathletes was examined by getting their grades.

Table 3. Mathletes' Grades during the grading periods with and without Mathletes' Training

Grade School Academic Performance	Mean	Md	SD	SDd	t	p-value	Interpretation
W/ Training	90.38	0.38	2.656	1.413	1.902	0.063	No significant Increase
W/O Training	90.00		2.407				
Junior High School Academic Performance							
W/ Training	87.66	0.7	2.89	2.306	2.147	0.037	**Significant Increase**
W/O Training	86.96		2.899				
Totality							
W/ Training	89.02	0.54	3.081	1.909	2.828	0.006	**Significant Increase**
W/O Training	88.48		3.06				

Grade school (n = 50) Junior High School (n= 50) , significant if p value(one-tailed) < 0.05

The grade school students during the grading periods with Mathletes Training ($\bar{X}$ = 90.38, SD = 2.656 and without the Mathletes Training ($\bar{X}$ = 90, SD = 2.407) and the Junior High School's grades with Mathlete Training ($\bar{X}$ = scores 87.66, SD = 2.890) and without Mathlete Training ($\bar{X}$ = 86.96, SD = 2.899) were determined. Differences were computed by subtracting each mean score during the grading periods with and without Mathlete Training. An informal analysis of the distribution of these scores using a histogram and Q-Q plot revealed no serious threats to the assumption of normality. A t-test for paired samples showed the difference between the means was not significant to the Grade school, t (49) = 1.902, p >.05 but significant to the Junior High, t (49) = 2.147, p <.05.

In totality, the Mathlete training program with t (99) = 2.828, p<.05 is statistically significant to the academic performance of the students. This means that the training program did really enhance the overall academic performance of the students. However, knowing that the overall relationship was significant did not tell whether this effect is strong or weak. Thus, there is a need to determine the strength of the statistical significance which is measured through its effect size. The effect size as measured by d was .2828, a value corresponding to a modest effect. The modest effect size correspond to a low reliable effect on the academic performance of the student Mathletes. Maybe because of the limited time schedule and the students need more sessions in order to increase the deviations of their grades.

In addition, these students also had already obtained high grades in Math at the start as evidenced by passing the qualifying exam. They were already performing well in the subject and just joined the training in order to enhance their skills and to enjoy Mathematics as well. Furthermore, the k -12 curriculum's grading system is averaging and one of its grading component is the performance task which comprised the 40% of the grades. This Performance Task (PT) may affect their grades.

The increase in the self-concept of the Mathletes after the training is a reason of joy since positive outcome is always the target of any intervention programs. As shown in Table 4, the Mathletes Training Program (MTP) created a positive effect in the self-concept of the Grades school before ($\bar{X}$ = 47.18, SD = 8.295) and after ($\bar{X}$ = 51.48, SD = 7.418) the training program.

Table 4. Mathletes' Self -Concept Before and After the Training Program

Grade School Self - concept	Mean	Md	SD	SDd	t	p-value	Interpretation
BEFORE Training	47.18	4.3	8.295	6.444	4.719	**0.01**	**Significant Increase**
AFTER Training	51.48		7.418				
Junior High School Self - concept							
BEFORE Training	40.96	10.3	8.624	1 0.098	7.213	**0.01**	**Significant Increase**
AFTER Training	51.26		8.189				
Totality							
BEFORE Training	44.07	7.3	8.979	8.95	8.156	**0.01**	**Significant Increase**
AFTER Training	51.37		7.774				

Grade school (n = 50) Junior High School (n= 50) , significant if p value(one-tailed)< 0.05 the perceptions of Mathletes towards themselves and others using a paired sample t – test

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com
Asia Pacific Journal of Multidisciplinary Research, Vol. 5, No. 2, May 2017

The same positive effect was also seen with the Junior High school students before ($\bar{X}$ = 40.96, SD = 8.624) and after ($\bar{X}$ = 51.26, SD = 8.189) the training program. Using a t-test for paired samples, the difference between the means was significant to the Grade school, t (49) = 4.719, p <.05 as well as to the Junior High school, t (49) = 7.213, p <.05.

In sum, there is a significant increase in the self – concept of the Mathletes with t (99) = 8.156, p<.05 before and after the training program. The effect size or the strength of the statistical significance value as measured by d was 0.82 which correspond to a very strong reliable effect. This puts into fore that the training program had helped improve the Mathletes' view about themselves and their capacity in Mathematics. It also shows that the more the students are engaged to a series of enhancement activities, the more chances of self-improvement. Through the training, they have developed not only their mathematical skills but also their social intelligence. Indeed, the social-cognitive theory of Bandura had been confirmed that once the students enjoy and find the activity interesting and meaningful, then there is no reason that learning that is stored in long-term memory cannot be attained. Constant interactions and collaborations with other Mathletes had also improved the way students perceived about themselves. They were also observed by mentors to have become happier, confident, satisfied, active, energetic, friendly, cooperative and optimistic toward self, others and Mathematics.

CONCLUSION AND RECOMMENDATION

In conclusion, the Mathletes Training Program has high positive impact on the mathletes. It also significantly improved their academic and self-concept or confidence of the students. They had learned a lot in the trainings as well as enjoyed Mathematics. This confirms that even if Math presents an unusual difficulty both to learn and to teach due to its abstract nature, then it is still possible to learn and enjoy the subject if taught creatively and meaningfully. The conclusion confirmed constructivist theories that if a student find meaning to what he is doing and has made significant connections to real life, then he eventually construct his own knowledge that can contribute to a more long lasting learning. In addition, the students frequent exposures to meaningful and enjoyable learning environment proved to develop self-concept of students which is an important factor in increasing math performance.

It is therefore recommended that any school may consider offering a similar program especially to the coming senior high schools who will be taking Science, Technology, Engineering and Mathematics (STEM) track in the K to 12 Curriculum. It is but fitting for them to hone their skills and expose them to a more rigid training to learn and have fun.

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