yourMathsCorner: A blog-based approach to learning prerequisite mathematical knowledge at the tertiary level

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***Abstract*—** Over the decades, the imparting of knowledge by teachers has always proven to be challenging. Research in teaching is playing a key role in coming up with more effective approaches to imparting knowledge to students. In the past decades, research in education has proposed various approaches to enhance the teaching / learning process, such as a social constructivist approach, a cognitive approach, a community approach, and a project-based approach. In the Caribbean, the traditional teaching approach to imparting knowledge, i.e., chalk and talk, continues to be used. This paper examines the challenges faced with the teaching of 1st year Mathematics students at the diploma level in a tertiary institution in the Caribbean. A cost effective approach is used to illustrate the teaching of mathematics to 1st year students. In the first phase of this project, the need to teach pre-requisite Mathematics to 1st year diploma students is addressed. The paper highlights the benefits of collaborative learning which stimulates students to think. A virtual classroom provides the opportunity for a student to explain to others thus performing the role of a teacher. This enhances the student's skill of communicating his ideas. An additional benefit of the virtual classroom is that a student is not restricted to learning only at the scheduled classroom hours. The success of the first phase of the project was highlighted by improved student academic success and better self-esteem.

***Keywords*—** blog, community learning, collaborative learning, virtual classroom.

I. Introduction

In the Caribbean, students do not like mathematics because it is hard [13]. The teachers often complain that the syllabus is too large hence the delivery of material is directed by the allocated teaching time. The method of delivery used is the traditional approach of 'chalk and talk'. A study [9] carried out in the Caribbean highlighted that computer technology (CT) is needed in secondary schools because of its benefits for both students and teachers and to stimulate interest, motivation and improvement in students' performance. The study concluded that the use of CT in the teaching of Mathematics should be further researched, based on the positive results obtained in the students' performance. However, research in the Caribbean is limited by the lack of available funds. In this paper, an inexpensive approach to teaching foundational knowledge will be presented..

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II. Problem formulation

The motivation behind this research was triggered by an unusual result of 1st year diploma Information Communication Technology (ICT) students at the University of Trinidad and Tobago (UTT). These students were given a quiz based on foundational knowledge of mathematics. Examples of the questions are as follows: determining gradient and y-intercept from a straight line graph and also solving simple one variable expressions. More than 80% of the students failed the quiz. This meant that teaching mathematics to the 1st year diploma students based on the syllabus was going to be an almost impossible task, given the extremely weak background of the students. In addition to this, the students were not very responsive. This meant that identifying what were the problems being experienced by the students would be difficult. The students were able to state that the equation of a straight line is $y = mx + c$. However, using a straight line graph to read off values on the graph posed great difficulty. On the algebra side, the student demonstrated lack of conceptualization of what is an unknown or variable. A study undertaken by Cai [7] has shown that most students know the mechanism of "adding all together and dividing" which constitutes the simple average calculation algorithm. However, only some of them were able to find an unknown value in a series of data where the average is known. Also [16] has shown that due to different biographical or cultural backgrounds or simply due to different ways of thinking, students often have different strategies, concepts, attitudes and beliefs. This can assist in understanding the reasons why students' level of fundamental knowledge varies so vastly. This project attempted to address the problem of conceptualizing of mathematics.

A. Teaching Approach

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B. Teaching in the Caribbean

In the Caribbean, the teaching of mathematics in secondary schools also poses a great challenge. In Trinidad and Tobago, a recent survey done in 2006 on the teaching of mathematics in the secondary schools was conducted by the National Institute for Higher Education, Research, Science, and Technology (NIHERST). Some of the interesting results published [14] from this survey were that only 28% of the mathematics teachers held a first degree in Mathematics, the traditional 'chalk and talk' method of teaching is still used, and all the teachers complained that time was not adequate to teach the syllabus. With respect to the students, 97% agreed that lots of hard work and studying at home was necessary to do well in mathematics. 93% of the students indicated that teachers used textbooks to teach mathematics and the teachers frequently showed them how to do mathematics problems. The report highlighted that the highest percentage of teaching time was spent on algebra which was identified as the most difficult area of the mathematics syllabus.

Another study carried out in the Caribbean concluded that there is a mis-match of purposes in the classroom [13]. Teachers have a structured approach to teaching which leads to students often learning less. Hence, gaps were made or further widened as teachers were not necessarily always meeting students where they were. The starting points of the teaching to the learning were sometimes so different that students could not make the connection [5]. Another study by Clarke [9] investigated the experience and perceptions of the secondary school mathematics teachers in the English-speaking Caribbean. The use of CT in the mathematics instructional practices was investigated and the identification of factors that were necessary for a successful integration of CT in mathematics instruction. Based on the result of the students' performance, the study concluded that it is evident that the teachers' conscious effort to move away from the traditional "chalk and talk" approach to a learner-centered approach did lend itself to genuine positive progress in using CT.

C. Tertiary Education

After secondary school, students decide what is their next step to higher education, considering options such as going on to the diploma level or the BSc level. The concept of an individual self-efficacy [18] to be used in helping students examine themselves in determining what programme is more suited to them (diploma or BSc). Self-efficacy uses "people's judgements of their capabilities to organize and execute courses of action required to attain designated type of performance" [3]. This personal cognition has been applied within the field of educational research [15] and is conjectured to be oriented around four core concepts: performance experiences, vicarious experiences, verbal feedback and physiological and effective states. The pilot study [18] concluded that on average students who were admitted to the BSc courses have better previous experiences of mathematics than diploma students. It was highlighted that these experiences were not based on qualification gained. The author concluded that diploma students often lack confidence and some basic mathematics skills.

III. PROBLEM SOLUTION

The above issues were taken into consideration when developing the selected test problem set. The test problem set was a set of diploma students who had an extremely high failure rate as mentioned above. The purpose of this project was to find an inexpensive, simple, reliable, comfortable approach to motivate and help these students conceptualize their background knowledge. An innovative approach to teaching these students was developed and tested during the first semester of the 2007/2008 academic year (Sept. – Dec., 2007). The explicit confrontation of the individual way of a student's thinking offer different approaches which lead to different mathematical concepts can result in interesting amplifications of perspectives [16]. This project was called yourMathsCorner, (YMC) project. In implementing the YMC project, two major constraints had to be considered, teaching-time constraint and varying student learning curves. The method employed to alleviate the teaching-time constraint was to use CT and create a virtual classroom. Research has shown that teachers who have a spectrum of attitudes such as fear of possible failure because of a lack of knowledge of the technology, and skepticism toward technology, gradually changed towards an appreciation through classroom experience that convinced them of the positive benefits technology has to offer as a problem-solving tool [1]. In a similar manner, the assumption taken was once the student was convinced of the benefits, they would be willing to use the technology.

A. Constructivism Approach to Teaching

The YMC was designed based on various approaches to the teaching of mathematics. The fundamental approach of the

YMC is the constructivism approach. In recent years, a lot of research has focused on this approach to teaching. Ernest [11], in his description of the many schools of thought of constructivism, suggests the following implications of constructivism which derive from both the radical and social perspectives:

- sensitivity toward and attentiveness to the learner's previous constructions;
- diagnostic teaching attempting to remedy learner errors and misconceptions;
- attention to metacognition and strategic self-regulation by learners;
- the use of multiple representations of mathematical concepts;
- awareness of the importance of goals for the learner, and the dichotomy between learner and teacher goals;
- awareness of the importance of social contexts, such as the difference between folk or street mathematics and school mathematics (and an attempt to exploit the former for the latter).

The problem set of the YMC having such a high failure rate can be as a result of some of Ernest's school of thought. The students' misconceptions in their mathematical concepts had to be identified. The solution must encourage the student to express their mathematical concepts in as many ways as needed using his/her own manner of communicating. The important goal was that the student should understand the correct mathematical concepts.

B. The Virtual Classroom

YMC attempted to resolve the problem of the students' lack of confidence and mathematical knowledge by making the student become the teacher of a virtual classroom. This approach could actually build the confidence of the student in his learning of mathematical concepts as well as build confidence in himself.

YMC used a web log (often called blog), to create the virtual classroom. A number of blogs has already been used for teaching purposes. Most of the approaches using blogs for teaching involve each student setting up a personal blog and using it as an online diary to express course content. Each student is normally instructed to make entries in each other's blogs. YMC uses blogs as a means of forming a learning community among the students with the weak mathematical knowledge.

C. Web Logs in the Teaching Approach

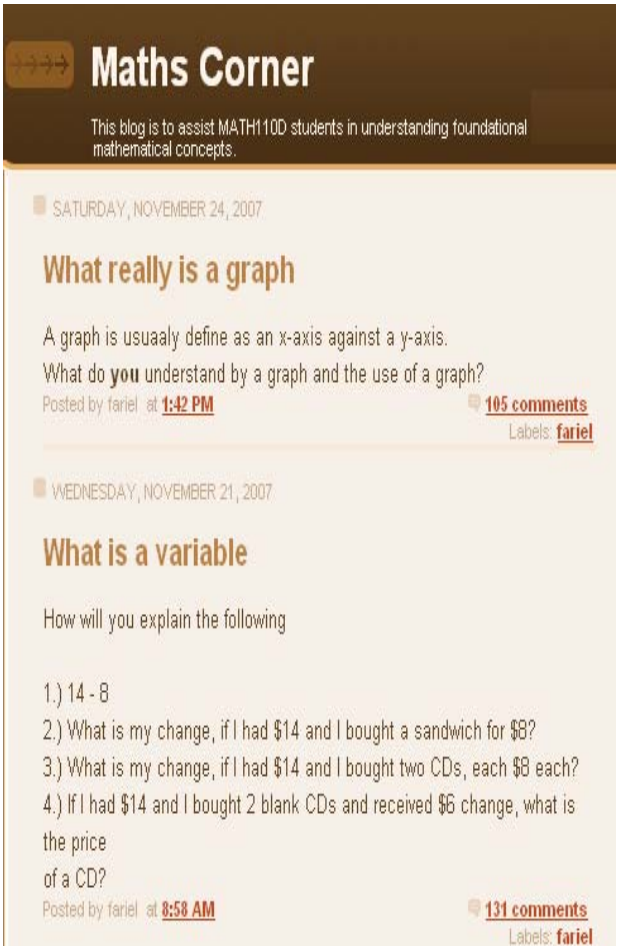
The use of web logs (blogs) in teaching is certainly not a new approach in teaching. The ability of students to easily maintain online diaries can encourage discussion and definitely improve writing skills. In addition, blogs can promote collaboration [12]. Blogs also encourage students to write and knowing a larger audience can be reading their blogs further develops critical thinking skills [4]. The benefits of using blogs in teaching in a study carried out by [10] concluded that using blogs across disciplines can enhance liberal learning. In these approaches of using blogs, each student maintains her own blog.

What then is different about the use of blogs in YMC and why weren't the blogs used as in the above mentioned approaches? The answer to these questions is a common virtual classroom needs to be established and the students' lack of confidence has to be addressed, their mis-conception and lack of basic knowledge is a critical issue. The virtual classroom is one blog that the students and the teacher share. Only one blog has to be maintained. Each student registers to the virtual classroom under a display name that is unknown to anyone except the instructor. With the comfort and assurance of hiding behind an unknown identity, students were able to express their views, doubts, mis-conceptions, questions, and problems. The instructor played the important role of directing the students into deeper thinking about a range of mathematical concepts.

This project had 5% of the final mark of the course allocated to it. This was to initially attract the students to get involved in the project. The students' comments had to be in one of the following categories: explanation in his own words, a question, a correction or an illustration. The comment should cause a response from the other students thus causing a virtual dialog. In this manner, a student can take on the role of a student, a teacher, or a motivator. When a student comments on his/her understanding of a given topic, it allows others to respond to that comment. Additionally, responding to a comment and trying to explain the correction of a comment really helps a student to understand thoroughly. This approach to learning allows the student to feel competent and responsible in teaching her peers and this will have the additional advantage of boosting her motivation to learn and will enhance her self-esteem. It has been established that intrinsic motivation is connected with the application of more effective deep level processing strategies [17]. These opportunities made students feel competent from this cooperative learning approach especially for the students who did not have positive experiences of competence. Some researchers claim that student perceptions of their competence in an area provide key ingredients to their self-concepts [6].

D. Types of Problems

The types of problems that were used in this project were based upon some fundamental pre-requisite knowledge in mathematics that was required to teach the 1st year mathematics course at UTT. The two topics that were concentrated upon were solving simple equations and graphs. The approach used was as follows. The instructor would post a blog title with some questions. The students were then allowed to answer the questions, provide illustrations based on the questions posted, or ask related questions. Fig. 1 below shows a screen shot of a question posed by the instructor together with responses by the students.



Maths Corner

This blog is to assist MATH110D students in understanding foundational mathematical concepts.

SATURDAY, NOVEMBER 24, 2007

What really is a graph

A graph is usuaaly define as an x-axis against a y-axis.
What do **you** understand by a graph and the use of a graph?

Posted by fariel at 1:42 PM — 105 comments
Labels: fariel

WEDNESDAY, NOVEMBER 21, 2007

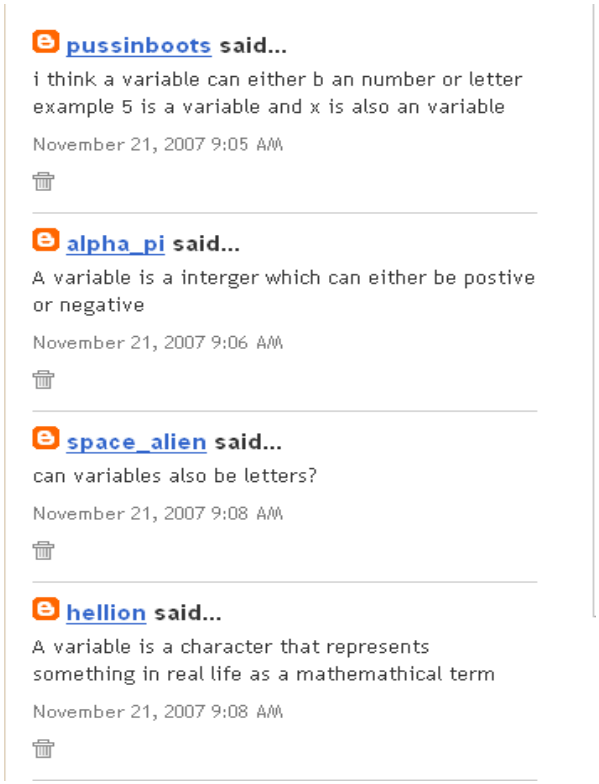
What is a variable

How will you explain the following

1.) 14 - 8
2.) What is my change, if I had $14 and I bought a sandwich for $8?
3.) What is my change, if I had $14 and I bought two CDs, each $8 each?
4.) If I had $14 and I bought 2 blank CDs and received $6 change, what is the price
of a CD?

Posted by fariel at 8:58 AM — 131 comments
Labels: fariel

It can be seen that 131 comments were posted to the question, What is a variable? These comments came from 23 students. Some examples of the students' comments are shown below in Fig. 2.



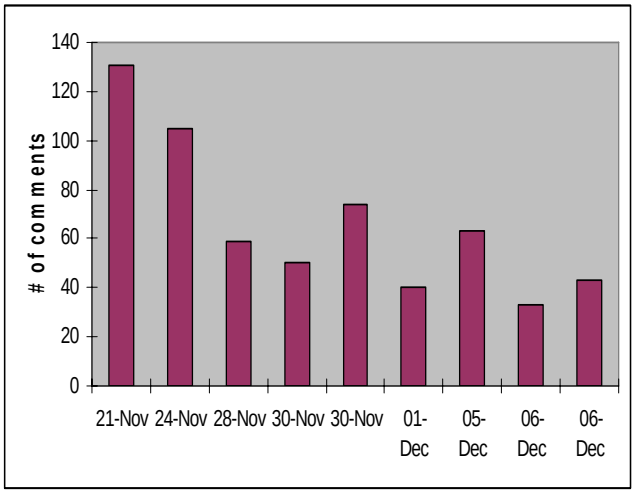
pussinboots said...
i think a variable can either b an number or letter example 5 is a variable and x is also an variable
November 21, 2007 9:05 AM

alpha_pi said...
A variable is a interger which can either be postive or negative
November 21, 2007 9:06 AM

space_alien said...
can variables also be letters?
November 21, 2007 9:08 AM

hellion said...
A variable is a character that represents something in real life as a mathemathical term
November 21, 2007 9:08 AM

The students' comments were monitored by the instructor. The instructor read all the comments by the students and then determined if the students understood the topic or if they needed more questions on the same topics. The project was undertaken during the period November 21st – December 6th, 2007. In that period, the instructor posted nine questions. The responses to these postings by the students are shown in the graph below.



On the dates shown in the graph above, the following topics were posted.

21-Nov	What is a variable?
24-Nov	What really is a graph?
28-Nov	Features of a graph?

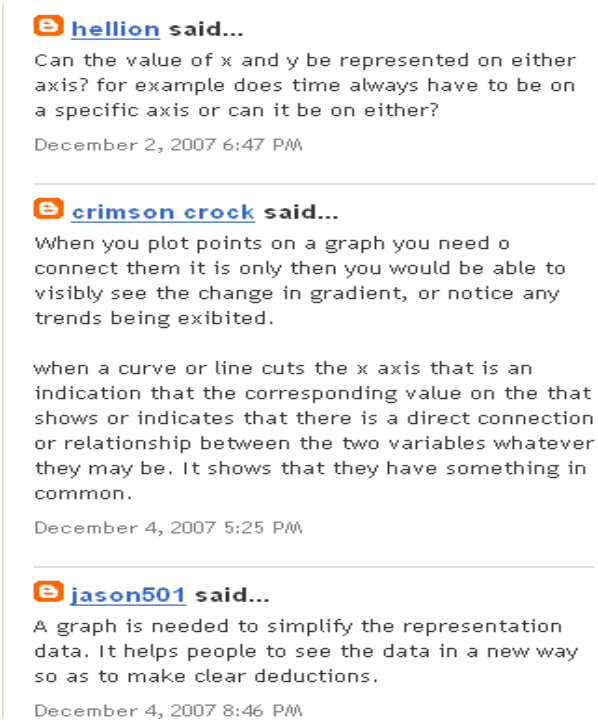
30-Nov The use of drawing a graph?
30-Nov Rate of change?
01-Dec Gradients and intercepts
05-Dec Intercept of two straight lines
06-Dec A curve

For each of these titles, a group of relevant questions were posted by the instructor. An example of this is for the topic titled, The use of drawing a graph, where the following questions were posted:

The use of drawing of a graph

1. Why do we need to draw a graph?
2. What is meant when a curve or straight line cuts the x-axis?
3. When a curve or straight line cuts the x-axis, does that have significance in real life?
4. What is meant when a curve or straight line cuts the y-axis?
5. When a curve or straight line cuts the y-axis, does that have significance in real life?
6. What is meant by y-intercept and x-intercept?

A screen shot of some comments from students about this topic is shown below in Fig 3.



hellion said...
Can the value of x and y be represented on either axis? for example does time always have to be on a specific axis or can it be on either?
December 2, 2007 6:47 PM

crimson crock said...
When you plot points on a graph you need o connect them it is only then you would be able to visibly see the change in gradient, or notice any trends being exibited.

when a curve or line cuts the x axis that is an indication that the corresponding value on the that shows or indicates that there is a direct connection or relationship between the two variables whatever they may be. It shows that they have something in common.
December 4, 2007 5:25 PM

jason501 said...
A graph is needed to simplify the representation data. It helps people to see the data in a new way so as to make clear deductions.
December 4, 2007 8:46 PM

The comments made by students can be of three different types, asking a question, answering a question, or illustrating a question. On the same topic title, Fig. 4 shows a screen shot that a student actually made postings in all the categories.

top shottar said...
blessed08

I would like to respond on the question u asked brainiac about a stand still or constant.

In a distance/time graph when a car is constant it means that there is no change in speed.
December 6, 2007 10:50 AM

top shottar said...
I would have to agree on brainiac's comment that when a straight line or curve cuts the x axis it means that the y value is 0

Therefore I would say that when a line or curve cuts the y axis the it means that the x value is 0.
December 6, 2007 10:57 AM

top shottar said...
Would someone answer my question? I am a little puzzled now.

How about when a line or curve cuts both x and y axis, what does this mean? Does this have a significance in life?
December 6, 2007 11:01 AM

IV. RESULTS

The YMC was highly used. 92 % of the students actively added comments and this was a good indicator of the project's success. A statistical analysis on the type of comments showed that most of the comments fell under the categories of self-explanation and illustration. This indeed stimulated a lot of virtual dialog among students.

A. Illustration of a Virtual Dialog

The following describes the discussion arising out of the question, Will a graph consisting of two lines intersect? that was posed by the instructor. The comments demonstrate that the students are very comfortable in expressing their personal views or thoughts to the question provided.

Student 1 comment to instructor -
Once lines have equations they will intersect unless they are parallel.

Student 2 comment to Student 1 -
You can have an equation that let you plot under the positive section of the x-axis and one that lets you plot over the negative axis.

Student 3 comment to Student 1 -
If something is separated doesn't it mean it doesn't touch? If you have two lines on a same graph paper but separated it will not intersect.

Student 4 comment to Student 2 -
The comment on the +ve and –ve quadrient is not correct, lines can still intersect. You must consider the fact that lines can exist on a graph even though they are not parallel because

it depends on how long the lines actually are.

Student 5 comment -

An example to consider is Hooke's law. Hooke's law there is a straight line at the end and when you pass the elastic limit it starts to curve. Would you consider that a straight line and a curve on the same graph?

Student 6 comment to Student 5 -

I think when the line starts to bend then it is considered a curve. In Hooke's law, if the elastic limit isn't reached then the graph remains a straight line.

Student 7 comment to Student 5 -

In Hooke's law, the line is considered a curve if it reached the elastic limit and starts to bend.

B. Benefits of the YMC Project

Phase 1 of the YMC project has already shown great success in improving students' learning. The students were more involved. This was reflected by the fact that on average a student added 3 comments to the blog on a given topic. The self-confidence of the students extends outside the virtual classroom into the actual classroom. The students had more dialog in the real classroom as a result of this project.

The fact that a student could be learning at his/her convenience in the virtual classroom is also of great importance. This 24-hour learning was reflected by the time of entry of the comments, e.g., 12:30 a.m. and 1:45 a.m. As long as the student had access to a computer with Internet access, 24-hour learning was possible. This reflected the great enthusiasm of the students in using the YMC blog.

At the end of 3 weeks, a quiz similar to the first one (mentioned before) was given. It should be noted that the teaching time did not facilitate any spare time for the instructor to teach these problem areas in the real classroom. The results were opposite to the first. Less than 20 % of the students failed. It should be noted that all the students who failed did not have more than one comment on any topic. The instructor did spend time in reading the comments and injecting further comments to clear up any problem areas. The background knowledge of the students was taught to the students without any additional financial cost and without using any allocated teaching time from the current course.

V. CONCLUSION

The YMC described in this paper involves using a blog to build a virtual classroom. This community approach of a virtual classroom provided the student with the convenience of learning when they have the time. It also broke down the barriers of being fearful to ask questions in class. This increased the confidence in the students. In the actual classroom, the students' increased self esteem was demonstrated by students asking questions. YMC was a cost effective solution. The ease of accessing any computer with Internet access was highlighted in the frequent comments by the student and the time when these comments were posted. The best part of YMC was the collaborative efforts by the students to achieve this result of teaching themselves. Every student contributed by expressing his own perspective which helped another student to understand. All of this is performed without knowing the identity of the student. The dialog that transpired among the students has demonstrated that the barriers of fear and low esteem were overcome. The virtual classroom has demonstrated its potential for assisting students in conceptualizing background knowledge.

The next step of the YMC project is to use the virtual classroom to test whether it can be useful in assisting the teaching of the content of a course. With this approach, extended hours can be reached. Hence the time allotted to a topic can now virtually grow to the needs of the weakest student. This approach would be used in three classes out of twelve classes that teach the same course content. The final examination will be the same. The main measurement of success in the second phase will be based on the academic success of the students. If the result is favourable, this approach will be tested with another course.

REFERENCES

[1] Abramovich S. & Brown G. Integrating problem-solving, technology and the experience of mathematical discovery in teacher education. Journal of Computers in Mathematics and Science Teaching, 15(4), pp.323 – 338.

[2] Aronson E. Building empathy, compassion, and achievement in the jigsaw classroom. In: J. Aronson, (Ed), Improving academic achievement. Impact of psychological factors on education, Academic Press, San Diego, CA, 2002, pp. 209–225.

[3] Bandura, A. Social Foundations of Thought and Action: A Social Cognitive Theory. New Jersey: Prentice-Hall Inc.

[4] Beeson P. Bringing blogs into the classroom, Journal of Online Learning and Teaching, 93(6), 2005, pp. 27-29.

[5] Boaler J. & Greeno G. Identity Agency and Knowing in Mathematics Worlds In: Boaler J. (Ed) Multiple Perspectives on Mathematics Teaching and Learning. Ablex Publishing, Westport, CT, USA, 2000.

[6] Bong M. and Skaalvik E. M. Academic self-concept and self-efficacy: how different are they really? Educational Psychology Review 15, 2003, pp. 1- 40.

[7] Cai J. Beyond the computational algorithm. Students' understanding of the arithmetic average concept. Psychology of Mathematics Education, Vol 3, 1995, pp. 144-151.

[8] Chilakamarri V. A few thoughts & many queries about mathematical culture and mathematics education. Mathematics Education and Society, 1998.

[9] Clarke P. J. Exploring the use of computer technology in a Caribbean context: Views of pre-service teachers. International Journal of Education and Development using ICT (IJEDICT), Vol. 3, no. 1, 2007, pp. 23- 38.

[10] Davi A., Frydenberg M. & Gulati G. J. Blogging across the disciplines: Integrating Technology to enhance Liberal Learning, Journal of Online Learning and Teaching, 2006.

[11] Ernest P. The one and the many. In L. Steffe & J. Gale (Ed), Constructivism in education. New Jersey: Lawrence Erlbaum Associates, Inc. 1995, pp.459 - 486.

[12] Flatley M. Blogging for enhanced teaching and Learning. Business Communication Quaterly 68 (1), 2005, pp. 77 – 80.

[13] George P. Making Mathematics Hard: Student views from a Caribbean Perspective, British Society for Research into Learning Mathematics 25 (2), 2005.

[14] Niherst, Survey of Mathematics in Secondary Schools, Trinidad & Tobago, 2006, www.niherst.gov.tt/st-statistics/surveys-publications.htm.

[15] Phan H. & Walker R. Maths Self-efficacy in Primary Schools: Evidence of a Hierarchical Structure. Inaugural International Self-Concept Conference.

[16] Prediger S. Diversity as a Chance in Mathematics Classrooms. International Journal for Mathematics Teaching and Learning, 2005.
[17] Schiefele U. Interest, learning, and motivation. Educational Psychologist 26, 1991, pp. 299 - 323.
[18] Warwick J. Mathematical Self-Efficacy: A Pilot Study Exploring Differences Between Student Groups. International Journal for Mathematics Teaching and Learning, 2006.