

Children's Mathematics Performance and Drawing Activities: A Constructive Correlation

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Abstract

There have been series of concerns raised on the general performance in mathematics in Ghana. This study, a mixed method research, looked into the use of drawings in mathematics teaching in improving 62 pupils' performance at the Ayigya M/A Primary School A, where performance of pupils in mathematics is low. Observation, interviews, achievement test and pictorial likert scale were used to examine relationships between discovery learning and mathematics performance. Pupil performance was obtained by analysing the continuous assessment cards from the previous year. Pre- and post test assessments were administered to measure improvement in pupil performance. Data analysis revealed that drawing activities significantly improved pupil performance in mathematics. The interventions employed also heightened pupils' interest in the learning of mathematics. Theory in the literature attests to the fact that the arts are very useful to education by establishing a relationship between thinking and the material with which teachers and their students work. This knowledge can be capitalized by professionals in curriculum research and development.

Keywords: Mathematics, drawing activities, discovery learning, pupil

1. Introduction

The general guiding principle on the delivery of the curriculum in the mathematics' syllabus and teacher's handbook in Ghana, encourage the use of investigational methods by the teachers to promote discovery learning. An analysis however, done by experts in the field of mathematics indicates that only few learning/teaching activities that would encourage the use of discovery methods were included in the syllabus (Mereku, 2003).

According to Akanmu and Fajemidagba (2013), "...mathematics is not only a language and a subject in itself, but it is also critical in fostering logical and rigorous thinking; as such its influence is immense."(p82). They also quote Aminu (1990) who maintain that mathematics goes beyond the language of sciences, it is a crucial nutrient for thought, logical reasoning and progress and it as well opens up the mind and gives individuals an assessment of the intellectual abilities.

Akanmu and Fajemidagba further point out that "mathematics is regarded as pillar of almost all the streams in academics given its importance in tertiary education and most careers" (p82), yet there are problems with its teaching as they noted in Fajemidagba's study (1986) who had earlier identified problems of mathematics learning and the adoption of poor teaching methods by teachers in schools.

On a similar count, pupil attainment in mathematics in Ghana is generally low (Mereku, 2003). Results from the Trends in International Mathematics and Science Study (TIMSS), conducted by the International Association for the Evaluation of Educational Achievement (IEA) of the USA in 2003 and 2007 indicate that grade 8 children show poor mathematics achievement in Ghana. In the international study, Ghana's eighth graders were ranked 43rd among 44 and 46th among 47 countries that participated in the study in the respective years (Agyei, 2010). Again, it was noted that teachers of mathematics adopt the expository method of teaching that induces rote learning ("chew and pour"). This way students do not necessarily grasp the concepts of mathematics to help them in their everyday lives but learn to pass their exams and forget what they have learnt soon afterwards (Agyei, 2010; Fajemidagba, 1986). They fail to recall the ancient Chinese proverb that "Tell me and I forget. Show me and I remember. Let me do and I understand" (as cited in Adu-Agyem, Enti and Peligah, 2009)

Eisner (2004) points out that the arts teach students to act and to judge in the absence of rule, to rely on feel, to pay attention to nuance, to act and appraise the consequences of one's choices and to revise and then to make other choices. Furthermore, arts integration supports the development of students' motivations, interests, and pre-service relationships (Mello, 2004). In support of these, Andrea, Nancy & Welch (1995) found that 920 elementary school students in 52 classrooms in Boston, Cambridge and Los Angeles who were given visual and performing arts lessons for three years outscored non-program students, earning significantly higher report card grades in the core subject areas including mathematics.

Hanson (2002) identified at least three primary reasons for the lack of incorporating drawing activities in mathematics teaching. These include the lack of academic value placed on visual art instruction; pressure to

achieve and maintain higher standardized test scores in core curriculum areas; and the lack of identification and use of multiple talents and skills. It is with this backdrop that this article seeks to demonstrate how infusing drawing activities into the teaching of mathematics can improve primary pupils' understanding of mathematics concepts, hence improving their score.

2. Methodology

Being a mixed method research, the quasi-experimental and action research approaches were adopted to find out how children's mathematics' performance could be enhanced using drawing activities. Both primary and secondary data were used for the study. A metaanalysis was made on some studies on integrated curricula, methods of mathematics teaching and learning, multiple intelligences, and teaching and learning theories. These formed the basis for the secondary data. Using purposive and convenience sampling, a public primary school in the Kumasi Metropolis was selected from whom a total of 69 respondents comprising 62 pupils and seven teachers of the school were selected for the in-depth study. It is from this sample the primary data was obtained. The pupils were divided into two groups, namely experimental and control. Pupil performance was obtained by analysing the continuous assessment cards from the previous year. Pre- and post-test assessments were administered to measure improvement in pupil performance.

2.1 Research Design

2.1.1 Observation

To gain insight into how teaching and learning of mathematics was done at the schools, we took on the role of observer-as-participant under non-participant method of observation. Before the drawing intervention, it was observed that teachers seldom integrate practical activities to explain mathematics concepts, class participation was low, evaluation exercises were in the form of written quizzes only, pupils worked individually during class exercises, and teachers did not consider the different learning abilities of pupils when teaching.

2.1.2 Likert Scale

To understand the pupils' reaction or feelings toward the intervention, we used the Pictorial Likert scale. The Pictorial Likert scale uses pictures in place of text in communicating levels of choice, with the most common set of pictures being the smiley face.

2.1.3 Drawing activities

Various drawing activities were used alongside various teaching methods. These drawing activities were based on an adapted version of model of discovery learning as developed by Thomas and Switzer (2001) (Figure 1). The teaching methods included discussing the use of problem questions, manipulation of tools and materials for art, and identifying drawing relationships between mathematics and art. The pupils drew images and coloured them on the drawing sheets.

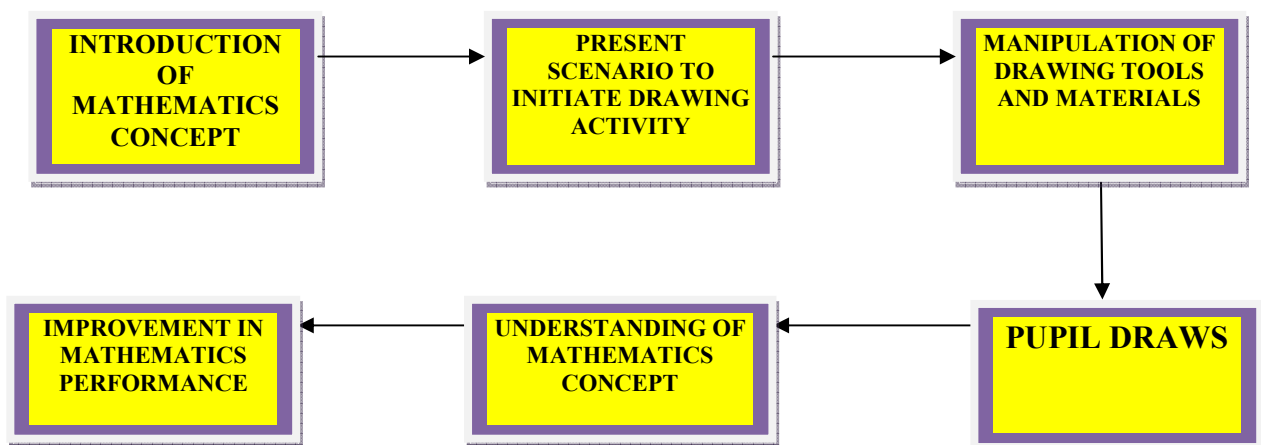


Figure 1: Adapted Model for Mathematics Teaching and Learning
 Source: Adapted from (Thomas & Switzer, 2001)

Table 1. Explanation of Adapted Model for Mathematics Teaching and Learning

Element	Description
Introduction of Mathematics Concept	Teacher Introduces the mathematics concept to be taught.
Present Scenario to Initiate Drawing Activity	Teacher poses a scenario that initiates thinking or cognitive actions by pupils.
Manipulation of Drawing Tools and Materials	Pupils make their own choice of tools and materials to be used for the drawing. Example is choice of color.
Pupil Draws	The pupil draws what the teacher instructs.
Understanding of Mathematics Concept	The pupil drawing what the teacher instructed leads to the understanding of mathematics concept by pupil.
Improvement in Mathematics Performance	The pupil's mathematics performance improves as a result of engaging in the discovery learning process.

2.1.4 Intervention

The teachers were contacted and informed of the intervention and when it would commence. The teachers were encouraged also to participate in the entire process. Nine weeks were used for the intervention activities for both the control and experimental groups. However, activities from weeks two to eight, and the Pictorial Likert scale activity in week nine were used with the experimental group only. Both the control group and experimental group learnt the same mathematical concepts. Achievement test was also used to measure the performance of the sampled pupils in mathematics before, during and after the intervention. In week one, pre-test was taken by both the experimental and control groups to get an idea of any prior knowledge of mathematics, how much they understood the concepts and their performance based on the standard test from Oforikrom sub-metro. The pre-test lasted 20 minutes for each of the group.

3. Results and Discussions

The intervention activities support the idea that when drawings are integrated into mathematics teaching and learning, pupils' interest in mathematics becomes greater (Ingram & Riedel, 2003; Andrea, Nancy & Welch, 1995). Moreover, the outcome of the drawing intervention activities confirms Goldberg's (1997) conclusion that the arts provide a stage for building self-esteem, encourage collaboration and intergroup harmony, expand expressive outlets, and provide a range of learning styles available to children. Also, the intervention results support the claim that arts integration supports the development of students' motivations and interests (Melo, 2004; Eisner, 2004). Additionally, the submission by Potter (2007) in Adu-Agyem, Enti and Peligah (2009) that the arts offer essential opportunities for creative expression, problem solving and social development is confirmed by the intervention activities

3.1 Pre-Test

Figure 2 shows the results of the pre-test conducted for the control and experimental groups in mathematics before the introduction of the drawing intervention to the experimental group.

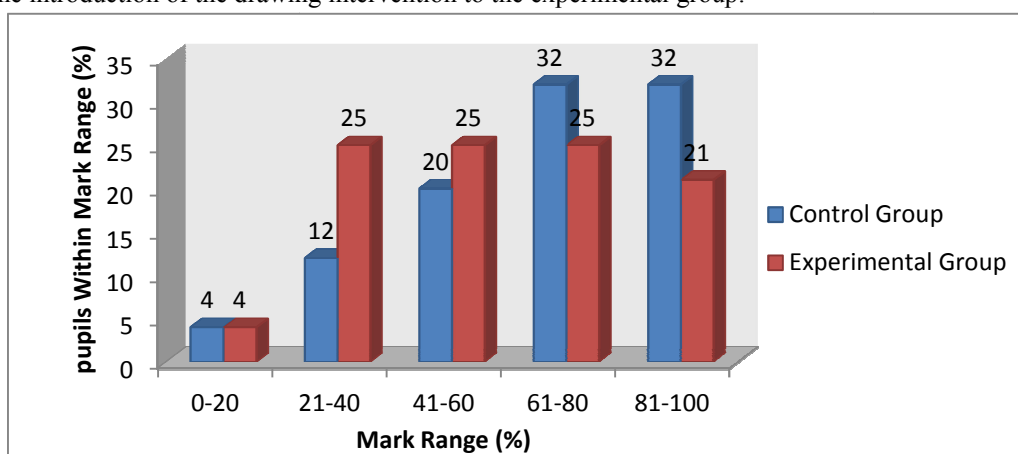


Figure 2. Comparison of Pre-test between Control Group and Experimental Group

Except for 0%-20% range where four pupils in both groups showed same performance, those in the experimental group were fairly distributed across the mark range but fewer pupils scored between 81%-100%. In the control group however, there was an exponential increase in pupil performance up to the 61%-80% range but remained the same for the 61%-80% and 81%-100% mark ranges.

3.2 Post-Test

During the post-test, no drawing intervention was introduced for the control group but for the experimental group there was a drawing intervention.

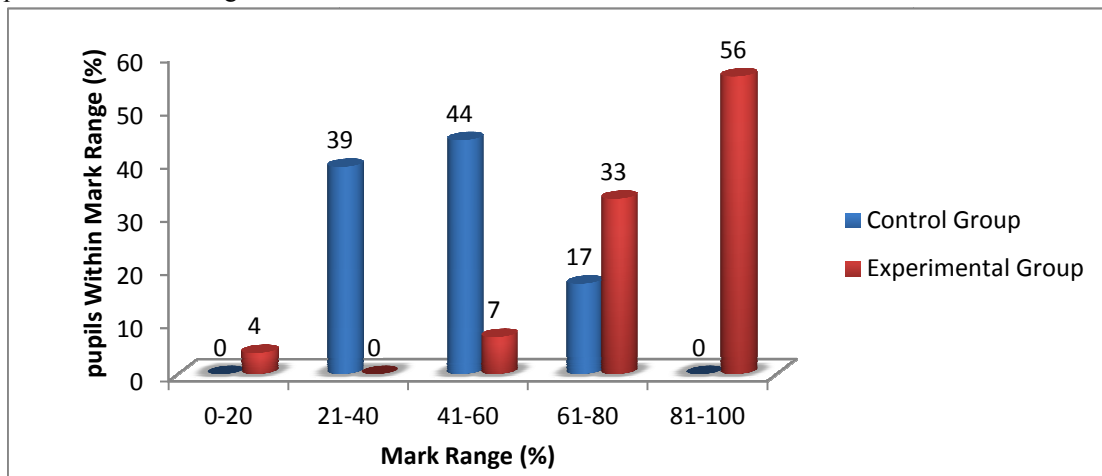


Figure 3. Comparison of Post-test between Control Group and Experimental Group

It is seen here that 56%, more than one half of the experimental group scored 81-100% compared to 33% from the control group. The significance of this result is that the drawing intervention actually improved the mathematics performance of the experimental group over the performance of the control group which had no drawing intervention during the post-test. This confirms Ingram & Riedel's (2003) conclusion that pupils' mathematical performance improves after the integration of arts into mathematics teaching.

3.3 Comparison of Pre-test and Post-test for Control Group

The comparison between the pre-test and post-test for the control group is presented in figure 4. During the pre-test and post-test, no drawing intervention was introduced for the control group.

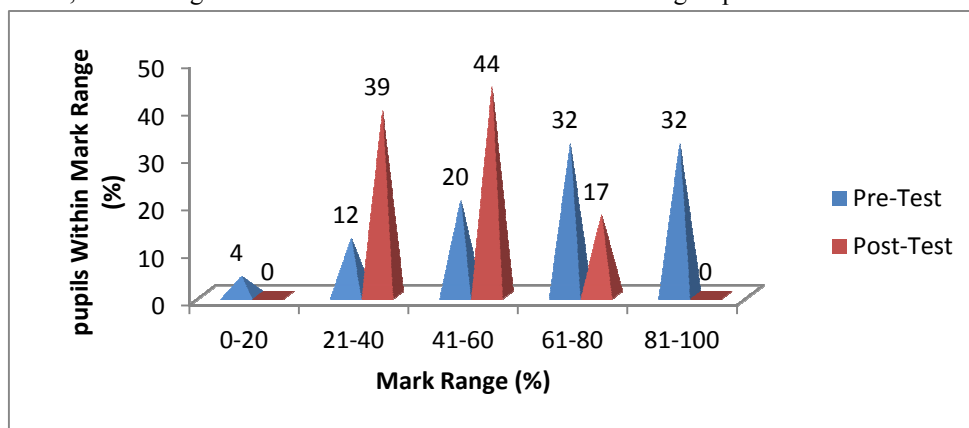


Figure 4. Pre-test and Post-test for Control Group

In figure 4, the pupils were fairly distributed across all the mark ranges during the pre-test except for the 0-20% mark range which had 4% of the pupils scoring within that mark range. However, except for the 0-20% and 81-100% mark ranges which none of the pupils attained; the pupils also were fairly distributed across the various mark ranges during the post-test. Since no drawing intervention was introduced, the control group's performance was not sustained or improved, rather their performance declined. This could suggest that if a drawing intervention was introduced, their mathematical performance could have improved (Eisner & Ecker, 1990; Gunn, 1998).

3.4 Comparing Pretest and Post-test for the Experimental Group

There was a comparison made between the pre-test and post-test of mathematics for the experimental group. This is shown in Figure 5. A drawing intervention was introduced during the post-test phase. It was observed that except for the 0-20% mark range where four percent of the pupils scored, the rest of the pupils were fairly distributed across the various mark ranges during the pre-test. However, more than half of the pupils scored within the 81-100% mark range during the post-test. This corroborates the findings of Andrea, Nancy & Welch (1995) that students' mathematics performance improves after being given lessons in the arts.

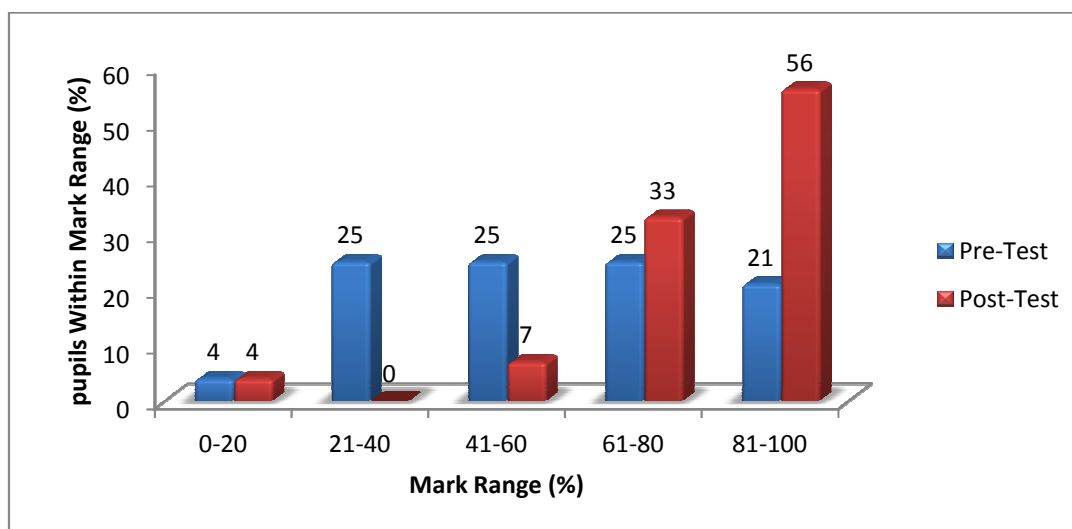


Figure 5. Pre-test and Post-test for Experimental Group

3.5 Correlation Analysis of Pre-test and Post-test for Experimental Group

The relationship between the use of drawings in Mathematics teaching (as measured by the Pre and Post-test marks for experimental group) and pupils' academic performance (as measured by the Pre and Post-test marks) was investigated using Spearman's rho correlation coefficient (which is a non-parametric alternative to the Pearson product moment correlation with more relaxed assumptions).

Table 2: Comparing Pre-test and Post-test for Experimental Group Using Correlation Analysis

			Pre and Post-test for Experimental Group	Pre and Post-test marks
	Pre and Post-test for Experimental Group	Correlation Coefficient	1.000	.533**
		Sig. (2-tailed)	.	.000
		N	55	55
	Pre and Post-test marks	Correlation Coefficient	.533**	1.000
		Sig. (2-tailed)	.000	.
		N	55	55

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Fieldwork, 2012

There was a strong, positive correlation between the two variables [$r = .533, n = 55, p < .0000$] with increasing use of drawings in Mathematics teaching associated with improvement in pupils' performance in Mathematics test (Potter, 2007; Adu-Agyem, Enti and Peligah, 2009).

3.6 Relationships between the Pre-test and Post-test of the Control Group and Experimental Group Using Descriptive Statistics

Table 3. Pre-test and Post-test of Control Group and Experimental Group Using Descriptive Statistics

	Pre-test Experimental Group	Post-test Experimental Group	Pre-test Control Group	Post-test Control Group
Mean	57.4643	82.9630	65.8400	50.8696
Std. Deviation	23.50805	18.56689	23.55080	13.45465
Minimum	15.00	20.00	15.00	30.00
Maximum	100.00	100.00	100.00	80.00

Source: Fieldwork, 2012

Table 3 presents the mean marks, standard deviations, minimum and maximum marks for the pre-test and post-test for the experimental and control groups. There was an increase in the mean value of the post-test (82.96) for the experimental group over the mean value of the pre-test (57.46) and this shows how effective the drawing intervention was in improving the pupils mathematics performance (Andrea et al, 1995; Ingram & Riedel, 2003).

4. Summary of Findings

These are the major findings in this study

- The drawing activities helped reduced truancy among some pupils.
- They boosted pupil interest in mathematics,
- They helped improved class participation,
- They encouraged collaboration among pupils and built their intergroup harmony.
- There was an increase in the mean value of the post-test (82.96) for the experimental group over the mean value of the pre-test (57.46) and this shows how effective the drawing intervention was in improving the pupils mathematics performance.
- There was a strong, positive correlation between the two variables [$r = .533, n=55, p < .0000$] with increasing use of drawings in Mathematics teaching associated with improvement in pupils' performance in Mathematics test

5. Conclusion

Drawing activities engage both teacher and learner, making them recognize the connections between mathematics and the arts, hence the use of drawing activities to explain mathematical concepts can improve the mathematical performance of pupils as well as make the studying of mathematics fun and interesting. (Mello, 2004). It can also be said that given extra time and considerations to multiple intelligences, the below average and average pupils can better their performance in mathematics.

6. Recommendations

To better integrate drawings into mathematics teaching and learning, mathematics teachers should acquaint themselves with the model of mathematics teaching which involves the introduction of mathematics concepts; presentation of scenario to initiate basic drawing activities (including use of matchstick drawings); manipulation of drawing tools and materials; and ensuring that the pupils draw; would enable them help their pupils to understand mathematics concepts and improve in mathematics performance. Although school supplies may not include art materials, they can use chalk, the chalkboard, pebbles, sticks and other objects to initiate such activities.

Also, teachers of arts should collaborate with mathematics teachers to align mathematics concepts to art in order to explain basic and complex concepts to the understanding of primary school pupils as well as to make mathematics learning enjoyable and stress free.

Again, Art Teachers Associations, Policy makers, Non-Governmental Organizations and stakeholders should organize seminars in art education for teachers in order to create awareness about what art education promises.

References

- Adu-Agyem, J., Enti, M. & Peligah, Y. (2009), Enhancing Children's Learning: the Art Perspective. *International Journal of Education through Art*, 5(2,3), 143-155. doi:10.1386/eta.5.2 ,3.143/1
- Agyei, D. (2010). Information Communication Technology use in Mathematics. [Online] Available: <http://www.slideshare.net/ddagyei/ict-use-in-the-teaching-of-mathematics> (September 6, 2011)
- Akanmu, M. Alex and IFajemidagba, M. Olubusuyi (2013), Guided-discovery Learning Strategy and Senior School Students Performance in Mathematics in Ejigbo, Nigeria, *Journal of Education and Practice* , 4(12), 82-89
- Aminu, J. (1990). Address by the Honourable Minister of Education. *Abacus* 20 (1), 22-29.
- Andrea, G., Nancy, C. & Welch, I. (1995), *Schools, Communities and the Arts: A Research Compendium*. Morrison Institute for Public Education.
- Eisner, E. W. (2004), 'What can Education Learn from the Arts about the practice of Education? *International Journal of Education & the Arts*, 5(4).[Online] Available <http://ijea.asu.edu/v5n4> (September 7, 2011).
- Eisner, E. W., & Eckner, D. W. (1970), "Some Historical Developments in Art Education". In G. Pappas] (Ed.), *Concepts in Art education*, Ontario: Macmillan (pp. 12–25).
- Fajemidagba, M. O. (1986). Theoretical basis for curriculum structuring. Its significance and implication for secondary school mathematics curriculum in Nigeria. *Journal of Research in Curriculum (JORIC)*. 4 (2), 12-20.
- Goldberg, M. (1997), *Arts and Learning: An Integrated Approach to Teaching and Learning in] Multicultural and Multilingual Settings*. White Plains, New York: Longman.
- Gunn, A. C. (1998), *Visual Art Education in Early Childhood Centers: Teachers' Beliefs and Practices*.] Canterbury: University of New Zealand.
- Hanson, J. (2002), *Improving Student Learning in Mathematics and Science through the Integration of Visual Art*. Saint Xavier University.
- Ingram, D. & Riedel, E. (2003), *Integrating Mathematics and the Visual arts*. Center for Applied Research and Educational Improvement College of Education and Human Development, University of Minnesota.

MacMillan, A., Preston, D., Wolfe J. & Yu, S. (2007), Basic Statistics: Mean, Median, Standard Deviation, Z-Scores, and P-Value. [Online] Available http://www.fourmilab.ch/rpkp/experiments/analysis/z_Calc.html. (November 21, 2012).

Mello, R. (2004). When Pedagogy Meets Practice: Combining Arts Integration and Teacher Education in the College Classroom. In J. Russell & R. Murphy, (Eds.) *Arts and Learning Research*, 20(1),135-161.

Mereku, K. (2003). Methods in Ghanaian Primary Mathematics Textbooks and Teachers' Classroom Practice. *Learning*, 23(June), 61-66.

Potter, J. (2007), Draw me a story, dance me a poem: Integrating expressive arts fosters emergent literacy [Online] Available <http://www.wiu.edu/thecenter/articles/draw2.html>. (November 21, 2012.)

Thomas, K., & Switzer, S. (2001). 'Discovery Based Learning Model - Where Art Meets Science.

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