FEASIBILITY OF TEACHING THE d-h THEOREM FOR FACTORIZATION OF QUADRATIC EXPRESSIONS IN SHS1

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ABSTRACT

This paper examined the feasibility of teaching the d-h theorem in SHS1. The study tried to find out if there is a significant difference between the scores of students who used d-h theorem and those who used the conventional method. Also, if students who used d-h theorem can remember and applied it as those who used the conventional method. The reliability coefficients of the tests were determined by the Cronbach Alpha method and Wilcoxon Rank-Sum Test was also used to test if the performance between both groups were significantly different or not. From the results, the reliability coefficients for all tests were above 70 percent. The results of the performance of the experimental group were better than that of the control group in test III and VII. This showed that students in the experimental group learnt and remember the d-h theorem and applied it more than their counterpart in the control group. In conclusion, the d-h theorem has the power that overcomes the inherent problems of the conventional methods of factorising quadratic expressions. Therefore, the d-h theorem holds a promise for mathematics education as a result a nationwide study is recommended to verify on a large scale the feasibility of the d-h theorem and subsequent inclusion in the core mathematics curriculum to help solved the problem of factoring quadratic expression.

Keywords: Feasibility study, d-h theorem, Cronbach Alpha method, Wilcoxon Rank-Sum Test, Reliability Coefficients

INTRODUCTION

Feasibility of Teaching the d-h Theorem in SHS1

The role of mathematics in the quest for better life cannot be overemphasized. This is because, mathematics is useful, it is part of our culture, and also mathematics trains the mind. According to Sawyer, W. W (1958), and mathematics is the classification and the study of all patterns. Sawyer used pattern to refer to all regularities that can be recognized by the mind. The theorem of mathematics must, therefore, account for the power of mathematics, its numerous applications to the natural sciences, its beauty and the fascination it has for the mind. These attributes of mathematics help us to understand our environment better, explore the opportunities which are within our reach and design plausible strategies to solve the ever-increasing problems that confront the human race in the quest for better life. This is because, mathematics trains us to know enough arithmetic in order to make simple purchases, count change, check wages and understand a popular newspaper and television station which make use of simple graphical illustrations as a means of communication**.**

Added to these, it can be argued that mathematics is of fundamental importance to the understanding of physical sciences, technology, economics and business, in general. It is increasingly employed in social sciences, business management and social administration so that the person with knowledge of mathematics has the key to many other areas of knowledge as well.

Again, mathematics helps individuals to understand things better - perhaps to understand the jobs on which they might later be employed, or to understand the creative achievement of the human mind or the behaviour of the natural world. It is the particular power of mathematics that its central ideas help us to do all these things. There are good deals mathematics offers not only to human beings, but also to other living creatures such as birds, insects, etc. According to Dantzig (1954), the importance of mathematics is known by virtue of the fact that even insects and birds have a sense of numbers. In his book entitled, Number the Language of Science (p. 57), Tobias Dantzig claimed that, "Mathematics is not only the model along the lines of which the exact sciences are striving to design their structure. Mathematics is the cement which holds this structure together. A problem, in fact, is not solved until the studied phenomenon has been formulated as a mathematical law.''

In view of these, mathematics has remained as a core subject on the timetable of Senior High Schools (SHS) in Ghana and has been of immense interest to many students who take it as elective subject. However, it is very disheartening to hear most students complain that Mathematics is difficult. This complains perhaps can be attributed to the fact that most of the mathematics teachers in our SHS have a scrappy knowledge about the subject matter or content. In this regard, they are unable to add the least flesh to mathematics, which will make the majority who have difficulty in learning the subject love to dance with it. Another great setback the subject suffers is the use of inefficient methods in presenting the subject matter to students. Perhaps, more efficient methods of treating topics in mathematics are needed in order to save the situation.

Polynomial equations are some of such topics in mathematics, which have a very wide spectrum of application in solving real life problems. According to Cordrey (1945), the quadratic function as a model has been depended on to solve problems in science, engineering, commence, and physics, and in many other fields of education. Coxford and Payne (1984) justified Cordrey assertion by revealing that even economics make use of quadratic expressions in describing their manufacturing cost, revenue and business profit assuming that these are functions of the number of items produced.

The solution of quadratic equation has been of interest not only to contemporary scholars, but it has been important long before the birth of Christ. The Babylonians and the Egyptians, who were thought to have started mathematical concepts in solving problems and practical application of algebra to real life situation used the quadratic equation to solve problems in areas like profit and loss. This was due to the pricing system in Mesopotamia at that time (Kramer 1981). Since then, the quadratic equation has been of immense interest in various fields of human endeavour.

In SHS curriculum, the solution of quadratic equation is required for immediate use in learning other subjects like physics and elective mathematics. For instance, in physics, students are faced with the equation of motion with uniform acceleration a which states that, for a body moving with initial velocity u and uniform acceleration a for time t seconds, the distance covered S is given by $S = ut + \frac{1}{2}at^2$.

This and other equations of motions are treated in the first year (CRDD Physics Syllabus 1989). In spite of these numerous application of quadratic equation in the early years of SHS programs, the curriculum planners of the SHS Mathematics programs, has delayed the solution of such equation until the third year of the program (SHS Mathematics (core) syllabus CRDD 1989, section 1.15.0& 9).

ISSN-L: 2307-3713, ISSN: 2307-3721
Vol. 2 No. 3 December 2013

The reasons for the delay, being that one of the standard methods for solving quadratic equation which is factorization, entails some difficult concepts and a lot of pre-requisites. Thus, it involves transforming the quadratics equation in to canonical form, factorizing the left hand side and then applies the principle of divisor of zero. In view of these, the physics teacher in the first year is compelled to resort to the use of quadratic formula, which, as rule, they teach perfunctorily. The consequences of this are that a very large proportion of students are unable to learn the solution of quadratic equation by formula, with relational understanding. This could lead to wrong attitude of students to topic in particular and to Mathematics in general. It has, however, been observed that "when the method of factorization can be used, this is the best way to solve quadratic equation'' (Cundy (Ed), 1968, School Mathematics Project: Advanced Mathematics Book 2, p426). It has, also been observed by Bowers et al (1950) that "This is generally the most convenient method provided the factors of the quadratic expression involve only rational numbers" (Mathematics for Canadians, p212).

These seem to imply that, not all quadratic equations can be solved by method of factorization. In fact, according to Lial and Miller, (1979) "Not all quadratics equation can be solved by this kind of factorization (Mathematics with application in Management, Natural and Social Science p23). This is particularly so when the quadratic equation is a non – square trinomial.

These conventional methods of factorizing quadratic expressions have inherent limitations that tend to affect their teaching and learning. So this study presents the feasibility of a more powerful method, devoid of these weaknesses in the conventional method of factorising quadratic expressions. This is the reason why educators feel that it must be taught gradually by breaking it into bits trying to go about each bit gingerly in order not to jeopardize the interest of students. Because of the inherent drawbacks, teachers and writers tend to be inhibited and they try not to introduce quadratic expressions where **a** and **c** are large and have several factors between them.

As a result, when more powerful method of factorizing quadratic expressions is available, there will be no fear about giving equation or exercises no matter the nature of the coefficients. One non – conventional method that is free from the inherent defects of the conventional method of factorizing quadratic expressions is the of the d-h theorem developed by Gyening, J. (1988). It uses pre –requisite concepts and skills normally taught at the basic level. These are properties of numbers, and finding the highest common factor of two numbers and finding the value of an expression when given the values of the variables involved, (Junior High Schools, JHS 2). It is, therefore, necessary to investigate whether this method can be efficiently taught at SHS1 as an alternative method of factorization by grouping.

The inherent limitations of the conventional methods of factorizing quadratic expressions taught in the first year of the SHS1 mathematics program have led to the problem being investigated. The purpose of the study therefore is to investigate if it will be feasible to teach the d-h theorem for students in SHS1 to learn it with ease just as they do with other topics in their Mathematics (Core) syllabus.

OBJECTIVE

The objective of the study is to verify the feasibility of teach the d-h theorem in SHS1 in Ghana.

HYPOTHESES

To guide the study, the following hypotheses were tested at 5 per cent level of significance.

H_0: Immediately following the treatment, there is no significant difference between the mean scores of the experimental group and the control group on the tests.

H_1: Immediately following the treatment, there is significant difference between the mean scores of the experimental group and the control group on the tests.

H_0: Three weeks after the treatment has ended, there is no significant difference between the mean scores of the experimental group and the control group on a test.

H_1: Three weeks after the treatment has ended, there is significant difference between the mean scores of the experimental group and the control group on a test.

LIMITATIONS OF THE STUDY

As in most research activities, this study was influenced by the following condition: The d-h theorem is not in the SHS Mathematics syllabus and these tests taken will not be part of their normal class work, therefore, students might have put little premium on the treatment knowing that their performance will not have any effect on their continuous assessment grade.

SIGNIFICANCE OF THE STUDY

Teachers of mathematics in Senior High Schools complain of too many topics in mathematics syllabus with little time to teach them. Students complain of difficulty in learning and remembering the methods of factorization. Also the West Africa Examination Council (WAEC) has been worried for some time now about the persistent errors in the solution of quadratic equations. All these are signals to mathematics educators to find new ways that could solve these problems facing teachers, students and the WAEC.

It is in this wise that the importance of this study lies. If the hypotheses of this study are upheld at Akro Secondary Technical School, then the stage will be set for a more extensive research to confirm or reject the findings. Also, it will make curriculum developers review the grade placement of the topic "solution of quadratic equations" in the SHS core mathematics syllabus for its optimum application in the study of other subjects. The study is also to find out if the use of the d-h theorem can help to cut down the length of time during which students have to wait to be introduced to the solution of quadratic equations. It is thus to find out the effectiveness or otherwise of the method and make recommendations accordingly.

The d-h Theorem

Gyening, J. (1988) developed the d-h theorem in an attempt to overcome the inherent weaknesses of the conventional methods of factorizing quadratic expressions. He claimed that the d-h theorem can be used to factorize quadratic expressions more easily and quickly. This method is described as follows:

Gyening arrived at the factorized form of the quadratic expression ax^2+bx+c where $a, b \text{ and } c$ are real constants and $a \neq 0$ by the use of the additive and the multiplicative identities in equivalent forms. Thus:

$$
\begin{aligned}
ax^2+bx+c &= \frac{4a}{4a}\left(ax^2+ba+c\right);\ where\ \frac{4a}{4a}=1\ (\text{multiplicative identity})\\
&= \frac{1}{4a}\left(4a^2x^2+4abx+4ac\right)\\
&= \frac{1}{4a}\left(4a^2x^2+4abx+\left(b^2-b^2\right)+4ac\right)
\end{aligned}
$$

Where $\left(b^2-b^2\right)=0$ (additive identity)

$$
\begin{aligned}
ax^2+bx+c &= \frac{1}{4a}\left(4a^2x^2+4abx+b^2-\left(b^2-4ac\right)\right)\\
&= \frac{1}{4a}\left(\left(2ax+b\right)^2-d^2\right);\ where\ d^2=b^2-4ac\\
&= \frac{1}{4a}\left(\left(2ax+b+d\right)\left(2ax+b-d\right)\right);\ difference\ of\ two\ squares\\
&= \frac{1}{h\,{}^{4a}\!/_{h}}\left(\left(2ax+b+d\right)\left(2ax+b-d\right)\right)\\
&= \left(\frac{2ax+b+d}{h}\right)\left(\frac{2ax+b-d}{4\left({}^{a}\!/_{h}\right)}\right)
\end{aligned}
$$

Where $h=$ highest common factor of $\left(2a,b+d\right)$ and $d=\sqrt{b^2-4ac}$

Thus, to factorize a quadratic expression ax^2+bx+c where $a,b\ and\ c$ are real constants and $a\neq 0$, all that is required is to determine the values of d and h, the quadratic expression ax^2+bx+c factorizes into $\left(\frac{2ax+b+d}{h}\right)\left(\frac{2ax+b-d}{4\left({}^{a}\!/_{h}\right)}\right)$.

The procedure is first illustrated with a specific example. It will then be shown that it always gives the desired factors irrespective of the nature of the coefficients.

Consider the quadratic expression $2x^2-9x-5$.

Solution

Step 1: Identify the coefficients that is $a=2,\ b=-9\ and\ c=-5$

Step 2: Determine the values of $d\ and\ h$.

$$
\begin{aligned}
d &= \sqrt{b^2-4ac}=\sqrt{(9)^2-4(2)(-5)}=11\\
h &= h.c.f\ \ of\ \ (4,2)=2
\end{aligned}
$$

Step 3: Substitute the values of $d\ and\ h$ into the d-h theorem and simplify.

Thus, $2x^2-9x-5=\left(\frac{2(2)x+(-9)+11}{2}\right)\left(\frac{2(2)x+(-9)-11}{4\left(2/2\right)}\right)$

$$=\left(\frac{4x+2}{2}\right)\left(\frac{4x-20}{4}\right)$$
$$=(2x+1)(x-5)$$

Thus, the factors of $2x^2-9x-5$ is $(2x+1)(x-5)$.

Factorize the quadratic expression, $48x^2-86x+35$

Solution: $48x^2-86x+35$; $a=48,\ b=-86,\ c=35$

$$d=\sqrt{(-86)^2-4(48)(35)}=\sqrt{676}=26$$
$$h=h.c.f\ \ of\ \ (96,-60)=12$$

Therefore, $48x^2-86x+35=\left(\frac{2(48)x+(-86)+26}{12}\right)\left(\frac{2(48)x+(-86)-26}{4\left(48/12\right)}\right)$

$$=\left(\frac{96x-60}{12}\right)\left(\frac{96x-60}{16}\right)$$
$$=(8x-5)(6x-7)$$

Advantages of the d-h Theorem

According to Gyening (1988), the d-h theorem has the following advantages:

I. The d-h theorem approach does not involve any searching or trial and error.

II. Because the formula does not require the teaching of any highly specialized pre-requisite skills, it can be taught within the shortest possible time thereby saving teaching time for use in practicing the skill.

III. The formula can be used to factorize all forms of quadratic expressions irrespective of their numerical coefficients. The formula is, therefore, not restricted in its application

IV. It has the advantage of extending factors into the complex domain for the benefit of high achievers or the science students.

The above strengths of the d-h theorem make it holds promise of proving superior to other methods of factorizing quadratic expressions.

METHODOLOGY

The sample of the study was the 2009/10 students of Akro Secondary Technical School, Odumase Krobo, Eastern Region of Ghana. The choice of the school was by convenience because the researcher was a mathematics teacher in the school. The student population consists of students from rural in majority and minority from urban areas. The school have four departments: General Arts, Agric-Science, Technical and Home Economics. Since it was first term of SHS1, students who reported were not many, therefore, Technical and Home Economics classes were combined to form one group and Agric-Science and General Art's classes were also combined to form another group. After the pre-test the Technical and Home Economics classes' performance was below that of Agric Science and General Arts classes. Therefore, the Technical and Home Economics classes were chosen as the experimental group. In this wise, if the average score of the Technical and Home Economics classes becomes the same or better than that of the Agric-Science and General Arts classes on the subsequent tests which will be conducted during and after the treatment, then with much confidence it can be concluded that the treatment was effective.

The essence of the pre-test, Test I, was to help in choosing the better class as the control group and the other as the experimental group. Both groups had five instructional and practice period each period consist of 30 minutes. Scores on the tests two to six were obtained during and after the treatment were used for the analysis and in evaluating whether the skill taught could be applied effectively by the students. Both the control and experimental groups took the same tests. The seventh test was obtained three weeks after the treatment to see if students from each group could remember what they have learnt. In the determination of the effectiveness of the d-h theorem, comparison was also made between students' scores on all the tests.

The instruments used for collecting the data were six achievement tests. The test one to four consisted of three items each and test five to seven consisted of five items each. The scores on the respective tests were then converted to twenty percentage scale. The items on the test were selected from SSS 1 Mathematics (core) textbook (Amisah et al 1991 p 43 – 46) and the researcher, on the other hand, constructed some of the test to increase the difficulty level. All test were discussed with other mathematics tutors in the school in respect of content and face validity. The scoring of the tests was done manually. Solution of each item was broken into steps and partial credits were awarded

The reliability coefficients of the tests were determined by the Cronbach Alpha method. This method was chosen because partial credits were awarded in scoring the responses on all tests. This helps to find out if the test was measuring what the tester intend to measure. The

Cronbach Alpha method is given as $r_{11} = \frac{n}{n-1}\left(\frac{\sigma_t^2 - \sum_{i=1}^{n}\sigma_i^2}{\sigma_t^2}\right)$,

Where r_{11} = coefficient of reliability

n = number of items

σ_t^2 = variance of the entire test

σ_i^2 = variance of the *i-th* item

The Wilcoxon Rank-Sum Test was the test statistic used to test the hypotheses which is given as $Z = \dfrac{T - \dfrac{N(N+1)}{4}}{\sqrt{\dfrac{N(N+1)(2N+1)}{24}}}$' where T = sum of the positive ranks and N = sample size.

RESULTS AND DISCUSSION

Background of the Students

There were 36 students in experimental group and it was made up of 12 girls. The control group also had 36 students, 18 of whom were boys. The ages of the students in the sample ranged from 15 to 21 years. The control group had a mean age of 16.75 with modal age of 16 years while the experimental group had a mean age of 16.72 with modal age of 15 years. The students mostly had their Junior High Schools education in town and villages. Their results of most of the students were grade 4 or 5 in English, Science and Mathematics. Majority of the parents were traders and farmers with basic education level.

Test Reliability

The table 1 below showed the Cronbach Alpha reliability coefficients statistics. The reliability coefficient of the test ranges from 73 to 89 percent. From the table, the fifth test had the highest reliability coefficient while the test two had the lowest reliability coefficients. However, the reliability coefficients for all tests were above 70 per cent. This shows that to a large extent the test measure what it intended to measure. Therefore, the tests were reliable and measured what it indented to measure.

Table 1. The Cronbach Alpha Reliability Coefficients Statistics

Tests	n	σ_t^2	σ_1^2	σ_2^2	σ_3^2	σ_4^2	σ_5^2	$\sum \sigma_i^2$	r_{11}
Test I	3	14.4336	2.1849	2.1983	2.6689			7.0521	0.7671
Test II	3	21.8445	4.8865	3.9707	2.3398			11.1969	0.7311
Test III	3	25.0323	3.9314	3.6251	3.6634			11.2199	0.8277
Test IV	3	26.2316	4.1346	3.7508	3.7122			11.5976	0.8368
Test V	5	32.9843	2.6165	2.6640	1.9767	1.1598	1.1650	9.5819	0.8869
Test VI	5	28.8933	2.6689	2.6728	2.7614	1.3965	0.7839	10.2835	0.8051
Test VII	5	22.5145	2.3916	2.1466	2.1240	0.8179	0.4833	7.9634	0.8079

Comparing the Performance Experimental and the Control Groups in the Tests

The descriptive statistics in table 2 below shows the summary of the performance in both groups. From the table, some students score as low as zero except in the fourth test of the experimental group where the minimum score was two. In all the tests the maximum scores out of twenty were 17 and 20 from the control and the experimental group respectively. From the table, on average the control group performed better than the experimental group on tests one and two, however, from the test three to seven as the test became progressively difficult the performance of the control group declined on average. Comparing the median scores, the experimental group performance is better than that of the control group from test III upwards.

All these showed that the d-h theorem has a promise for the core mathematics curriculum. Considering the mean and the median it is clear that the scores are not normally distributed hence the use of the Wilcoxon Rank-Sum Test.

Table 2. Comparative Performance in the Tests over Time

	N	*Mean*	*Std. Dev*	*Min*	*Max*	*Percentiles*		
						25th	*Median*	*75th*
Experimental Test I	36	7.28	3.947	0	12	4	8	10
Experimental Test II	36	8.74	5.578	0	18	4.32	11	13
Experimental Test III	36	7.52	6.017	0	18	0	7.5	12
Experimental Test IV	36	7.19	5.120	2	20	3.25	7	9
Experimental Test V	36	6.25	4.625	0	15	2	5.5	10.75
Experimental Test VI	36	7.61	4.704	0	16	4.25	9	11
Experimental Test VII	36	7.22	4.952	0	20	4	7	9
Control Test I	36	9.19	5.137	0	16	5.5	11	13
Control Test II	36	12.00	3.964	0	15	12	12	15
Control Test III	36	3.28	4.227	0	14	0	1.5	6.5
Control Test IV	36	4.25	5.342	0	17	0	1.5	8.75
Control Test V	36	4.50	4.925	0	13	0	1.5	10
Control Test VI	36	4.25	5.342	0	17	0	1.5	8.75
Control Test VII	36	3.58	4.519	0	14	0	1.5	7.75

The Wilcoxon Rank-Sum Test results were summarised in table 3 below. From the table, in the first test I, there was no significance difference in the performance of the control and experimental groups. Considering test II, the ranks of the absolute values of the difference between both groups showed that the performance of the control group was superior to that of the experimental group with 11 scores out of 36 ranked positive with Z(2.636) and p-value of 0.008. Therefore, the performance of the control group was superior. This confirmed the fact that the experimental group was learning a new concept while the control group is still dealing with a concept which they had been taught at Junior High Schools. Also, the test items were not difficult.

The ranks of the absolute values of the difference between both groups in test III showed that the performance of the experimental group was superior to that of the control group with 23 scores out of 36 ranked positive with Z(3.098) and p-value of 0.002. Therefore, at 5 percent level of significant, the performance of the experimental group was superior. Considering test IV, the ranks of the absolute values of the difference between both groups showed that the performance of the experimental group was superior to that of the control group with 21scores ranked positive. The Z value of 2.621and p-value of 0.009 showed that at 5 percent level of significant, the performance of the experimental group was superior.

Table 3. The Wilcoxon Rank-Sum Test Results for both Experimental and Control Group

	Ranks	*N*	*Mean Rank*	*Sum of Ranks*	*Z*	*Asymp. Sig. (2-tailed)*
Experimental Test I - Control Test I	Negative Ranks	23	18.7	430	-1.889	0.059
	Positive Ranks	12	16.67	200		
	Ties	1				
	Total	36				
Experimental Test II - Control Test II	Negative Ranks	23	19.63	451.5	-2.636	0.008
	Positive Ranks	11	13.05	143.5		
	Ties	2				
	Total	36				
Experimental Test III - Control Test III	Negative Ranks	8	11.25	90	-3.098	0.002
	Positive Ranks	23	17.65	406		
	Ties	5				
	Total	36				
Experimental Test IV - Control Test IV	Negative Ranks	5	14.5	72.5	-2.621	0.009
	Positive Ranks	21	13.26	278.5		
	Ties	10				
	Total	36				
Experimental Test V - Control Test V	Negative Ranks	11	13.32	146.5	-1.992	0.046
	Positive Ranks	20	17.48	349.5		
	Ties	5				
	Total	36				
Experimental Test VI - Control Test VI	Negative Ranks	7	12.36	86.5	-2.656	0.008
	Positive Ranks	21	15.21	319.5		
	Ties	8				
	Total	36				
Experimental Test VII - Control Test VII	Negative Ranks	7	13.14	92	-3.060	0.002
	Positive Ranks	24	16.83	404		
	Ties	5				
	Total	36				

From the table, test V, the ranks of the absolute values of the difference between both groups showed that the performance of the experimental group was superior to that of the control group with 20 scores ranked positive with Z value of -1.992 and p-value of 0.046. Therefore, the performance of the experimental group was superior. Also, from test VI, the ranks of the absolute values of the difference between both groups showed that the performance of the control group was still superior to that of the experimental group with 21 scores ranked positive with Z value of 2.656 and p-value of 0.008. Therefore, the performance of the control group was superior. Finally, in test VII, the ranks of the absolute values of the difference between both groups showed that the performance of the experimental group was superior to that of the control group with 24 scores ranked positive with Z value of 3.06 and p-value of 0.002. Therefore, the performance of the experimental group was superior.

From the results, it was clear that the performance of the experimental group was better than that of the control group in test III to VII, the test items were progressively difficult as a result the performance of the control group declined while the performance of the experimental group progressively improved. This performance upheld the alternative hypothesis that immediately following the treatment, there is significant difference between the mean scores of the experimental group and the control group on the tests. Also, the performance of the experimental group in test VII was superior to that of the control group. This showed that students in the experimental group remember the d-h theorem and applied it more than they counterpart in the control group. This performance also upheld the alternative hypothesis that three weeks after the treatment has ended, there is significant difference between the mean scores of the experimental group and the control group on a test. These conclusions implied that the d-h theorem has the power that overcomes the inherent problems in the conventional methods of factorising quadratic expressions.

CONCLUSION

This study compared the performance of students who were taught new concept d-h theorem, experimental group, and the control group who were taught the conventional method of factorising quadratic expression. Both groups were given the same instructional hours and took the same test items. The results showed that, at 5 per cent level of significant, the experimental group performance was superior to that of the control group. In terms of remembering the concept after three weeks the performance of the experimental group was also superior to that of the control group. In sum, it is clearly showed that students learnt the d-h theorem well and able to remember and applied it better than their friends in the control group who used the conventional method of factorising quadratic expression. So the the d-h theorem has the power that overcome the inherent problems in the conventional methods. Therefore, a nationwide study is recommended to verify the feasibility of the d-h theorem and subsequent inclusion in the core mathematics curriculum to help solved the problem of factoring quadratic expression in Ghana, Africa and the world at large.

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ISSN-L: 2307-3713, ISSN: 2307-3721
Vol. 2 No. 3 December 2013

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