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Comparing Conventional Methods and Equivalent Simultaneous Linear Equation Method of Solving Quadratic Equations: A Case Study of Bagabaga College of Education

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ABSTRACT: The conventional methods of solving quadratic equations have inherent limitations that tend to affect their teaching and learning. It is against this backdrop that this study explored the use of Equivalent Simultaneous Linear Equations method in solving quadratic equations in Bagabaga College of Education. A purposive sampling technique was used to select level 100 Social Studies and French students. The sample size for the study was 100 students. The students were divided into two groups of 50 each. Group 1 was taught the conventional methods while Group 2 was taught the ESLE method. The research design was an action research. The methods employed for the study were interview, pre-test and post-test exercises. The exercises were marked, scored and analysed using descriptive statistics and paired samples t-test. The results show that there is no statistically significant difference in the mean scores obtained from pre-test exercise between Group 1 and Group 2 students using conventional methods of solving quadratic equations. The post-test exercises show that there is a statistically significant difference in the mean scores obtained between Group 1 students using conventional method (45.2) and Group 2 students using ESLE method (63.5) in solving quadratic equations. In the light of the findings of the study, it is recommended that policy makers and curriculum developers should strongly consider the inclusion of the ESLE method in the educational curriculum for teaching and learning in all Colleges of Education.

KEYWORDS: Quadratic equation, factorization, graph method, quadratic formula and equivalent simultaneous linear equation
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I. INTRODUCTION

The theory of algebraic equations in which the fundamental difficulty is the solution of an nth–degree equation in one variable such as $a_nx^n+a_{n-1}x^{n-1}+ a_{n-2}x^{n-2}+\ldots+ a_1x+a_o = 0$, where $a_n \neq 0$, gradually began to occupy a central place in mathematics since the nineteenth century [1]. Britton and Bello (1979) define a quadratic equation as a second-degree sentence whose standard form is $ax^2+bx+c=0$, where a, b, c are real numbers and $a\neq0$ [2]. Evans (1959) states that "if a conditional equation in one letter is such that its sides are polynomials of degree two or less, so that by appropriate use of the laws of equality it can be put in the form $ax^2+bx+c=0$ where a, b, c are real numbers, $a\neq0$, then the equation is said to be an equation of the second degree or a quadratic in the letter which occurs in it" (p.72) [3]. The importance of quadratic equations cannot be over emphasized. For instance, the construction of the Holland Tunnel under the Hudson River in New York was based on a quadratic equation and its solution [4]. Also, Wheeler and Peeples (1986) indicate that the radar dishes, reflectors or spotlights, components of microphones and some cables of suspension bridges are all in the shape of parabolas. Likewise, the profit and cost functions in business equilibrium point and Laffer curve in economics, blood velocity and pollution in life sciences, and population growth in the social sciences are all models of quadratic functions [5].

Quadratic equations can be written in three forms; complete, incomplete, and reduced form. The common conventional methods for solving quadratic equations are solving by graphical method, solving by factorisation, solving by completing the square and solving by the quadratic formula [6]. According to Gyening and Wilmot (1999), each of the conventional methods of solving quadratic equations is based on a prerequisite skill [7]. However, there are difficulties

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that students face in solving quadratic equations using the conventional methods such as factorization when the quadratic equation is a non–square trinomial [8]. Therefore, this current study assessed the Equivalent Simultaneous Linear Equation (ESLE) method as an alternative of solving quadratic equations. The ESLE method was developed by [7] that use pre–requisite concepts and skills usually taught at the basic level of education. Gyening and Wilmot (1999) state that simultaneous linear equations can be taught to pupils learning the topic for the first time even in the second year of the Junior Secondary School in one lesson [7]. They argue that it is possible to use simultaneous equations as an introduction to algebra because no rules need to be learnt as the work proceeds on a basis of common sense. The importance of the ESLE method is that it helps to avoid the defects inherent in the conventional methods of solving quadratic equations. The ESLE method will also help mathematics teachers address the complaints of little time to teach students on how to memorize the conventional methods of solving quadratic equations.

II. STATEMENT OF THE PROBLEM

According to Havi (2014), the West Africa Examination Council is worried that there is persistent errors in the solution of quadratic equations [9]. Also, according to the Institute of Education, University of Cape Coast, over 85% of level 100 students of Colleges of Education performed poorly in quadratic equation questions between 2008 and 2016 end of semester examination. The Institute states that the few students who attempted solving quadratic equation questions had difficulties in identifying constants when the coefficient of x^2 is not unity and as well as difficulties in finding the factors of the equation. Bossè and Nandakumar (2005) indicate that the factoring techniques for solving quadratic equations are problematic for students especially, when the leading coefficient or constant in the quadratic has many pairs of possible factors [10]. The inability of students to fully understand quadratic equations are shown by the way they go about in solving the process. Vaiyavutjamai and Clements (2006) pointed out that students' difficulties with quadratic equations arise from the lack of both instrumental and relational understanding of the associated mathematics [11].
According to Vaiyavutjamai and Clements (2006) students think two *x*s in the equation $(x-3)(x-5)=0$ stood for different variables [11]. Vaiyavutjamai and Clements (2006) emphasised that students' performance in that context reflects a lack of relational understanding [11]. While an instrumental understanding of factorizing quadratic equations with one unknown requires memorizing rules for equations presented in particular structures, relational understanding enables students to apply these rules to different structures easily [12]. Skemp (2002) argues that when students have relational understanding, they can transfer knowledge of how both rules and formulas worked and why they worked from one situation to another [13]. There is growing consensus that whatever students learn, they must learn with understanding. Hiebert and Carpenter (1992) in the work differentiated between conceptual and procedural understanding [14]. Procedural knowledge isolated from conceptual meaning can result in misunderstandings or instrumental understanding [13, 14]. One of the methods of solving quadratic equations that have received little attention is the ELSE method. The purpose of this study was to explore the use of the Equivalent Simultaneous Linear Equation (ESLE) method as an alternative method in solving quadratic equations in Bagabaga College of Education.
The findings of this study will help Ghana Education Service to organize in-service training on the use of the ESLE for solving quadratic equations. The study will also inform mathematics educators and policy makers on considering the method to be used in schools and colleges of education curriculum development. Furthermore the findings will add to the existing body of knowledge that policy makers and teachers have concerning methods of solving quadratic equations. The paper is organised into four sections. The first section is the background to the study and problem statement. The succeeding section provides the various methods of solving quadratic equations. The penultimate section presents the materials and methods used for the study. The section presents the results and conclusions of the study.

III.LITERATURE REVIEW

A. Graphical method

Butler and Banks (1970) asserted that the graphical method is not strictly an algebraic method and can give only approximate solutions [6]. The graphical method has the advantage that students can actually see the answers in the graphical method if a convenient scale is used to draw the graph accurately. However, the difficulty in using the graphical method is that it is slow and tedious in ploting. Miller (1957) also shares the view that the real roots of a quadratic equation sometimes cannot be obtained exactly by graphical methods [15]. The disadvantage is that students

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sometimes do not know what to do when the curve does not cross the x-axis, sit, or hang on the x-axis. Vaiyavutjamai and Clements (2006) ascertain that quadratic equations taught using traditional way like graphing do not allow students to acquire relational understanding of what they are taught [11]. For example, an algebra class learning about quadratic equation might be asked purely procedural questions such as, solve the quadratic equation $x^2 - x - 6 = 0$. In such a problem, students can find a solution without any understanding of the structure of quadratic equation simply by factoring or use of the quadratic formula. Alternatively, a conceptually focused question might ask students to graph $y = x^2 + 6x + 8$ and explain how the x intercepts of the graph are related to the factors of the equation.

B. **Factorization method**

Factoring is an alternative way to solve quadratic equations. This means that for students to be able to use the method, they must be taught factorizing quadratic expressions first. Factorizing quadratic expressions is a common didactic topic in mathematics at both the Junior High School and Senior High School level. The factoring method consists of expressing the given quadratic equation as the product of two linear factors, each of which is set to zero. Hoffman (1976) presents two approaches for factorizing quadratic expressions through observing and grouping [16]. Hoffman (1976) shows this approach with the following second degree polynomial $3x^2 + 7x + 2$ [16]. Hoffman assets that two approach can be applied to factorize the polynomial:

Approach 1;

Step a) Multiply $3x^2$ and 2 to get $6x^2$

b) Decompose 7x into the sum of two terms whose product is 6

This gives $7x = 6x + x$.

Factorize $3x^2 + (6x + x) + 2$

$$3x^2 + (6x + x) + 2 = (3x^2 + 6x) + (x + 2)$$
$$= 3x(x + 2) + 1(x + 2)$$
$$= (x + 2)(3x + 1)$$

Approach 2;

Making the Coefficient a =1 in $ax^2 + bx + c,\ a \neq 0$

$$3x^2 + 7x + 2 = \frac{1}{3}[(3x)^2 + 7(3x) + 6]$$
$$= \frac{1}{3}[(3x + 6)(3x + 1)]$$
$$= (x + 2)(3x + 1)$$

These two approaches of factorization are dependent on skills in multiplication and division. Factoring quadratic expression is the first step to solving a quadratic equation. Hoffman approach is based on the observation of the distributive, commutative and associative laws. In this approach, observing the relationships between the coefficients to x^2 and x as well as the constant is the important starting point. Solving the quadratic equation $3x^2 + 7x + 2 = 0$ by factorization is actually to decompose the polynomial into a factoring form. $(x + 2)(3x + 1) = 0$ and to use the zero-factor property. Jackman (2005) also demonstrates a systematic procedure for factorizing $ax^2 + bx + c$ [17]. Jackman's (2005) approach follows: $ax^2 + bx + c. = (px + q)(rx + s)$ where a, b, c, p, q, r, and s are all integers [17]. By multiplying the right side we get; $ax^2 + bx + c = prx^2 + (ps + qr)x + qs$, so that $a = pr$, $b = ps + qr$, and $c = qs$. Writing the factors of a and c on two lines:

$$\begin{matrix} p & & q \\ & x & \\ r & & s \end{matrix}$$

Finding the right pairs of factors for a and c is done by listing the groups of products of different factors. For example, in the polynomial $6x^2 + 5x - 4$, the factor pairs for 6 are (6,1); (1,6); (3,2); (2,3); and the factor pairs for (-4) are (4, -1); (-4,1); (2,-2); (-2,2); (1,-4); (-4,1).

p	6	1	3	2		**q**	4	-4	2	-2	1	-1
					x							
r	1	6	2	3		**s**	-1	1	-2	2	-4	4

Using the above approach is too complicated and time consuming. Commenting on solving by factoring, Butler et al. (1970) say that when an equation such as $x^2+5x-14 = 0$ is given in factorised form as $(x+7)(x-2) = 0$, it is not always clear to students why one has the right to set the factors separately equal to zero and thus get two linear equations. The

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justification for this, they claim should be made clear to students and that the practice lacks generality in terms of real numbers. Richardson (1966) also indicates that x^2-5x+6 = 0 is equivalent to (x-2) (x-3) = 0 [18]. Solving for x, we have x-2 = 0 or x-3 = 0 which means that x can only be either 2 or 3. Richardson in the presentation below asserts that the third line is erroneous because we cannot make the number 12 a statement as "product of two quantities can be 0 only when one or the other is zero or both of the quantities are zero" [18].

$x^2-5x+6 = 12$
$(x - 2)(x - 3) = 12$
$x – 2 = 12$ or $x – 3 = 12$
$x = 14$ or $x = 15$

Zero is the only number with this property. Richardson continues to say that we factor essentially by remembering our experiences in multiplying. Hofmann (1976) supports Richardson's assertion that students who do not have a reasonably strong skill in multiplication should not be expected to develop strong skill in factorisation [16]. Studies by Reeves (1952), Miller (1957), Richardson (1966), Budnick (1985), Western and Haag (1959) stated that many quadratic equations involve trinomials either cannot be factored or are factored by trial and error means [4, 15, 18, 19 and 20]. According to Reeves (1952) it is impossible to find a quadratic equation in a real life situation that can be solved by factoring [4]. Reeves suggests that solving quadratic equations by factoring is artificial. For instance x – 6x + 7 = 0 cannot be solved by factoring. It is however claimed by Miller (1957) that solution by factoring is convenient and simple when it can be applied [15]. It is a well-known fact that students who have learned to solve quadratic equations by factoring e.g. x^2-5x+ 6 = 0 to be equivalent to (x-2) (x-3) = 0, so that x – 2 = 0 or x – 3 = 0, tend to make the following error:

$(x - 2)(x - 3) = 12$
$x – 2 = 12$ or $x – 3 = 12$

This error is very difficult to eradicate. Even with able students receiving good instruction emphasising the special role of zero in the product property, this error will continue to crop up in students' work. Matz (1980) presents a theory that explains the persistence of this error [21]. According to Matz (1980) there are two levels of procedures guiding cognitive functioning such as surface level procedures, which are the ordinary rules of arithmetic and algebra, and deep level procedures, which create, modify, control and in general guide the surface level procedures [21]. The weaknesses of using the factorization approach to solving quadratic equation are that quadratic may be prime or difficult to factor. Another weaknesses is that quadratics may seem factorable, but may not actually be and the approach is time consuming.

C. **Completing the Square Method**

A number of school textbooks treat the method of solving quadratic equations by completing the square as a procedure of putting a quadratic expression as a sum or difference of a perfect square and a number and then solving for the variable that occurs in it by taking square roots and simplifying it. Before teaching quadratic equations by completing the square, students need some firm grounding in the concept of a square root, which is more subtle than usually realized. Given a positive number q, then there is one and only one positive number r so that r^2= q. By definition, this q is called the square root of r and is denoted by r = √q. Thus, by the definition of the notation, √q is always ≥ 0. From the uniqueness of the square root, one concludes the critical fact that √ab = √a √b for all positive a, b. Consider the quadratic equation $x^2 + 6x + 7 = 0$. Since $x^2 + 6x + 7$ is not a perfect square trinomial, we must find a perfect square trinomial that has $x^2 + 6x$ as its first two terms. Since one-half of 6 is 3 and $3^2 = 9$, our goal is to get $x^2 + 6x + 9$ on the left-hand side.

$x^2 + 6x + 7 = 0$	
$x^2 + 6x = -7$	Subtract 7 from each side
$x^2 + 6x + 9 = -7 + 9$	Add 9 to each side
$(x + 3)^2 = 2$	Factor the left-hand side
$(x + 3) = \pm\sqrt{2}$	Square root property
$x = -3\pm\sqrt{2}$	

From the original equation, the solution set is $\{-3-\sqrt{2}, -3+\sqrt{2}\}$. In completing the square of a quadratic expression, it is always advisable to make the coefficient of x^2 to be one (1). Discussing the method of completing the square, Butler et al. (1970) suggest that the principal function for which this method is taught is to provide a means of developing the general quadratic formula and hence it is not an end in itself as a method [6]. Western and Haag (1959) in an attempt to

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explain the method show that $(x+a)^2 = x^2+2ax+a^2$ and illustrate with $(x + 5)^2 = x^2+10x + 25$ concluding that in general, a is one half the coefficient of x [20]. Western and Haag (1959) follow it with the example below:

Solve for x. $x^2+8x+6 = 0$

$x^2+8x = - 6$ Half the coefficient of x is 4 and 42 is 16

$x^2 + 8x + 16 = - 6 + 16$ Adding 16 to both sides

$(x+4)^2 = 1\ 0$ Factoring

$x+4 = \pm\sqrt{10}$ Square root property

$x = -4 \pm \sqrt{10}$

Therefore the roots are $\{-4 + \sqrt{10}, -4 - \sqrt{10}\}$

Dave (2007) came out with an approach that avoided the use of fractions [22]. This is achieved by multiplying the quadratic equation by four (4) times the coefficient of x^2. Dave (2007) illustrated this approach with the following example: Solve $3x^2 + 14x + 8 = 0$. The general form of the equation is $ax^2 + bx + c = 0, a \neq 0$ [22]. Comparing it with the given quadratic equation a = 3, b = 14, and c = 8. As in most completing the square methods, we first remove the constant term to the other side of the equation; $3x^2 + 14x = -8$. Next we multiply through each term by the constant 4a, or in this case 12, to get $36x^2 + 168x = -96$. We can see that avoiding the use of fractions increase the coefficient of x^2, x and the constant term. The final step in completing the square is to add b^2 to both sides. In this equation b=14 so we need to add 14^2 or 196 to each side to give us $36x^2 + 168\ x +196 = -96+ 196$. By using this process we have now made a perfect square trinomial on the left side of the equation, the square of (6x + 14). The process is even simpler than it may first appear because it will always be (2a + b). We obtain:

$(6x + 14)^2 = 100$

$(6x + 14) = \pm 10$

$6x + 14 = 10$ or $6x + 14 = - 10$

Therefore the roots are: $\{-4, -\frac{2}{3}\}$

D. **Quadratic Formula**

Solving quadratic equations by factorization and completing the square is constrained within the simple quadratic equation over the whole integers and rational numbers as coefficients. The quadratic formula is a solution to such a situation. Butler et al. (1970) indicate that the general quadratic formula is important and should be thoroughly mastered by every student [6]. Its development requires the use of the method of completing the square and provides an excellent review of operations with literal symbols. The formula itself is indispensable, and every student should memorize it and use it until he is perfectly familiar with its form and meaning. It is possible in a quadratic equation under proper hypotheses of reality or rationality of the coefficients to determine the nature of the roots from a study of the discriminant alone without solving the equation. Roberts and Stockton (1957) and Brixey and Andree (1966) also agree that the quadratic formula should be memorized [23, 24]. Most school textbooks apply the method of completing the square to the general quadratic equation of the form $ax^2+bx+c = 0, a \neq 0$ to obtain the quadratic formula

$x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$ as follows:

In some European textbooks, the above formula is written in p-q form by making a =1 in the equation $ax^2+bx+c = 0$, that is:

$$x = -\frac{p}{2} \pm \sqrt{(\frac{p}{2})^2 - q} \qquad \text{with } p = \frac{b}{a} \text{ and } q = \frac{c}{a}$$

Olteanu (2007) showed that difficulties in using algebraic symbols are no longer the problem but rather how to handle the parameters or coefficients in quadratic equations like $ax^2+bx+c = 0$ and rewrite them in the equivalent form $x^2+ px+ q = 0$. Besides the formula, students have problem understanding the symbol $\pm$. Furthermore, quadratic formula is far from being sacrosanct since there is an alternative version. Olteanu (2007) observes that the advantage of the quadratic formula is that the numbers produced by the formula have been shown to be the roots and the only roots of the quadratic equation [25]. Hence, there is no logical necessity for checking the values obtained by the application of the formula except to catch mistakes in arithmetic or to catch an original equation which is transformed to fit the quadratic equation. Britton and Bello (1979) assert that examples like $3x^2 + x - 5 = 0$, which cannot be factored display the tremendous advantage of the quadratic formula over other methods of solving quadratic equations [2].

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E. **Equivalent Simultaneous Linear Equation (ESLE) method**

The method of ESLE by Gyening and Wilmot (1999) involves reducing the quadratic equation $ax^2+ bx+c = 0$ into an equivalent system of two linear equations in the form [7]:

$ax_1+ ax_2 = -b$ (1)

$ax_1 - ax_2 = d$ (2)

where x_1 and x_2 are the roots of the quadratic equation and $d = \sqrt{(b^2-4ac)}$. By solving these simultaneous linear equations, one can obtain the solution set of the quadratic equation. The method involves the following four steps:

- Compute $d = \sqrt{(b^2-4ac)}$
- Write down the simultaneous equations as
  - $ax_1+ ax_2 =-b$ (1)
  - $ax_1 - ax_2 = d$ (2)
- Solve the equations to obtain the values $x_1$and x_2
- Write down the solution set, (x_1, x_2)

The proof given to justify the method is as follows:

Let x_1, and x_2 be the roots of the quadratic equation,

$ax^2+bx+c = 0$ (1)

Then according to the well-known elementary properties of the roots of quadratic equations

$x_1+ x_2 = -b/a$ (2)

and $x_1 x_2= c/a$ (3)

multiplying equation (2) by a, we have

$ax_1+ ax_2= -b$ (4)

And from equation (3),

$ax_1x_2 = c$ (5)

Squaring equation (4) we obtain

$a^2(x_1 + x_2)^2 = (-b)^2$ (6)

Also $a^2(x_1 + x_2)^2= a^2(x_1^2 + 2x_1x_2 + x_2^2)$

And $a^2 (x_1- x_2)^2 =a^2(x_1^2 - 2x_1x_2 + x_2^2)$

So that $a^2 (x_1- x_2)^2= a^2(x_1 + x_2)^2- 4a^2 x_1 x_2$ (7)

By making use of (5), (6) and (7) we obtain

$a^2 (x_1- x_2)^2= b^2- 4ac$ (8)

Finding the square root of both sides of (8) gives

$a(x_1- x_2)=\sqrt{(b^2- 4ac)}$ (9)

Replacing $\sqrt{(b^2- 4ac)}$ in equation (9) by d gives

$a(x_1- x_2)= d$ (10)

Equations (4) and (10) constitute the Equivalent Simultaneous Linear Equations (ESLE).
The advantages of the ESLE method cannot be over emphasized because it is applicable to various forms of quadratic equations. According to Gyening (1988) it is simpler to understand and be used for teaching and learning [26]. According to Cooney et al. (1975), the ESLE method can be taught in a single lesson by using the inductive discovery strategy [27].

IV.MATERIALS AND METHODS

The research design was an action research. The study was conducted in Bagabaga College of Education. The College is a mixed sex institution that trains teachers in various disciplines including French, Mathematics, Science, Social Studies and Technical skills. The College's student population is 897 for the 2016/2017 academic year. The study sampled level 100 French and Social Studies students. A total of 100 students participated in the study. The students were put into two groups namely, Group 1 and Group 2 of 50 students each.
The study utilized pre-test exercise, which consisted of five quadratic equation questions given to students to answer in order to have first-hand information of students' capabilities in solving quadratic equation questions. The exercises were marked, scored and evaluated on the basis of the methods used to answer the questions. Interview guides were used to elicit information from students on the challenges encountered in solving the quadratic equations. The information obtained during the pre-test exercises enabled the researchers to develop the most appropriate intervention

strategies including the preparation of scheme of work, lesson plan, preparation and gathering of teaching learning materials for conventional (factorisation, completing the square and quadratic formula) method. Each group had one contact period of 40 minutes weekly for four consecutive weeks where the various approaches to solving quadratic equations were taught. Both groups were given the same attention in terms of class discussion, assignments and contact period. During the experiment session, the researchers took Group 2 class differently using the ESLE method through some activities. After the four weeks period, both Groups were re-examined. The researchers tasked Group 2 to specifically use the Equivalent Simultaneous Linear Equations (ESLE) method to solve the five quadratic equation questions while Group 1 was tasked to use the conventional methods. The field data was analyzed in Statistical Product for Service Solutions version 20. The analysis involved comparing students' mean scores for pre-test exercises and post-test exercises employing the paired-samples t-test.

V. RESULTS

The t-test was conducted to compare the Pre-test scores of conventional methods of solving quadratic equations for Group 1 and Group 2. Table 1 shows the paired-samples statistics and test for Group 1 and Group 2. The findings indicate there was no significant difference in Pre-test scores for Group 1 (M = 45.30, SD = 8.30), and Group 2 (M = 45.21, SD = 8.16; t(98) = 1.43, p = 0.961). The magnitude of the differences in the means was very small (eta squared = 0.020). This means that only 2% of the variance in scores is explained by the conventional methods used by the two groups. The results indicate that 85% of Group 1 students used the quadratic formula, while 70% of Group 2 students used the factorization method. The study also observed that 35% of the students who used the quadratic formula did not simplify the quadratic equation to get correct answers, while 25% of the students who used the factorization method were unable to get the factors of the quadratic equation right. The study confirms Sönnerhed (2009), and Taylor and Mittag (2001) assertion that students memorize procedure and rarely understand the structure of solving quadratic equations [28, 29].
Furthermore, a paired-samples t-test was conducted to evaluate the impact of the intervention on students' score on ESLE method of solving quadratic equation. The findings show that there was a statistically significant improvement in solving quadratic equations using the ESLE method for Group 2 students. Table 1 shows the paired samples statistics and test for Post-test scores for Group 1 (M = 46.24, SD = 7.17), and Group 2 (M = 63.53, SD = 8.06; t(98) = 3.69, p < 0.005). The eta squared statistics (0.12) indicated a large effect size. This implies that Group 2 students remember and apply the equivalent simultaneous linear equations more quickly for solving quadratic equations.

Table 1: Paired samples statistics and test

Descriptive statistics	Group 1		Group 2	
	Pre-test score	Post-test score	Pre-test score	Post-test score
Mean	45.30	46.24	45.21	63.53
Standard Error of Mean	1.17	1.01	1.15	1.14
Standard Deviation	8.30	7.17	8.16	8.06
Variance	68.88	51.36	66.64	64.91
Minimum score	28	31	30	45
Maximum score	60	65	63	79

Source: Computed. Sig. (2-tailed) Pre-test p = 0.961; Post-test p < 0.961

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VI. CONCLUSION

The findings show that the ESLE method had a positive impact on students' capabilities in solving quadratic equations. It is evident in the study that the ESLE method can be taught in Colleges of Education as an alternative method to solving quadratic equations. It is clear that ELSE method has the tendencies of helping students to overcome the problems inherent in the conventional methods of solving quadratic equations. The promotion and use of the ESLE method is possible if Ghana Education Service and other important educational stakeholders help in instituting regional workshops and seminars for mathematics teachers to share experiences and skills on how to teach the ESLE method. This will enable mathematics teachers to rapidly cover the syllabus because the ESLE methods can reduce the length of

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time to teach and learn quadratic equations. The study therefore recommends that policy makers and curriculum developers should strongly consider the inclusion of the ESLE method in the educational curriculum for teaching and learning in all Colleges of Education.

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