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Effects of Lesson Study on Students' Self-Efficacy, Motivation and Performance in Learning Algebra

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ABSTRACT

This study explores the effects of Lesson Study on Junior Secondary School students' self-efficacy, motivation, and performance in algebra. Utilizing a pre-test, post-test quasi-experimental design, a sample of fifty-seven (57) students participated in the study. Three research questions and three hypotheses guided the study. The instruments used for data collection were the Mathematics Self-efficacy Questionnaire (MSQ), Mathematics Learning Motivation Questionnaire (MLMQ) and Algebraic Expression Achievement Test (AEAT). All the three instruments were validated and found reliable. The data collected were analyzed using both descriptive and inferential statistics at 0.05 level of significance. Results revealed that Lesson Study significantly enhanced students' self-efficacy by almost 14%; motivation by 19% and performance in algebra by 25%. The study therefore recommends that mathematics teachers should incorporate Lesson Study as a teaching strategy to boost students' self-efficacy, motivation, and achievement in learning algebra. Furthermore, it advocates for policymakers to support continuous teacher training and professional development on the use of Lesson Study to enrich instructional quality and improve students' learning outcomes.

Keywords: Lesson Study, Motivation, Algebra, Self-efficacy, Secondary Schools, Mathematics Performance.

Introduction

Algebra is an important topic in mathematics because of its connection to other mathematics topics (Susac et al., 2014). It also connects mathematics to other areas of science (Didis & Erbas, 2015). Despite its importance, students face a number of challenges in learning it. For instance, Gunar and Uygun (2016) reported that students got frustrated and lost interest in learning algebra because of its abstract nature. Some other studies have found students' poor self-efficacy (Fernandez & Yoshida, 2013) and lack of motivation (Karigi & Tumuti, 2015) as the main causes of students' poor performance in mathematics. Different researchers have employed various teaching approaches and strategies with a view to improve students' understanding and performance in mathematics (Alabi & Sanni, 2021; Scheper et al., 2017). Lesson Study is among these approaches. It is a teacher professional development that originated from Japan, and was found to be one of the most effective, widely accepted and fastest growing teacher professional development (Dudley et al., 2019). The approach provides the opportunity for teachers to observe cyclic process in teaching, reflect over what transfers in the previous session, problems observed are addressed in the next lesson. This cycle continues until a better teaching and learning experiences are achieved (Cajkler, et al., 2014). Moreover, due to the strong involvement of teachers and researchers in a Lesson Study, it provides an avenue for both to integrate their various experiences and expertise into a teaching design that leads to better learning outcomes (Dudley et al., 2019; de Vries et al., 2016). The approach is reported to be very effective in enhancing teachers pedagogical content knowledge, addressing challenges of students' learning, as well as improving students' learning outcomes (Lewis & Pery, 2017; Dudley 2013; Jansen et al., 2021). Cajkler, et al. (2014) found that, students who were taught by teachers that were engaged in Lesson Study develop higher confidence in their abilities. Similarly, the iterative cycle of planning, teaching and reflecting inherent in Lesson Study inculcate adaptation and development of lessons that are more relevant and engaging for students, which leads to higher motivation (Jansen et al., 2021).

Many studies have been conducted on the effectiveness of Lesson Study on various students' learning out comes in mathematics both locally in Nigeria (Lawal & Adeneye, 2019) and internationally (Intaros & Inprasitha, 2019; Huang & Shimizu, 2016). However, none of these studies was found to have been conducted specifically on learning Algebra which is a fundamental concept in mathematics, and as a correlate to non-cognitive variables such as self-efficacy and motivation especially at the secondary school level, particularly in Nigeria. Therefore, this study aims to fill this gap.

Literature Review

Collaboration approaches, such as lesson study, offer teachers' valuable opportunities to refine their instructional methods to better meet students' needs. This study draws upon Bandura's (1986) social cognitive theory, which posits that individuals develop self-beliefs through observing and mastering tasks.

Lesson study supports this process by helping teachers design engaging and effective lessons that foster students' confidence and persistence (Lewis, 2016).

Moreover, the model is grounded in Deci and Ryan's 1985 self-determination theory, which recognizes competence, autonomy, and relatedness as central elements for fostering intrinsic motivation. According to the theory, motivation increases when learners perceive themselves as being competent, autonomous, and related to others. In lesson study, teachers have the ability to develop learning experiences that alter students' attitudes and promote belief in their ability to solve complex mathematical problems developed by Takashi & McDougal, 2016.

Lesson Study is a professional development approach originated in Japan in the 1870s (Lewis, 2002). It is a form of collaborative professional development that involves teachers, researchers as well as students. The approach gradually developed and get accepted in the Japan's Ministry of Education as an authentic and effective way of improving teaching practices, and later as a professional development strategy. In the last three decades or so, Lesson Study has received international recognition and adaptation. Lesson Study is now recognized and practiced in over 100 countries including United States, Australia and Southeast Asia (Lewis, 2002). Hence, the global interest in the adaptation of Lesson Study in various countries and contexts has generated different models of Lesson Study, incorporating technology and diverse teaching contexts. This demonstrates adaptability and effectiveness of Lesson Study in improving teaching practices as well as better students' learning outcomes (Seleznyov, 2018)

The strategies of Lesson Study are effective in getting the teachers reflect on their practice as they engage more on it and comprehend their work better (Dudley et al., 2019). Several studies suggest that Lesson Studies are very useful in the professional development of teachers across different subjects, although they have been especially effective and widely adapted in the field of mathematics (Lewis, 2002). According to the findings of Fernandez and Yoshida (2004) the application of LS improved teachers' mathematical knowledge and self-efficacy. Moreover, in their investigation, Takahashi and McDougal (2016) proved that LS enhanced teacher self-efficacy and students' performance in mathematics. Lesson study was found to promote collaboration and reduce isolation and promote confidence (Takahashi & McDougal, 2016). Also, Delahunty, Ní Shúilleabháin, and Waters (2023) noted that maths teachers' self-efficacy levels affected their participation in LS, where teachers with high self-efficacy demonstrated high levels of interest in social engagement in professional development. Boyacı and Erdamar Koç (2023) found that the application of LS as a model had a positive effect on the participants' attitude towards the profession and increased their self-efficacy. Mynott and Michel (2022) also investigated the promotion of LS with the differentiation that 'invisible leadership' in LS process helps achieve the goal of providing assistance while also welcoming teachers to resolve problems independently. Gholami and his colleagues (2019) showed that the LS model considerably advanced the students' problem solving skills and HOTS levels in the experimental group whilst in the advanced traditional group no such improvements were noted. Saran, R. (2018) highlighted that PCK and LS model used in combination augmentation the pre-service teachers in selection of best instructional strategies, content deliveries and teaching confidence in mathematics. This underscores the importance of teacher conviction in changing their teaching techniques and the way LS helps pedagogues build such conviction.

In several other studies apart from these there is supportive evidence showing the effectiveness of Lesson Study in increasing the motivation of the learners which is of great essence for greater student success, especially in subjects that require a lot of hard work such as mathematics.

Gholami et al. (2020) showed that the motivation of the experimental group increased significantly, showing evidence about the effects of LS on any motivation of students to learn. In addition, the cooperative environment that LS creates helps in group interaction as well as a helpful approach to solving problems, thereby making learning interesting and lively. Such involvement motivates learners but also creates a deeper bond between the learners and what they study thus, reinforcing the view that motivation is not something given but something brought about. The LS approach, which is intrinsically and collectively reflective, creates an ecosystem in which the learners are encouraged actively to learn and solve problems (Seleznyov, 2018).

The primary goal of LS is to enhance students' academic performance, and multiple studies have shown that the model significantly improves academic achievement in mathematics. Gholami et al. (2020) found that students who participated in LS-based lessons showed a 12.5% increase in achievement scores, demonstrating the effectiveness of LS in enhancing students' academic outcomes. Similar results were reported by Aykan (2024), whose study indicated a 12% improvement in students' mathematics achievement when taught using the LS model compared to traditional methods.Dudley et al. (2019) also observed significant gains in student performance, with a 20% increase in achievement in the experimental group, further solidifying the positive impact of LS on student academic success. This finding is echoed in the study by Lawal and Awofala (2019), who noted that students in the LS group achieved significantly higher scores on mathematics assessments compared to those in the control group. The evidence consistently supports the idea that LS improves students' academic achievement by fostering a more engaging and reflective learning environment that encourages active participation and deep understanding.

In Nigeria, the study by Ogoke et al. (2022) had established that a modified LS technique when implemented in some selected Imo State schools, improved the academic achievement of students in mathematics by 22%. While many studies have documented the effectiveness of Lesson Study to enhance students' self-efficacy, motivation, and performance in mathematics at different levels and contexts of learning, there is a gap which is yet to be addressed in Junior Secondary School Students, specifically in Nigeria. This scarcity is more in algebra which is a critical area of mathematics. This study, therefore, intends to fill this gap.

Purpose of the study

This study investigated the effects of Lesson Study on Students' self-efficacy, motivation and performance in algebra. Specifically it seeks to determine the followings:

1. The effect of school-based Lesson Study model on Junior Secondary School Students' self-efficacy in learning Algebra
2. The effect of school-based Lesson Study model on Junior Secondary School Students' motivation in learning Algebra
3. The effect of school-based Lesson Study model on Junior Secondary School Students' performance in Algebra

Methodology

A quasi-experimental with pre-post approach is the research design employed in this study, in which a repeated measure type of experimental study was used to collect quantitative data for the study. A repeated measure design is a type of experimental design in which a single group is used to measure the effects of different treatments with the being its own control (Creswell, 2014). In the design, the outcomes of the group after one treatment are compared with its outcomes after another treatment(s).

Table 1: Repeated Measure Design

Select participants for group	Measure or observation	Experimental treatment 1	Measure or observation	Experimental treatment 2	Measure or observation

Participants

A purposive sampling was used to select Junior Secondary school II of a particular secondary school for the conduct of the study. The researchers choose JSS II because it is the early stage of students' encounter with algebra particularly algebraic expansion (FGN, 2014). An intact class of the JSS II was used as the sample of the study. A total of 72 students participated in the study. The participants comprised of both male and female students.

Rationale, Planning and Implementation of the Lesson Study.

The study was prompted by the reports of students' weakness and problems in algebra as indicated by studies such as (Didis, 2015; Gunar & Uygun, 2016) These difficulties affect students future learning since algebra has connection to future topics such as quadratic equation, logarithms and other higher polynomials among others. It is because of this that the faculty of educational technology education of Abubakar Tafawa Balewa University Bauchi embark on Lesson Study to improve the problem since it is proved to be effective at improving students' learning outcomes as indicated in studies such as (Aykan, 2024; Lawal, 2019).

The researchers begin by seeking for approval from the management of the university, through which a sponsorship was obtained from the Tertiary Education Trust Fund (TETFund) for the conduct of the study. Thereafter, the researchers carried out a series of planning meetings chaired by the principal investigator.

During the initial meetings, the participating school was purposefully selected by the research team. Hence, consent and permission were obtained from the school management. Two mathematics teachers of the targeted class were added to the research team. Therefore, five researchers and two mathematics teachers made up the research team. A member of the research team who is an expert on think-pair-share teaching strategy gave a training to the mathematics teachers on the teaching strategy which is adopted for use in the study. Other required materials for the conduct of the study such as: Lesson Plan, Lesson Notes, Data Collection Instruments, Activity Sheets for students, provision and testing of cameras for recording of the Lesson Study processes.

The last part of the preparations was a micro-teaching in order to test the accuracy and suitability of all the prepared materials and tools and also to amends any area that appears to have any issue. The micro teaching also allows for the participating teachers to rehearse how to teach using the think-pair-share strategy in order to ascertain their level of understanding of the teaching strategy before the implementation of the Lesson Study. The micro-teaching was conducted just the way the lesson study will be implemented, with teacher A first presenting and recorded. the video record of his presentation was played and revied thereafter, then teacher B also presented his lesson. All the micro-teaching videos were viewed collectively by the research team and adjustments were made before the main Lesson Study.

Data Collection

Three instruments were used to collect data for the study. They are the Algebraic Expression Achievement Test (AEAT), Mathematics Self Efficacy Questionnaire (MSQ) and Mathematics Learning Motivation Questionnaire (MLMQ): the AEAT was developed by the research team, it consists of 25 multiple choice items. The AEAT was developed the research team. It was validated by two experienced mathematics teachers who have more than 10 years of teaching experience and an expert in measurement and evaluation from the faculty of mathematics education from Abubakar Tafawa Balewa University, Bauchi. The instrument was tested for reliability using the Cronbach Alpha reliability and a reliability coefficient of 0.87 was obtained and therefore the instrument was found to be reliable; the Mathematics Self Efficacy Questionnaire (MSQ) was adopted and used in the study, it has a reliability coefficient of Cronbach Alpha 0.90 therefore, it is considered reliable; the (MLMQ) with reliability index of 0.98 was adopted from Zakariyya and Barattucci (2021). All the three instruments were first administered after the use of conventional teaching method for teaching and then re-administered after Lesson Study was used in teaching the concept of algebraic expansion.

Data Analysis

Data collected were analyzed using descriptive statistics and inferential statics. Specifically, mean and standard deviation were used in answering the research questions and paired sample t-test were used in testing the hypotheses at .05 level of significance all with the use of SPSS.

Results

The results of the effect of Lesson Study on the self- efficacy of Junior Secondary School Students in Algebra is presented in Table 1 to answer Research Question 1

Table 1: Mean and Standard Deviation of Pretest and Posttest of Students' self- efficacy scores

S/N	Items	Pre Test		Post Test		Percentage Gained
		Mean	SD	Mean	SD	
1	I believe I am the type of person who can solve Algebra	3.28	1.03	3.86	0.95	17.7%
2	I feel confident when using Algebra outside of school	3.96	0.98	4.02	0.92	1.5%
3	I believe I can complete all of the assignments in a Algebra class	3.56	1.15	3.95	0.97	10.9%
4	I believe I am the kind of person who is good at Algebra	3.44	1.45	4.02	0.89	16.9%
5	I am confident I can understand the basic concepts of algebra	3.47	1.02	4.00	1.02	15.3%
6	I believe I will be able to use Algebra in my future career when needed	3.56	1.08	4.02	0.88	12.9%
7	I feel confident enough to asks questions in my Algebra class	3.82	1.15	4.00	0.91	4.7%
8	I believe I can get an excellent when I am in Algebra class	3.73	1.04	3.84	0.99	2.9%
9	I want to do well in Algebra because it is important	4.09	0.87	4.29	0.87	4.9%
10	I believe I can do well on an Algebra test	3.72	0.86	4.07	0.88	9.4%
11	I feel that I will be able to do well in future Algebra	2.93	1.42	3.93	0.96	34.1%
12	I believe I can do the Algebra in a mathematics class	3.00	1.69	4.12	1.02	37.3%
13	I dare to express my opinion when studying Algebra in group	3.12	1.28	3.96	0.99	26.9%
14	I study various learning resources when I have difficulty working on an Algebraic problem	3.74	1.01	3.84	1.01	2.7%
15	I am confident in my way to resolve Algebraic problems without influence from friends	3.61	1.36	4.17	0.87	15.5%
Grand Total		**3.53**	**1.16**	**4.01**	**0.94**	**13.6%**

Results in table 1 above indicate that Lesson Study approach increased self-efficacy of students in Algebra. Precisely, the analysis of results indicated that the students' self-efficacy significantly rose from pre-test grand mean score of 3.53 and SD of 1.16 to post-test grand mean score of 4.01 and SD of 0.94 a mean difference 0.48, which means 13.6% mean gain. Furthermore, the decline in the standard deviation from 1.36 to 0.94 points to reduced variability in self-efficacy scores after the intervention, thus signifying that the improvement of students' self-beliefs has been more consistent. Such increased consistency may reflect the capacity of Lesson Study to support diverse learning needs.

Mean post-test scores for all items are higher, which would mean that students felt more confident and capable in their Algebraic capabilities after having experienced Lesson Study-based instruction. Students initially reported an increased belief that they are "the type of person who can do Algebra," with the mean moving from 3.28 to 3.86, a 17.7% increase, indicative of a stronger identity as competent mathematics learners. Confidence in using Algebra outside school and completing assignments in Algebraic class also improved, the latter with a mean gain of 1.5%, reflecting students' growing belief in their practical Algebraic abilities and in handling academic responsibilities.

On one hand, students perceived themselves as "good at Algebra" by increasing the average from 3.44 to 4.02, reflecting an increase in self-confidence in the form of almost a 17% mean gain. Students came out capable of understanding the foundational algebra concepts, as represented by means scores increased from 3.47 to 4.00, implying core-skill strengths for a 15.3% increase. Their belief in the future usefulness of Algebra rose from 3.56 to 4.02, indicating almost 13% mean increase as students began to see mathematics relevant for their career paths.

A higher willingness to ask questions in class, together with improved confidence in their potential to perform well in Algebra tests, signal that Lesson Study has positively influenced students in active engagement and academic self-belief. Confidence to do well in future Algebra courses increased by 34.1%, with scores rising from a mean of 2.93 to 3.93, suggesting that the approach instilled a more forward-looking and resilient mindset. Self-efficacy in handling Algebraic tasks independently and the ability to voice opinions in group settings also increased, recording a 26.9% mean gain in self-reliance and communication skills in Algebra contexts. Moreover, students demonstrated an increased confidence in using their own ways of solving Algebraic problems without the influence of others, as was indicated by a rise in the mean scores from 3.61 to 4.17, reflecting a gain of 15.5%. In general, it is observed that on all items, Lesson Study enhanced students' self-efficacy in Algebra.

On the other hand, the result of the effect of Lesson Study on the motivation of Junior Secondary School Students in Algebra is presented in table 2 to answer Research Question 2.

Table 2: Mean and Standard Deviation of Pre-test and Post-test motivation scores

S/N	Items	Pre Test		Post Test		Percentage Gained
		Mean	SD	Mean	SD	
1	In a Algebra class, I prefer topics that really challenge me so I can learn new things	3.09	1.45	4.02	1.04	30.1%
2	I believe I will receive an excellent grade in Algebra examination	3.68	1.43	3.82	1.36	7.1%
3	Getting good grade in Algebra is the most satisfying thing for me right now	3.44	1.36	3.91	1.02	13.7%
4	When I have the opportunity, I choose Algebra past questions and solve on my own	2.87	1.43	3.80	1.01	33.5%
5	I am confident I can understand the basic concepts such as algebraic expansion taught in mathematics	3.02	1.36	4.00	0.96	32.4%
6	If I can, I want to get better grades in Algebra class than most of the other students	3.00	1.48	3.88	1.00	29.3%
7	I think I will be able to use what I learn in Algebra to understand other subjects	3.49	1.48	4.08	0.87	16.9%
8	I'm confident I can understand difficult concepts such linear algebraic expression presented by the mathematics teacher	3.44	1.36	3.91	1.15	13.7%
9	I want to do well in Algebra because it is important to show my ability to my family, friends, employer, or others	2.70	1.36	4.08	0.83	51.1%
10	I am very interested in algebra content area of mathematics	2.86	1.34	4.05	0.91	41.6%

11	I am confident that I can do an excellent job on assignments and tests in Algebra	3.05	1.46	4.12	0.80	35.1%
12	I can do well in Algebra if my parent and teachers can give some gifts	3.53	1.48	3.98	1.04	12.7%
13	I like the topic: expansion of algebraic expression in mathematics	3.44	1.36	3.91	0.80	13.7%
14	I expect to do well in Algebra lessons	2.87	1.43	4.00	0.84	39.4%
15	I like studying mathematics because I know that it is a compulsory subject for admission to higher institutions	3.01	1.36	4.02	0.85	33.6%
16	Understanding the topics algebraic expansion of mathematics is very important to me	3.67	1.20	3.82	1.03	4.1%
17	I'm certain I can master the skill being taught in Algebra	3.35	1.44	4.12	0.78	22.9%
18	I want to get a good grade in mathematics so as not to disappoint my parent and teachers	3.68	1.25	4.15	0.73	12.8%
19	I think that learning Algebra is important because it stimulates my thinking	3.63	1.15	3.91	0.89	7.7%
20	I am sure that I can do well on mathematics tests and examinations by learning expansion of algebraic expressions	3.47	1.45	3.87	1.19	11.5%
21	I study hard in mathematics because I want to represent my school in mathematics competition	3.86	1.10	4.08	0.85	5.7%
22	I am willing to participate in Algebra class because it is challenging	3.53	1.21	3.82	1.00	8.2%
23	During a mathematics examination, I feel most fulfilled when I attain a good score	3.70	1.33	3.82	1.24	0.03%
24	I want to learn Algebra so that I can teach my friends and younger ones	3.50	1.41	4.03	1.03	15.1%
Grand Total		**3.33**	**1.36**	**3.96**	**0.97**	**18.9%**

Results from table 2 showed that Lesson Study improved students' motivation, with the grand mean score rising from 3.33 and SD of 1.36 in the pre-test to 3.96 and SD of 0.97, in the post-test, representing almost 19% improvement in mean score. This decrease in standard deviation, from 1.36 to 0.97, shows less variability in post-intervention motivation levels and, in fact, suggests that not only do students have increased motivation, but their motivations have also become more consistent. Such consistency suggests that Lesson Study may assist in creating a learning community through assisting motivational needs among a diverse group of students.

In particular, Students showed a stronger preference for challenging topics, with mean scores rising from 3.09 to 4.02, representing a 30.1% improvement, reflecting an increased willingness to engage with complex material. They also felt more confident with receiving good grades: the mean went from 3.68 to 3.82-a 7.1% mean gain. Students expressed greater satisfaction resulting from getting good grades-an increase from 3.44 to 3.91, a 13.7% gain, reflecting intrinsic motivation toward academics. In addition, students proved a keen increase in their interest to work out Algebraic problems themselves: scores rose from 2.87 to 3.80, a boost of 33.5%, and they expressed an increase in confidence in grasping basic algebraic concepts, surging from 3.02 to 4.00, a 32.4% enhancement. The desire to outperform the peers rose from 3.00 to 3.88, which shows a 29.3% gain, and emphasizes competitive motivation. The belief in Algebraic applicability to other subjects has strengthened from 3.49 to 4.08, showing almost 17% improvement. Confidence to handle

challenging concepts, such as linear algebraic expressions, grew from an average of 3.44 to 3.91, or 13.7%, and motivation to do well and please others grew from a mean of 2.70 to 4.08 or an improvement of 51.1%. Interest in algebraic content increased from an average of 2.86 to 4.05, which is a gain of 41.6%, while students' confidence in performing well on assignments and tests increased from an average of 3.05 to 4.12, or 35.1%. The average score for motivation engendered by possible rewards went from 3.53 to 3.98, which is a 12.7% gain; interest in certain algebraic expansions went from 3.44 to 3.91, reflecting a 13.7% improvement, suggesting that specific areas of algebra are of increasing interest. Optimism of performing well in Algebra increased from a mean of 2.87 to 4.00 thus showing percentage mean gain of 39.4%, while Appreciation of mathematics relevance for higher education admission increased from 3.01 to 4.02 showing an improved rate of 33.6%. Knowing the importance of algebraic concepts rose from a mean of 3.67 to 3.82, which is a 4.1% improvement, and the students' belief in mastering Algebraic skills has grown from a mean 3.35 to 4.12, showing almost 23% improvement. The motivation driven by the desire to meet others' expectations strengthened from a mean of 3.68 to 4.15, representing a 12.8% improvement, and students' recognition of Algebra as a means to stimulate critical thinking rose from a mean of 3.63 to 3.91, reflecting a 7.7% improvement. Confidence in using algebra skills for examination success improved slightly from a mean of 3.47 to 3.87, representing an 11.5% improvement, and motivation to represent their school in mathematics competitions rose from a mean of 3.86 to 4.08, indicating a 5.7% improvement. The mean scores in the willingness of students to engage in Algebra as a challenging topic increased from 3.53 to 3.82, which showed an increase of 8.2%. Likewise, satisfaction from high scores in examinations also increased from 3.70 to 3.82, reflecting an increase of 0.03%. Finally, the desire to share their acquired knowledge increased from 3.50 to 4.03, an improvement of 15.1%.

On The effect of Lesson Study on the performance of Junior Secondary School Students in Algebra. the result is presented in Table 3 to answer Research Question 3

Table 3: Mean and Standard Deviation of Pre-test and Post-test performance scores

Group	N	Mean	SD	Mean Difference	Percentage Gained
Pre-Test	57	9.05	3.45		
Post-Test	57	15.39	3.03	6.34	25.36%

The results, in table 3 indicates an improvement from a pre-test mean score of 9.05 and SD of 3.45 to a mean of 15.39 and SD of 3.03 in the posttest, resulting in a mean difference of 6.34, indicating a substantial improvement in students' performance in algebra with about 25.36% mean gain, thereby suggesting a positive effect of Lesson Study on their understanding of algebraic concepts.

To check if Lesson Study has any significant effect on students' self-efficacy in algebra. A paired sample t-test analysis was conducted and the results is presented in Table 4 for testing null hypothesis 1

Table 4: Paired Samples *t*-Test Results for Pre-Test and Post-Test Scores on self-efficacy

	Paired Difference					T	Df	Sign
	Mean	SD	Error Mean	Confidence Interval of the Difference				
				Lower	Upper			
Pre Self – Post Self	8.29	5.08	0.67	9.65	6.95	12.329	56	0.000

The results in table four showed that Lesson Study significantly enhances students' self-efficacy in Algebra, the mean of the difference between pre-self-efficacy and post-self-efficacy was 8.30 with a standard deviation of 5.08, the t-value is 12.33 with df = 56, and a p-value of.000, indicating that there is a significance. The confidence interval ranged from 6.95 to 9.65 at 95%, which also points to the positive effect of Lesson Study on students' self-efficacy in Algebra.

To determine if Lesson Study has any significant effect on students' motivation in mathematics. A paired sample t-test was conducted and the result is presented in Table 5 for testing null hypothesis 2

Table 5: Paired Samples *t*-Test Results for Pre-Test and Post-Test Scores on motivation

	Paired Difference					T	Df	Sign
	Mean	SD	Error Mean	Confidence Interval of the Difference				
				Lower	Upper			
Pre Mot – Post Mot	16.61	12.22	1.61	19.86	13.37	10.26	56	0.000

Results indicated a significant increase in the scores of students after the intervention. The mean difference between the pre-motivation and post-motivation scores is 16.61 with an SD of 12.22. The t-value is 10.26 with df =56, with a p-value of.000. The 95% confidence interval falls between 19.86 and 13.37, showing that an improvement in motivation is statistically significant. Improvement in these aspects shows that Lesson Study contributed toward higher motivation levels of students in learning algebra.

To determine if Lesson Study has any significant effect on students' performance in algebra a paired sample t-test was conducted and the result is presented in Table 6 for testing null hypothesis 3

Table 6: Paired Samples *t*-Test Results for Pre-Test and Post-Test Scores on algebra performance

	Paired Difference					T	Df	Sign
	Mean	SD	Error Mean	Confidence Interval of the Difference				
				Lower	Upper			
Pretest– Posttest	6.33	4.51	0.59	5.13	7.53	10.595	56	0.000

The results of the paired sample t-test for student performance in algebra were significant. The mean pretest to posttest difference in student performance in algebra was 6.33 with a standard deviation of 4.51. The t-value was 10.6, df = 56 with a p-value of .000, which falls within the 95% level of statistical significance. Confidence Interval: The confidence interval ranges from 5.13 to 7.53. Therefore, one may infer from this that the practice of Lesson Study benefitted students' performance in algebra.

Discussion of Findings

The findings related to the 'Lesson Study' phenomenon's effect on students' self-efficacy in algebra have shown a significant improvement with an average percentage gain of 13.6% and the paired t-test has also corroborated the positive result. Such findings show that the Algebra mathematics Lesson Study as a pedagogical approach positively facilitates the development of self-efficacy in students and is consistent with recent studies Gholami et al (2020). For example, Gholami et al. (2020) indicate that Malaysian foundation program students have an increase of 15% in self-efficacy and recommend the use of Lesson Study on a larger scale in raising students' professed ability to do mathematics. In addition, Delahunty, Ní Shúilleabháin and Waters (2023) were more concerned about the teacher's self-efficacy as a precursor to teacher engagement with Lesson Study and provided an explanation on how teacher self-efficacy is a predictor of children's self-concept. These findings are consistent with a growing body of literature demonstrating the effectiveness of the Lesson Study as a framework for building resilience and improving mathematics self-efficacy that have the potential to change teachers' and students' experience of mathematics learning (Aykan, 2024).

Referring to the effect of Lesson Study on students' motivation in algebra, the results indicate almost 19% mean gain in students' motivation in learning algebra with a paired sample t-test showing that the effect is significant. These findings provide substantial evidence that Lesson Study practices have a positive effect on students' motivation which is in accordance with other recent investigations in the domain. For instance, Gholami et al. (2020) carried out a quasi-experimental study to see the efficacy of LS on students' motivation and academic performance in Malaysia. They reported an increase of 15.8 % in motivation of LS students which implies that LS can be used as a useful tool to motivate students. In addition, Delahunty et al. (2023) sought the motivational factors that determined teachers' participation in LS and it was found that teachers with high self-efficacy experienced more motivation to engage in LS whereby motivation is no longer seen as an outcome of students but a process within the teachers.

Regarding the influence of the lesson study method on algebra performance, the data demonstrated that the mean students' performance increased by 25.36%, giving the effect of the lesson study intervention a positive response according to the paired t-test results obtained. This result is consistent with similar studies including that of Aykan (2024) and Dudley et al. (2019a) which claimed there were improvements in the students' outcomes at the end of the Lesson Study. For example, Mathematics performance in students improved after the teachers engaged the student in team teaching and lesson evaluation, as reported by Dudley et al. (2019a). Bufasi et al. (2024) also emphasized that as teachers went round the cycle of planning, teaching and critical deliberation the students' performance was heightened as the teachers modified their methods. The results of the current study, therefore, add to the increasing literature that advocates the positive role of the iterative process of Lesson Study Thinking that improves academic performance due to the supportive strategies that include feedback and multiple approaches to the same method of teaching.

These findings highlight how Lesson Study can help improve teaching and learning, showing it can tackle issues in math education (Ogoke et al., 2022; Tachie, 2020). The results show that Lesson Study is a good teaching method, backed by other research that shows similar improvements in math learning. For instance, Gholami et al. (2020) reported that students involved in Lesson Study lessons had a 12.5% rise in test scores, proving its effectiveness in boosting students' grades. Aykan (2024) also found a 12% increase in math scores for students taught using the Lesson Study model over traditional techniques.

Additionally, Dudley et al. (2019) noted a significant 20% increase in scores for students in the Lesson Study group, reinforcing the positive effects of this method on academic performance. Lawal and Awofala (2019) supported this, showing that students in the Lesson Study group performed much

better on math tests compared to those not using this approach. The evidence consistently suggests that Lesson Study enhances students' learning by creating a more interactive and thoughtful classroom that promotes engagement and understanding.

Conclusion

The findings indicate that lesson study had a positive impact on students' self-efficacy, motivation, and performance in algebra. Significant increases in mean scores, along with reductions in score variability, suggest that lesson study not only enhanced students' confidence and motivation but also led to more consistent academic improvement across classes. This demonstrates the effectiveness of lesson study as a teaching approach that can foster both individual growth and a cohesive learning environment. The results underscore the potential of lesson study to enhance key factors of learning engagement, making it a valuable strategy for mathematics education.

Recommendations

Based on the findings, it is recommended that schools integrate lesson study as a central teaching strategy in mathematics, given its potential to enhance students' self-efficacy, motivation, and performance. Teachers should receive continuous professional development focused on lesson study implementation to ensure they can adapt it effectively to diverse learning needs. Educational policymakers should support collaborative learning models such as lesson study by allocating resources and creating frameworks that encourage teachers to plan, observe, and reflect on their lessons collectively. Further research should explore the long-term impact of lesson study on self-efficacy, motivation, and academic performance in other areas of mathematics and different level of education, as well as identify specific components of lesson study that most effectively improve these learning outcomes.

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References:

Abubakar, M., Adewale, T., & Usman, K. (2020). Action research on lesson study: Boosting mathematics engagement in Nigerian secondary schools. *African Journal of Educational Development*, 7(3), 89-102.

Alabi, I. A., & Sanni, R. (2021). Effects of the think-pair-share instructional strategy on students' learning achievements in secondary school mathematics. *Abacus Mathematics Education Series*, 46(1), 118–127

Aykan, A. (2024)**.** The impact of the lesson study model on students' mathematics achievement and attitudes: A mixed-methods research. *International Journal for Lesson and Learning Studies*, 13(4), 1-18. https://doi.org/10.1108/IJLLS-05-2024-0106

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Boyacı, Z., & Erdamar Koç, G. (2023). Lesson study's effect on math teacher candidates' attitudes, self-efficacy, and teaching anxiety. *Asian Journal of Instruction, 11*(2), 23–42. https://doi.org/10.47215/aji.1353516

Bufasi, E., Čakāne, I., Greitans, K., Dudareva, I., & Namsone, D. (2024). Lesson study as a professional development model for teaching spatial ability in primary STEM. *Education Sciences, 14*(5), 512. https://doi.org/10.3390/educsci14050512

Cajkler, W., Wood, P., Norton, J., & Pedder, D. (2014). Lesson study as a vehicle for collaborative teacher learning in a secondary school. *Professional Development in Education*, 40(4), 511-529 https://www.tendfonline.com/doi/pdf/10.1080/19415257.2013.866975?needAccess=true

Choy, B. H., Tan, K. L., & Lee, C. S. (2020). Closing the achievement gap through lesson study: Evidence from Singapore schools. *Educational Studies in Mathematics*, 105(3), 321-336.

De Vries, S., Verhoef, N., & Goei, S. L. (2016). *Lesson study: A practical guide for teaching practice (Translated).* Grant Publishers. ISBN: 978-90-441-3404-9.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media.

Delahunty, T., Ní Shúilleabháin, A., & Waters, L. (2023). Unpacking the motivational variables which impact engagement in Lesson Study: Mathematics teaching self-efficacy and attitudes towards self-development. *Irish Educational Studies, 42*(4), 315–332. https://doi.org/10.1080/03323315.2023.2263437

Didis, M. G., & Erbas, A. K. (2015). Performance and difficulties of students in formulating and solving quadratic equations with one unknown. Educational Sciences: *Theory & Practice,* 15(4), 1137-1150.

Dudley, P. (2013). Teacher learning in lesson study: What interaction level discourse analysis revealed about how teachers utilized imagination, tacit knowledge of teaching, and fresh evidence of pupils' learning to develop practice knowledge and so enhance their pupils' learning.Teaching and Teacher Education, 34, 107-121. https://dx.doi.org/10.1016/j.tate.2013.04.006

Dudley, P., Xu, H., Vermunt, J. D., & Lang, J. (2019). Empirical evidence of the impact of lesson study on students' achievement, teachers' professional learning, and on institutional and system evaluation. *European Journal of Education,* 54, 202-217. https://doi.org/10.1111/ejed.12337

Dudley, P., Xu, H., Vermunt, J.D., & Lang, J. (2019a). Empirical evidence of the impact of lesson study on students' achievement, teachers' professional learning, and on institutional and system evolution: An illustrative, complex case-development exemplar in London. *European Journal of Education*, 54(2), 202–217. https://doi.org/10.1111/ejed.12337

Fernandez, C., & Yoshida, M. (2004). *Lesson study: A Japanese approach to improving mathematics teaching and learning.* Lawrence Erlbaum Associates, Inc. https://doi.org/10.4324/9781410610867

Gholami, H., Md. Yunus, A. S., Mohd Ayub, A. F., & Kamarudin, N. (2019). The impact of lesson study on achievement in mathematical problem solving and higher-order thinking skills (HOTS) among foundation level students. *International Journal of Innovation, Creativity and Change, 10*(2), 290–310. https://www.ijicc.net

Gholami, H., Yunus, A. S. M., Ayub, A. F. M., & Kamarudin, N. (2020). Impact of lesson study on motivation and achievement in mathematics of Malaysian foundation programme students. *Journal of Mathematics Education, 5*(1), 39–53. https://doi.org/10.31327/jme.v5i1.1179

Guner, P. & Uygun, T. (2016). Developmental Process of Quadratic Equations from past and Reflections on Teaching- Learning. *International Conference on Educational Research and Social Studies,* http://Eric.com.pdf.

Hauk, S., Salguero, A., & Jackson, B. (2021). Lesson study's effect on middle and high school math performance: A multiyear study. *Journal of Mathematics Education,* 14(3), 215-233

Huang, R., & Shimizu, Y. (2016). Improving teaching, developing teachers and teacher educators, and linking theory and practice through lesson study in mathematics: An international perspective. *The International Journal on Mathematics Education*. Retrieved on 24th October, 2024 from https://doi.org/10.1007/s11858-016-0795-7,

Intaros, P., & Inprasitha, M. (2019). How students' mathematical ideas emerged through flow of lesson in classroom using lesson study and open approach. Psychology, 10, 864-876. Retrieved 24 October 2024 from https://doi.org/10.4236/psych.2019.106056

Jansen, S., Knippels, M. C. P. J., & Van-Joolingen, W. R. (2021). Lesson study as a research approach: A case study. *International Journal for Lesson and Learning Studies*, 10(3), 286-301. https://doi.org/10.1108/IJLLS.12.2022-0096

Karigi, M. W., & Tumuti, S. (2015). Students and teachers attitude factors contributing to poor performance in mathematics in Kenya National Examination Council in selected public secondary school in Kiambaa division of central province, Kenya. *The Strategic Journal of Business Change and Management*, 2 (58), 316-332.

Lawal, R. F., & Awofala, A. O. A. (2019). Effect of lesson study on senior secondary school students' achievement in mathematics. *Journal of Science, Technology, Mathematics and Education (JOSMED), 15*(3), 66–76. https://www.researchgate.net/publication/368780026

Lewis, C. (2016). How does lesson study improve mathematics instruction? *ZDM Mathematics Education, 48*(4), 571–580. https://doi.org/10.1007/s11858-016-0792-x

Lewis, C., & Hurd, J. (2011). *Lesson study: A handbook of teacher-led instructional change*. Portsmouth, NH 03801-3912: Heinemann

Lewis, C., & Perry, R. (2015). *A randomized trial of lesson study with mathematical resource kits: Analysis of impact on teachers' beliefs and learning community*. In E. J. Cai & J. A. Middleton (Eds.), Large-scale studies in mathematics education (pp. 133–158). Springer. https://doi.org/10.1007/978-3-319-07716-1_7

Lewis, C., & Perry, R. (2017). Lesson study to scale up research-based knowledge: A randomized, controlled trial of fractions learning. *Journal for Research in Mathematics Education,* 48(3), 261-299 https://doi.org/10.5951/jresematheduc.48.3.0261

Lewis, C., (2002). *Lesson study: A handbook of teacher-led instructional change.* Philadelphia: Research for Better Schools, Inc.

Mynott, J. P., & Michel, D. (2022). The invisible leader: Facilitation in lesson study. *Educational Process: International Journal, 11*(3), 48-61. https://dx.doi.org/10.22521/edpij.2022.113.3

Ogoke, C. J., Nsiegbe, N. A., & Achugamonu, P. (2022). Effect of modified lesson study technique on secondary school students' academic achievement in mathematics in Obowo LGA of Imo State. *AJSTME,* 8(2), 138-144. Retrieved from https://www.ajstme.com.ng

Patel, A., & Shah, R. (2021). Sustaining math self-efficacy in middle school through lesson study: Insights from India. *International Journal of Educational Studies,* 12(5), 321-338.

Saran, R. (2018). Investigating the impact of lesson study and pedagogical content knowledge on mathematics teaching practices of minority pre-service teachers. *Journal of Urban Learning, Teaching, and Research, 14*, 37–49. Retrieved from https://eric.ed.gov/?id=EJ1195955

Schipper, T., Goei, S. L., De-Vries, S., & Veen, K. V. (2017). Professional growth in adaptive teaching competence as a result of lesson study. *Teaching and Teacher Education,* 81, 61-73.

Seleznyov, S. (2018). Lesson study: An exploration of its translation beyond Japan. *International Journal for Lesson and Learning Studies*, 7(3), 171-187. https://doi.org/10.1108/IJLLS-06-2018-0043

Susac, A., Bubic, A., Vrbanc, A., & Planinic, M. (2014). Development of abstract mathematical reasoning: The case of algebra. Frontiers in Human Neuroscience, 8(9). Retrieved 20th October 2024 from https://doi.org/10.3389/fnhum.2014.00679

Tachie, S. A. (2020). Teachers' attitudes towards Lesson Study as a viable strategy to improve the teaching and learning of mathematics. *Universal Journal of Educational Research*, *8*(6), 2326-2334. https://doi.org/10.13189/ujer.2020.080616.

Takahashi, A., & McDougal, T. (2016). Collaborative lesson research: Maximizing the impact of lesson study. *ZDM Mathematics Education,* 48: 513-526. https://doi.org/10.1007/s11858-015-0752-

Thompson, P., & White, L. (2021). Increasing middle school math self-efficacy through lesson study: A quasi-experimental analysis. *Journal of Educational Research and Practice,* 15(2), 123-137.

Zakariya, Y. F., & Barattucci, M. (2021). Development of mathematics motivation scale: A preliminary exploratory study with a focus on secondary school students. *International Journal of Progressive Education,* 17(1), 314-324.