


## Enhancing Students' Engagement in Simultaneous Equations Involving Indices with Cooperative Learning Strategy and Technology Use

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### ABSTRACT

This study explores the process of enhancing students' engagements (SE) in simultaneous equations involving indices (SEII) with cooperative learning strategy (CLS) and technology integration (TI). The concept paper sensitively expresses the need for a learning strategy (LS) and how it can change students' learning difficulties in SEII through CLS and GeoGebra (GG). Also, to specifically to answer the research questions related to quantitative findings via MAT-test and follow-up with qualitative approach through an interview on how students successfully engage in their procedural and conceptual understanding with SEII using the LS developed. Multimodal analysis with a special package for social sciences (SPSS) and qualitative study research (QSR) via NVivo were used for the research study analysis. The study finds that the LS is a critical blueprint for formulating and creating a new approach to learning school algebra and SEII.

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**Contribution/Originality:** This concepts paper articulate and designing a systematics technique to build the pupils' LS with CLS and GG through think-pair-share and social constructivism ideology phases that may take care of students learning difficulties in SEII. Thus, procedural, and conceptual knowledge to obtain mathematical challenges and concepts as well as to the interested researchers to teach mathematics and algebra.

## 1. Introduction

Engaged students, pedagogical partnerships and repertoires are the three dimensions of student engagement (SE) with the framework for engagement with mathematics (FEM). The subject of this study is the first of these sections. The first component addresses SE by requiring learners to complete a technologically assisted mathematics activity, procedural and conceptual knowledge, motivation-based cognitive engagement, and a thorough understanding of the mathematical topic (high cognition). Formulas, symbols, tables, graphs, numbers, manipulative materials, and equations are all examples of conceptual and procedural knowledge, according to [Zulnaidi and Zamri \(2017\)](#). In addition, technology-based learning connects to a wide range of real-world issues. CL promotes specific information, skills and the method by which students develop problem-solving abilities ([Zengin & Tatar, 2017](#)). GG can be used to instruct students on how to utilize GG to change mathematical notions used in constructions for a better visual representation of mathematical concepts ([Mudaly & Fletcher, 2019](#)). GG can create an environment where students may understand and appreciate the advantages of freely researching mathematical topics ([Bayaga et al., 2019](#)). Simultaneous equations involving indices (SEII) is a mathematics topic taught as part of the minimum standard in institutions of education (GSE 113 and Math 224, often known as JSS content). One of the most significant elements for students to boost their learning milestones is to use GG to construct a learning strategy for simultaneous equations. GG is a free, user-friendly, and dynamic application that encourages higher-order reasoning ([Aliyu et al., 2021](#)).

## 2. Need for this Study

There are calls for change in Nigerian secondary schools learning of SEII because of students' poor performance and challenges in simultaneous equations involving indices (SEII). The [Chief Examiner's Report \(2018\)](#) listed several students' difficulties and weaknesses in (a) addressing probability challenges, (b) interpreting word challenges into mathematical statements, (c) responding measurement questions and (d) simultaneously completing equations involving indices. The problem at hand should be solved by defining and developing a learning strategy in SEII. To obtain an in-depth understanding of the entire scenario, the study designed and developed a learning strategy (LS) with cooperative learning strategy (CLS) and GeoGebra (GG), GG, and CLS through expert evaluation form via descriptive statistics and mathematics lectures responses through interview to obtain in-depth information of the entire scenario at both pilot and actual research findings.

## 3. Background

Learners' difficulties in relating mathematical structures that involve terms and symbols from the traditional approach motivate stakeholders to raise the alarm for change by offering a rigorous training in areas of their learning problems because of poor performance in students learning simultaneous equations involving indices in Nigeria ([Ugboduma, 2013](#)). Despite the implications of mathematics' prominent position, [Usman \(2019\)](#) stated that pupils' examination performance in mathematics has remained dismal, consistently falling below 50% for the years 2014-2018. Because of generalisations and the usage of documents, as well as transforming and translating phrases into algebraic structures prior to mathematical evaluation methodologies, [Omolola \(2013\)](#) highlighted the complications in learning simultaneous equations. [Esan \(2015\)](#) asserted that most mathematics learning methods used in Nigerian secondary

schools are teacher-centred and ineffective, and he recommended cooperative learning strategy (CLS) with technology. Thus, the groups allow students to interact and learn more about the subject. Each group member is responsible for not only studying but also for teaching their peers how to help one another. Also, regarding the traditional approach utilised in solving simultaneous equations, [Zakaria and Syamaun \(2017\)](#) stated that high school pupils' theoretical and practical knowledge of mathematics was low. However, [Aliyu \(2019\)](#) claims that understanding of sketches and graphs may be learnt simply by utilising a computer, and that students who were taught using a computer understood graphs of simultaneous linear equations better than those who were taught using traditional methods.

#### 4. Objectives

The objectives of the research are to:

- i. Design and develop a learning strategy for simultaneous equations involving indices with cooperative learning strategy and GeoGebra integration.
- ii. Determine the students' engagement before and after the use of the three strategies, cooperative learning strategy with GeoGebra, GeoGebra and cooperative learning strategy among college students in Kaduna state.
- iii. Compare the effect of the three strategies, cooperative learning strategy with GeoGebra, GeoGebra and cooperative learning strategy, using the estimated marginal means in the final test scores of students' engagements and the initial test as covariate among college students in Kaduna state.
- iv. Investigate how the students successfully engage in their procedural and conceptual knowledge with simultaneous equations involving indices using the learning strategy developed.

#### 5. Research Hypothesis

- i. There is no significant effect between the students' engagement before and after the use of the three strategies, cooperative learning strategy, GeoGebra and cooperative learning strategy with GeoGebra, among college students in Kaduna state.
- ii. There is no significant difference in the estimated marginal means between the three strategies, cooperative learning strategy, GeoGebra and cooperative learning strategy with GeoGebra, in the final test scores of students' engagements and initial scores as covariate among college students in Kaduna state.

#### 6. Methodology

Students' engagement (SE) was investigated utilising a cooperative learning strategy (CLS) in simultaneous equations involving indices (SEII) with GeoGebra (GG). GG, an interactive geometry software application, will be used by the participants. The discussion in this section is in three parts with ADDIE paradigm in Design Development Research (DDR) as the first step. A quasi-experimental design is used in the second stage (pre-test and post-test) through MAT -test. Phase3 is to investigate SE success through procedural and conceptual knowledge in SEII via focus group interview. Thus, the CLS and the social constructivist principle of learning ideology were linked together to facilitate the learning process in SEII with GG integration. The purpose is the effectiveness of SEII with GG integration through CLS. Also, to determine the effect of

before and after using the three strategies, compare the impact of the three strategies in the final test scores of student engagements via special package for social sciences (SPSS), and investigate how students successfully engage in their conceptual and procedural understanding through the DDR of learning material for SEII via qualitative study research (QSR), NVivo software.

## 7. Research Timeline

The study is estimated to take three years to complete, with the following activity durations for each phase of the research projects as illustrated in [Table 1](#) below.

Table 1: Research segment and duration

S/NO	Research Segment	Time
	Title	6 months
	Introduction	3 months
	Need for this study	4 months
	Background	3 months
	Objectives	1 month
	Research Questions and Hypothesis	2 months
	Research Methodology	2 months
	Data collection, analysis, and discussion	8 months
	Summary conclusion and recommendations	3 months
	Examining work for final submission	4 months

## 8. Contribution of Research to the Body of Knowledge

In the 21st century, the learning process has shifted from the teacher transmitting the learning experience to student-centred. As a result, using participatory learning (a cooperative learning technique), technology, experiential learning, and observation to aid the learning process may be beneficial. Also, specific learning strategies in developing conceptual understanding, problem-solving, motivation, interest and creativity as learners' engagement may ease learning difficulties. Consequently, [Avcı, Kirbaslar and Sesen \(2019\)](#) argue that cooperative learning has been utilised in a small number of studies to teach all of the identified science disciplines and to help students overcome misconceptions. Thus, issues that facilitated understanding include carrying out experiments or activities to modify findings with tangible conclusions. The LS with CLS and GG learning strategy was established based on the link between the CLS and the ideology phases of social constructivism, which supports active learning and partnership through the impacts offered on the theoretical framework behind the current research. The successful integration in developing an alternate strategy is known as the LS with CLS and GG. Thus, other contributions include the following:

- i. The findings could be useful to researchers interested in the LS with CLS and GG methods to teach mathematics and algebra.
- ii. A learning structure and systematic technique for designing class activities to build students' LS with CLS and GG was established.
- iii. This is the first study in the state of Kaduna to investigate the pupils' LS with CLS and GG in SEII. Also, in learning SEII in school algebra, through the think-pair-share and social constructivism ideology phases.
- iv. The knowledge collected regarding students' general scores performance in learning SEII and algebra in Kaduna state is another addition of the current study.

As a result, teachers will be able to recognise the students' general difficulties and design appropriate learning strategies for SEII and algebra.

- v. In SEII, the students' procedural and conceptual learning skills would help them obtain a complete comprehension of their mathematical concepts and challenge.

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### Conflict of Interests

The authors declare no conflict of interest in this study.

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