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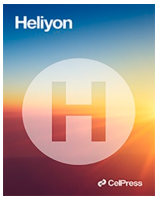

Research article

Evaluating learning outcomes of Christian religious education learners: A comparison of constructive simulation and conventional method

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ABSTRACT

Learning outcomes in Christian Religious Education (CRE) are attributed to the teaching and learning approaches utilized by teachers. In Kenya, conventional methods of teaching are prevalent in classrooms, as teachers often prefer methods that alleviate their workload. Nevertheless, the implementation of learner-centred methods such as constructive simulation enhances learning outcomes. Therefore, this research evaluated the dissimilarity in learning outcomes of CRE learners instructed by constructive simulation, and those instructed with a conventional approach. The research employed a quasi-experimental study with groups under treatment and control, incorporating a pre-test and post-test approach. In total, 90 form two CRE learners from two sub-county secondary schools were purposively selected for the research. Data were collected using the Learner Attainment test in CRE as the assessment tool. The research utilized correlation analysis to establish the similarity scores between the pre-test and post-test assessments. Additionally, the *t*-test statistical model was employed to test the effectiveness of the two teaching methods. Results revealed a strong positive connection between the two assessment tests of learners taught using constructive simulation ($r = 00.0510, p < 0.01$) and conventional method ($r = 0.673, p < 0.01$). Notably, constructive simulation ($t_{(49)} = -9.76$, n = 50, $p < 0.05$) significantly outperformed the conventional method of teaching ($t_{(39)} = 2.700$, n = 40, $p < 0.324$). These findings implied that constructive simulation was more effective in enhancing learning outcomes as opposed to the conventional method of teaching. The results suggest that when designing curricula and formulating educational policies, educators and policymakers should incorporate constructive simulation as a learner-centred method.

1. Introduction

The achievement of desirable outcomes depends on the technique of learning and instruction [1]. Forman and College [2] stated that effective teaching plays a vital role in bringing about tangible improvements in both the intellectual and social development of learners, thus providing definitive indications of successful learning outcomes. Optimum successful learning and, in turn, improve learning outcomes, CRE educators need to demonstrate expertise in their subject matter and proficiency in employing effective instructional techniques [3]. Numerous policies and documents have underscored the significance of proper pre-service and in-service

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training for teachers to guarantee pedagogical competence [4–7]. A study by Dami et al. [8] revealed that, a teacher's competence is assessed based on their grasp of subject matter, pedagogical knowledge, skills, conduct and commitment towards learners. In particular, certified and knowledgeable CRE teachers are expected, as part of their core responsibilities, to possess sufficient knowledge of the subject content and the ability to create suitable teaching and learning experiences [9–11]. Enhancing competence allows teachers augment their proficiency and skills in developing teaching materials and utilizing various teaching methods throughout the educational process [12,13]. Consequently, the pedagogical competence of a CRE teacher can significantly impact learners' acquisition of values and skills, ultimately influencing their learning outcomes [14,15].

The CRE curriculum encompasses a broad spectrum of concepts, principles, and skills, all of which are influenced by the learners' environment [16]. CRE holds a distinctive responsibility for impacting values because its content and approach are centred on value and skill acquisition grounded on the Bible [17,18]. This subject is tasked with guiding learners in understanding values from a religious standpoint, aiding in acquisition of social and moral insights necessary for making sound moral choices in life [6]. In the Kenyan form two curriculum, the Gospel of Luke holds significance due to its rich content concerning the moral values and skills crucial for learners, despite a worrying decline in learning outcomes [19]. Additionally, there is a growing negativity among CRE learners towards this subject, viewing it as preachy and dull [20]. As a result, objectives of CRE, particularly regarding the Gospel of Luke, remains largely unrealized, and this may be attributed to pedagogy in terms of the instructional methods employed by teachers [10,15]. Effective learning of these essential values and skills requires active engagement in the learning process, suggesting a shift from theoretical teaching approaches to practical methods that directly instil the desired values and skills in learners [21].

The aforementioned arguments prompt a discussion on which teaching methods, learner-centred or teacher-centred, are more effective in achieving desirable learning outcomes in CRE [22]. Various researchers have explored and confirmed the impact of learner-centred methods such as flipped classrooms, activity-based teaching, cooperative learning, and inquiry-based learning when compared to conventional teaching methods [2,23–25]. Srikoon and Shah [26,27] further affirm that to enhance the learning outcomes of CRE as a noble subject, it is imperative to incorporate learner-centred methods. This integration complements conventional teaching methods and ultimately enhances learning outcomes in CRE [28]. Moreover, a report by KICD in 2019 stated that current educational reforms highlight the importance of learner-centred instructional practices, advocating for approaches that prioritize the learner's active participation in the learning discourse [6]. In light of the above, CRE teachers are expected to utilize teaching methods that accord learners an opportunity to take charge of their learning hence enhancing learning outcomes [29]. As a result, this research introduced an innovative and learner centred pedagogical framework known as Constructive simulation and compared its effectiveness to the conventional method of teaching in a bid to derive a conclusion on learner centred versus teacher centred methods of teaching the Luke's gospel in CRE.

Constructive simulation is a form of instruction which centralizes the learner throughout the teaching discourse by integrating the principles of constructivist learning theory with a simulation-driven instructional model [30]. Jin et al. [31] argued that the constructivist theory proposes that learners come into the learning environment with pre-existing knowledge and then build upon it as they seek to make sense of new experiences. Drawing from their prior experiences, learners endeavour to emulate real-world abstractions, situations, concepts, or activities as close as feasible to create new insights [32]. Simulation, on the other hand, is a straightforward yet effective learning strategy that embeds practical experience within a contextual framework, thereby enhancing the acquisition of knowledge— that is the primary goal of education [33]. Findings by Sierra [34] postulated that simulation-based teaching and learning emphasizes substantial collaboration between educators and learners, involving hands-on practice within the learning discourse, ultimately leading to improved learning outcomes.

Jančič and Hus [35] posit that when employing constructive simulation, learners, guided by the teacher, strive to replicate real-life situations, concepts, or processes as meticulously as possible, resulting in the construction of new knowledge through experiential learning. This approach places the learner at the centre of learning and can take the form of games, narrations, role-playing, and inquiry thus actively engaging learners while reinforcing their understanding [36]. Although numerous researchers have advocated for the constructive simulation method as a means to promote interactive education across various subjects, there remains scarcity of research in the context of Christian Religious Education, particularly concerning the Gospel of Luke [30,37,38]. A notable gap exists regarding its adoption and pedagogical implementation in teaching of the Gospel of Luke, which is crucial in achieving CRE objectives, yet learning outcomes in this area are lacking. To address this pedagogical and methodological gap, this research examined four topics within the Gospel of Luke with the aim of improving learning outcomes. These topics include Infancy and early life of Jesus, Jesus and John the Baptist, Galilean Ministry, and The Sermon on the Plain.

Conversely, conventional methods revolve around a teacher-centred approach where the teacher is at the core of all classroom activities, encompassing explanations and discussions [39]. Nevertheless, Ndwiga and Odundo [40] established that these methods exhibit several drawbacks, including inadequate planning, overwhelming content delivery, a lack of innovation, and inconsistency in lesson delivery. These issues ultimately result in disengaged, bewildered, and less motivated learners, leading to subpar learning outcomes [41]. Additionally, conventional methods come with several limitations, as they tend to discourage inquiry and confine learners to passive roles as mere recipients of information in the classroom [42]. Furthermore, they promote a superficial sense of learning through rote memorization, which does not necessarily translate into the ability to apply acquired knowledge during assessments [28]. However, in recent years, there has been a significant shift in the role of the teacher towards that of a facilitator, guiding learners throughout their educational journey [43]. As a result, the diminishing effectiveness of conventional methods in terms of learning outcomes has spurred a growing need for the adoption of learner-centred approaches to enhance learners' acquisition of knowledge and skills [3]. The theoretical inferences, Vygotsky's social cognitive theory and John Dewey's philosophy of reflective practice, are commonly linked to pedagogical research, providing insights into the impact of constructive simulation and conventional method on learning outcomes [30,44,45].

While this research primarily focused on constructive simulation and conventional methods of teaching, it is important to acknowledge that gender dissimilarities influence learning outcomes. Okeke [44] explained that the interaction of gender with the method of teaching contributes to poor learning outcomes in religious education. Yuliskurniawati et al. [46] defined gender as socially or culturally constructed characteristics and roles, which are ascribed to males and females in any society. Although there have been progressive efforts towards attaining gender parity, gender inequality persists in educational achievements among males and females at all levels in developing countries [47]. Notably, Sub-Saharan Africa lags in achieving gender equality in education [48]. An acknowledged issue is the underperformance of female learners compared to their male counterparts, even when conditions are seemingly equivalent [49]. The controversy over which gender attains better learning outcomes has been the subject of different studies [50,51].

Researchers have asserted that, in subjects related to science, male learners tend to outperform their female counterparts while in humanities, female learners often excel over male learners [52–54]. Nevertheless, some researchers have reported contradictory findings, indicating no significant disparities in learning outcomes between males and females in liberal arts (humanities) and social sciences where CRE is situated [55]. Furthermore, it is argued that when learner-centred teaching methods are utilized instead of teacher-centred approaches, female learners tend to exhibit superior learning outcomes compared to male learners [56,57]. The use of appropriate instructional methods can serve as a source of motivation during instruction [46]. Educators are expected to explore strategies for enhancing the learning outcomes of both male and female learners in the context of Luke's gospel [58]. They are also urged to investigate modern techniques that can improve learning outcomes and attainment of educational objectives [50]. CRE instructors are challenged to adopt innovative teaching methods such as constructive simulation [30]. In light of the above, research in the area of gender and its influence on learning outcomes when learners are taught using learner-centred and teacher-centred methods was desirable.

The research therefore aimed to accomplish the following objectives; to i.) Determine the difference in the effectiveness of constructive simulation and conventional method, ii.) Establish the relationship between gender and method of instruction, and iii.) Assess the magnitude of difference in the mean scores of male and female learners when taught using constructive simulation and conventional methods. Based on these objectives, the researchers formulated the following hypotheses; i.) There is a significant difference in the effectiveness of Constructive simulation and Conventional method. ii.) There is a significant positive relationship between gender and method of instruction. iii.) There is a significant magnitude of difference in the mean scores between male and female learners when taught using Constructive simulation and Conventional methods.

1.1. Constructive simulation instructional model versus conventional method

Constructive simulation relies on the teacher as a facilitator for learners who come into the learning environment with prior knowledge and seek to build on it by replicating real-life situations, concepts and processes. Within the context of this research, the principles of constructive simulation were fully embraced to ensure its effective utilization. The teacher initiated the process by asking probing questions aimed at motivating individual learners and discerning their prior knowledge and experience upon entering the learning environment. Furthermore, questions were strategically crafted to establish connections between newly acquired knowledge and the learners' existing knowledge base.

Diverse instructional materials and methods, ranging from audio and visual aids to role-playing, narrations, gamifications, presentations, resource persons, and discussions, were employed to cater for various learning styles and preferences of learners. Learners were actively engaged throughout the instructional process, fostering a democratic learning environment that encouraged free expression, collaboration and exchange of ideas. Additionally, the teacher demonstrated care for learners by acknowledging and accommodating individual learners' problems and learning styles. Learners were challenged with tasks while the teacher provided timely support and feedback to aid in learning. Questions were designed to prompt the application of acquired knowledge to real-life situations, drawing inspiration from the teachings of the Gospel of Luke.

Finally, continuous monitoring and evaluation of the learning process allowed for the identification of areas needing improvement, with instructional practices being revised based on the received feedback. In contrast, the conventional method placed the teacher at the centre of the learning environment, relying on lectures and viewing the teacher as the primary source of knowledge. Drawing from Vygotsky and Dewey's learning theories, constructive simulation involved reflective practice by the teacher and established a learner centred, practical, and interactive learning environment. This approach facilitated easier comprehension of the concepts within the topics of the Gospel of Luke, leading to improved learning outcomes. Continuous monitoring of CRE lessons was conducted to ensure the proper implementation of the intervention.

2. Theoretical background

Vygotsky's social cognitive theory [59] and John Dewey's philosophy of reflective practice [60] acted as the foundational theoretical framework, as seen in previous studies [30,44]. These theories elucidate how the teaching methods utilized by educators affect the learning outcomes of learners. Vygotsky's social cognitive theory posits that intellectual development and cognitive skills are fostered through social relationships within a social-cognitive milieu [61]. On the other hand, John Dewey's work emphasizes the integration of theory and practice, emphasizing the cyclic nature of learning experiences and the conscious application of these experiences [62].

Vygotsky's theory holds significant relevance in the realm of teaching and learning across various subjects including CRE. For this theory to be aptly utilized, the CRE instructor must delve into the cognitive development of their learners [63]. Furthermore, Dewey

asserts that an ideal curriculum should take into account the interests and abilities of learners to imbue it with meaning for them [64]. To further expound on the significance of Vygotsky's social cognitive theory to this research, Anagün [65] elucidates that constructive simulation is rooted in the belief that learners actively construct knowledge through their internal cognitive processes. This entails presenting learners with diverse problem-solving activities to gauge the optimal starting point for instruction [66]. The teacher should embrace the principle of commencing with familiar concepts before introducing new ones, aligning their approach with the learners' prior experiences [67]. Similarly, in education, Dewey's reflective practice centres on the construction and reconstruction of experiences, all of which enhance the ability to shape the direction of subsequent experiences [68]. Consequently, in a classroom utilizing constructive simulation, learners assume responsibility for their learning, and the teacher's role shifts towards facilitating skill acquisition and the generation of new knowledge [67].

Recognizing the pivotal role of social interaction in cognitive development, the CRE teacher is encouraged to cultivate a learning environment that encourages peer-to-peer interaction among learners [69]. Within the framework of constructive simulation, learners are encouraged to freely express themselves, engage in collaborative efforts with peers, and exchange ideas, all of which contribute to improved learning outcomes [70]. The responsibility of the teacher is to assign tasks that are within the learners' grasp and proximity [71]. To support this argument by Vygotsky, Dewey's theory indicates that tasks given to learners should ignite their desire for accomplishment and the pursuit of knowledge [40]. As the learners enhance their competence and attain the Zone of Proximal Development (ZPD), the teacher incrementally reduces their guidance [72]. Dewey's reflective practice philosophy holds significant implications not only for teaching in general but also for CRE in particular by challenging educators, urging them to incorporate reflective practice skills into the teaching and learning process [73]. In line with a study by Odundo and Gunga [21], habitually, classroom practices in CRE embrace the conventional methods where the teacher's role has been perceived as that of the primary source and conveyer of knowledge. However, Situma [10] elucidated that although these methods may seem more straightforward in terms of teachers' preparation, they prove ineffective in promoting a deep understanding and long-term retention of the subject matter. Consequently, the CRE teacher is tasked with creating diverse opportunities that facilitate a practical and collaborative learning environment among the learners.

Vygotsky and Dewey's theories complement each other in their arguments because when teachers continuously reflect on their teaching methods and classroom practices, they create an interactive learning environment. Consequently, interaction among learners and between the teacher and learners ensures learning is more practical than theoretical hence, learners understand CRE concepts better.

3. Methodology

3.1. Study area

The research took place in Embu County, Kenya, comprising five sub-counties: Embu East, Embu North, Embu West, Mbeere North and Mbeere South. At the time of the research, Embu County had 195 public secondary schools, categorized into national, extra county, county and sub-county levels, which had 2, 23, 25, and 145 secondary schools respectively. However, the research had a specific focus on form two learners in sub-county schools. Consequently, the research encompassed 145 sub-county secondary schools and 6650 form two learners. According to the ministerial policy in Kenya, the appropriate age for form two learners, equivalent of Grade 10 in the Competency Based Curriculum, should be 15–16 years [74]. Form two learners were selected for this research due to the declining number of learners selecting CRE as they progress to higher classes. In addition, sub-county schools were selected because they provided a coeducational learning environment, thereby minimizing potential gender bias.

Embu West sub-county was selected for the research. The choice of Embu West sub-county for the research was driven by the aim of ensuring maximum similarity in the participants' conditions and attributes. The pilot phase was conducted in the Embu East sub-county where 40 form two learners were used in piloting.

3.2. Study variables

The main aim of this research was to evaluate the learning outcomes of CRE learners when instructed using constructive simulation compared to a conventional teaching method. The dependent variable of the research was the learning outcomes of Form 2 CRE learners. Test scores of the pre-test and post-test assessment served as an indicator of these learning outcomes [75]. The assessments were quantified to elucidate differences in test scores, thereby comparing the learning outcomes resulting from these teaching methods [76]. The intervention was administered to the treatment group and their subsequent outcomes compared with those of the control group.

The selection of independent variables was informed by the researchers' expertise, existing literature, and attributes of the sampled CRE learners [13,15,77]. The independent variables were founded on their ability to predict the learning outcomes, as indicated by previous research [40,51]. Gender and teaching methods served as elucidating aspects influencing learning outcomes as utilized by the instructors.

Gender is a distinguishing descriptive variable between male and female participants in this research. Past studies have documented the impact of gender distinctions on learning outcomes [46,54,78]. Gender differences in art-based subjects have distinguished male and female learners' learning outcomes when utilizing learner-centred and teacher-centred methods. As such, the research aimed to explore gendered disparities in the learning outcomes of CRE learners instructed through constructive simulation and conventional methods.

Instructor's choice of teaching methods holds significance in influencing CRE learning outcomes [16,79]. The ongoing debate on the effectiveness of learner-centred methods versus teacher-centred methods in improving learning outcomes has been of interest to a wide spectrum of researchers. The choice of teaching method can either enhance or diminish learning outcomes [80,81]. Therefore, the research compared the impact of two teaching methods on the learning outcomes of learners.

Key aspects underlying learning outcomes of CRE learners include the teaching method used in classroom instruction as well as the interaction of gender interaction with the chosen method. Learner-centred approaches such as constructive simulation have been identified as having a positive impact on learning outcomes. Consequently, there is a crucial need to evaluate and compare learning outcomes based on learner-centred and teacher-centred methods. The variables mentioned in Table 1 collectively shaped the fundamental determinants of learning outcomes in this research.

3.3. Research design, sampling procedure and sample size

This research utilized a quantitative approach to evaluate the learning outcomes of CRE learners through two distinct teaching methods. The preference for this method stemmed from its capacity to distinguish between the intervention and control groups, enabling conclusions to be drawn about them [82,83]. In this research, it was not entirely possible to regulate all variables and experimental conditions rigorously. Therefore, it was categorized as a quasi-experimental non-randomized control group study, using a pre-test and post-test design because intact classes were used [84–87]. In this type of design, a pre-test is administered at the beginning of the study and post-test data is used to establish whether the participants in different groups are homogeneous or not [44,88]. The experimental design is represented in Table 2.

The research's target population comprised 145 sub-county schools and 6650 form two CRE learners. The research employed purposive sampling to select the Embu West sub-county as the location for their research. Naisuma's Simplified formula was applied to determine the sample size for the participants. The researchers determined the sample size using the formula described in equation (1).

$$n = \mathrm{NC}^2 \,/\, \left(C^2 + (N-1)e^2\right) \tag{1}$$

Where n is the sample size, N is the total population (6650), C is the coefficient of variance (21 %) and e is the standard error (0.02). Furthermore, the coefficient of variance range of 21 % ≤ C ≤ 30 % and standard error of 2 % ≤ e ≤ 5 % are acceptable for this formula. Consequently, the sample size was 108 learners which was sufficient for this experimental study as indicated in Ref. [89]. In the Embu West sub-county, sub-county secondary schools typically have an average of 45–55 form two learners per class [90]. Consequently, two sub-county schools within this sub-county were selected using voluntary sampling, ensuring adherence to the predetermined sample size. Being situated in a peri-urban area, the selected schools experience similar school challenges and experiences including inadequate infrastructure, limited access to resources, diverse student population with varying socioeconomic backgrounds, diverse learning environments, and insufficient funding [91–93]. One of these schools constituted the treatment group, where learners were instructed using constructive simulation, while the other school comprised the control group, employing the conventional teaching method.

In quasi-experimental studies, there is no randomization in assigning the participants to the treatment and control group [88,94]. This research therefore applied self-selection by the CRE teachers from the two schools to decide the treatment and control groups to study the effect of the teaching methods on intact classes rather than randomly assigning participants to the experimental or control groups because complete randomization of the subjects was not possible. However, the research encountered an average response rate of 83 %, resulting in 90 CRE learners as shown in Table 3. The attrition differed across the treatment (93 %) and control (74 %) groups, which was attributed to discrepancy in school absenteeism emanating from lack of school fees, high inconsistency in class attendance and learner dropout rates in the two schools.

3.3.1. Interpretation of the research design

Within the context of this research, the interpretation of the diagrammatical representation of the design was as follows:

O_1 = Pre-test, O_2 = Post-test, X = Treatment Condition.Where:

O_1 = Pre-test of Learner Attainment Test in CRE.

O_2 = Post-test of Learner Attainment Test in CRE.

X = Treatment condition (Constructive simulation)

3.3.2. Control of confounding variables

This research involved several confounding variables that required careful control. Firstly, initial group differences were addressed.

Table 1
Description of variables.

Variables	Explanation	Sign
Dependent	Continuous: Pre-test, Post-test	
Learning outcomes		
Independent	Binary: 1 if male, 2 female	+
Gender	Continuous: Constructive simulation as treatment	–
Teaching methods	Continuous: Conventional method as a control	

Table 2
Diagrammatic representation of Research Design (Adopted from Olaitan & Nwoke 1988).

Pre-test	Treatment	Post-test
O_1	X	O_2
O_1		O_2

O_1 = Pre-test, O_2 = Post-test, X = Treatment.

Table 3
Distribution of the sample size.

Group	Sample size	Response rate	Percentage
Treatment	54	50	93
Control	54	40	74
Total	108	90	83

Due to the impracticability of randomization, intact classes were utilized to maintain normal school administration while controlling for this confound. Additionally, an independent samples test was computed to demonstrate the absence of significant differences between the two groups at baseline. Secondly, ensuring homogeneity of the instructional setting across all participant classes was crucial. To achieve this, participants were taught identical content from the CRE curriculum focusing on the Gospel of Luke, covering topics such as the Infancy and early life of Jesus, Jesus and John the Baptist, Galilean Ministry, and the Sermon on the Plain. These lessons were delivered within the regular periods allocated to the subject in the school timetable. Thirdly, addressing the non-equivalence of pre-test and post-test assessments was essential. As the post-test included more items than the pre-test, adjustments were made to introduce novelty in the test items. This modification aimed to accommodate the expected increase in knowledge and skills acquired by learners over the course of the study, thereby ensuring the validity of the assessment process.

3.4. 4. Data collection instrument

Out of 6650 CRE learners, researchers collected data from the sampled 108 participants through pre-test and post-test assessment. The assessment tools used were validated Learner Attainment Tests in CRE. The instruments were selected because they effectively gauged the efficacy of the utilized teaching methods as described in Refs. [85,86,95]. The Learner Attainment Tests were developed based on four topics in the form two CRE curriculum centred around Luke's gospel, chosen from topics consistently yielding unsatisfactory learning outcomes as reported by the Kenya National Examination Council (KNEC). The topics include the infancy and early life of Jesus, Jesus and John the Baptist, The Galilean Ministry and The Sermon on the Plain.

The 18-item questions in the pre-test were crafted to evaluate the knowledge learners bring into the learning environment. See the supporting information in supplementary material S_1. The post-test included item questions that assessed the learners' ability to apply knowledge acquired in the classroom to real-life situations and societal values. Refer to the additional information provided in supplementary material S_2. The Learner Attainment Tests encompassed a combination of open-ended, fill-in-the-gap, and application questions. Both the experimental and control groups responded to the item questions within a 50-minutes timeframe for the pre-test and 1 hour for the post-test under similar examination conditions. The testing duration was determined by recording completion times from the first, middle and last participants during the pilot study in each school, and subsequently calculating the average time. This average became the testing time for the Learner Attainment Tests in the main study. Before the research, CRE learners, through their teachers willingly provided their consent to participate. Researchers conducted the pilot study to affirm the appropriateness of the research instruments in gathering data aligned with the research objective.

3.5. Statistical analysis

Data were analysed using SPSS version 25 software. Data cleaning and coding were conducted prior to statistical analysis. Both experimental and correlational methods were employed, involving an intervention followed by a correlation analysis of the results [96,97]. Researchers conducted descriptive statistical analysis, encompassing the calculation of frequencies and percentages, the generation of graphs, and the computation of standard deviation and means. Additionally, the researchers executed inferential statistical tests, including Pearson Correlation, Paired samples *t*-test and Independent samples *t*-test.

Within the context of this research, the validation of the Learner Attainment Tests was determined through a comprehensive examination by the researchers' supervisors and experts in the research field. Furthermore, piloting was carried out whose aim was to scrutinize the concepts within the Learner Attainment Tests hence identifying any complexities that may have existed before its utilization in the research [98]. In addition, the assessment tools were subjected to piloting to measure its validity and reliability. The Learner Attainment Tests were trial tested on a sample of 40 form two CRE learners who were not part of the actual research. Johanson and Brooks [99] stated that 30 to 40 participants were sufficient for pilot studies comparing groups. Researchers conducted the pilot study to validate the research instruments' suitability for gathering data aligned with the research objective.

The tests were administered twice, the first test and retest to the same participants after a five weeks intervention duration. Researchers tested for reliability using the Kudder Richardson formula (k – R21) as defined in equation (2), to establish internal consistency because the test included pass and fail questions.

$$KR-21=\left(\frac{n}{n-1}\right)\left(1-\left(\frac{M\,(n-M)}{N\,(Variance)}\right)\right) \tag{2}$$

Where: n = sample size, Variance = variance for the test, M = mean score for the test.

A reliability index of 0.79 was recorded and was high enough for the Learner Attainment Test to be considered reliable because it was above the 0.7 threshold [44]. Moreover, the Pearson Product Moment Correlation Coefficient formula to establish the stability was calculated because the test involved a test-retest. The formula is outlined in equation (3)

$$\mathrm{r}=\sum(\mathrm{zx})(\mathrm{zy})\Big/\mathrm{N} \tag{3}$$

A reliability coefficient of 0.71 was established which indicated a moderately strong correlation between the pre-test and post-test scores, affirming the reliability of the instrument [96,97]. Therefore, the credibility of the research was ascertained using diagnostic tests, including Kudder Richardson and Pearson Product Moment Correlation tests for reliability.

The descriptive characteristics of the research were categorized into males and females in both the treatment and control groups. The research involved hypothesis testing hence required a statistical approach that could quantify the significance of differences that existed between the two continuous variables and the explanatory variable. For that reason, the primary analysis of this research was a *t*-test. We ascertained the plausibility of the data for *t*-test analysis using histograms and Shapiro-Wilk test for normality to guarantee the necessary assumptions were met.

A comparison of means test was conducted on the continuous variables to assess the mean gain score for both groups. Additionally, a paired samples *t*-test and an independent samples *t*-test were executed on the continuous variables. The paired samples *t*-test was suitable in determining whether the intervention given was effective to the treatment group and to which gender it was more effective. This was done by determining whether there was statistical evidence that the mean difference between the pre-test and post-test scores was significantly different from zero [98]. The independent samples *t*-test, on the other hand, sought to establish if gender interaction with the instruction method used influenced the learning outcomes of learners. This analysis was preferred due to its ability to measure the difference in means of both groups and with the explanatory variable [97].

3.6. Ethical considerations

The research went through an ethical evaluation and obtained approval from the University of Embu's Board of Postgraduate Studies (BPS). This approval was subsequently utilized in attaining a research license from the National Council for Science and Technology (NACOSTI) with identification number NACOSTI/P/23/24037. Furthermore, a formal approval letter was secured from the County Director of Education and Ministry of Education offices, specifically the State Department of Early Learning and Basic Education in Embu County, under the reference EBC/GA/32/1/Vol. V/97. Participation in the research was voluntary, and it was contingent upon the completion of a consent form signed by the CRE teachers responsible for the CRE learners. Respondents were explicitly reassured that the information provided would be handled with the utmost confidentiality during data analysis and reporting.

4. Results and discussion

4.1. Descriptive attributes of form two CRE learners

The descriptive characteristics of variables studied are presented in Table 4. Findings on gender showed that 30 learners (60 %) in the treatment group were male, while the remaining 20 learners (40 %) were female. In the control group, 25 learners (62 %) were male the remaining 15 learners (38 %) were female. School enrolment in both groups was higher for male learners than that of their female counterparts. With reference to this study, the results were explained by high levels of dropout rates of girls and parents' attitude towards education. In recent studies, girls have lower enrolment rates and greater dropout rates than boys, suggesting a higher risk of opting out for the few girls who are enrolled in school [89]. When either of the parents is educated or if women are literate, they are more willing to educate their children, particularly girls to school [90]. Policymakers need to eliminate the barriers that impede girls from pursuing education. These findings, however, contradict a UNESCO report [7], which determined that male learners' school

Table 4
Descriptive attributes of form 2 CRE learners.

Variables	Group	Description	Frequency	Percentage
Gender	Treatment	Male	30	60
		Female	20	40
	Control	Male	25	62
		Female	15	38

enrolment declines as they progress to higher levels of learning in compared to female learners.

With reference to Table 5, there were no significant differences (t (48) = 1.321, p = 0.193) in pre-test scores for male learners (M = 28.43, SD = 13.866) and female learners (M = 22.65, SD = 16.950) in the treatment. The magnitude of the differences in means (Mean Difference = 5.783, 95 % CI: −3.017 to 14.583) was very minimal. Similarly, in the control group, findings of this study (Table 5) revealed that there were no significant differences (t (38) = 1.922, p = 0.062) in pretest scores for male learners (M = 32.56, SD = 15.677) and female learners (M = 22.13, SD = 18.106). This showed that the magnitude of the differences in means (Mean Differences = 10.427, 95 % CI: −0.557 to 21.411) was very small. In light of the aforementioned results, there were no gender differences between male and female learners in the two groups. The implication is that treatment and control groups were similar at baseline and therefore suitable for the study. In line with these findings, Andayani et al. [49] posit that gender differences are basic characteristics but do not necessarily mean that one gender is superior to the other in performance.

Fig. 1 shows a comparison of individual learners' test scores from the pre-test and post-test assessments in the treatment group. In the pre-test, two learners (4 %) had above-average scores (50 % and above) while 48 learners (96 %) registered below-average scores (50 % and below). In the post-test, however, 18 learners (36 %) had above-average scores while 32 learners (64 %) recorded below-average scores. When constructive simulation was employed, 47 learners (94 %) improved on their scores while the remaining three learners (6 %) dropped. Fig. 2 illustrates individual learners' comparison of the pre-test and post-test scores attained by the control group. In the pre-test, six learners (15 %) had above-average scores while 34 learners (85 %) recorded below-average scores. Likewise, in the post-test, six learners (15 %) had above-average scores while 34 learners (85 %) registered below-average scores. The results demonstrate that 12 learners (30 %) improved their scores; three learners (8 %) maintained their scores while the remaining 25 learners (62 %) registered a drop in their scores when the conventional method of teaching was utilized. Unlike constructive simulation, the conventional method of teaching was ineffective in enhancing learning outcomes for the majority of the learners. Constructive simulation is a learner centred method while the conventional method is teacher centred. Vitorino [89] argues that new pedagogical frameworks such as the constructivist method should be embraced in order to ensure learners are active participants in their learning which in turn improves their learning outcomes. Moreover, conventional methods of teaching hinder the learners' ability to actively construct knowledge hence leading to poor learning outcomes [13].

Individual pre-test and post-test scores of male learners in the treatment group are presented in Fig. 3. One male learner (4 %) achieved above average scores in the pre-test while 29 male learners (96 %) attained below-average scores. In addition, 12 male learners (40 %) attained above-average scores in the post-test while the remaining eight male learners (60 %) achieved below-average scores. Fig. 4 shows individual pre-test post-test scores of female learners in the treatment group. One female learner (5 %) achieved above average scores while 19 female learners (95 %) recorded below-average scores. In post-test, however, seven female learners (35 %) attained above average scores while 13 female learners (65 %) achieved below average scores. When constructive simulation was utilized, 28 male learners (93 %) improved on their scores while the remaining two male learners (7 %) registered a drop. Similarly, 19 female learners (95 %) improved their scores while the remaining one learner (5 %) dropped. Similar to male learners, these results reflect the effectiveness of constructive simulation in enhancing learning outcomes for the majority of the female learners. When constructivist based teaching methods are utilized, learners outcomes improve irrespective of whether they are male or female [54]. Furthermore, learner centred methods of learning accommodate both male and female learners hence ensuring equality in instruction, which is reflected in the learning outcomes [55].

Fig. 5 illustrates pre-test and post-test scores for male learners in the control group. Results reveal that four male learners (16 %) attained above-average scores in pre-test while 21 male learners (84 %) recorded a drop. Likewise, in the post-test, four male learners (16%) achieved above average scores while the remaining 21 male learners (84 %) dropped. Fig. 6 represents pre-test and post-test scores of female learners in the control group. Results show that two female learners (14 %) attained above average scores while 13 female learners (86 %) achieved below average scores. Similarly, in the post-test, two learners (14 %) achieved above-average scores while the remaining 13 female learners (86 %) attained below average scores. When the conventional method was applied, seven male learners (28 %) recorded an improvement in their scores; one male learner (4 %) maintained their score while 17 male learners (68 %) registered a drop. Furthermore, six female learners (40 %) improved their scores; two female learners (14 %) maintained their scores while the remaining seven female learners (46 %) indicated a drop in their test scores. In comparison to treatment group, the conventional method was ineffective in improving learning outcomes for the majority of both male and female learners. The relationship between passive and active methodologies has been a conversation of interest [89] Conventional methods put the teacher at the centre of the learning which side lines the learner in their own learning and results in poor learning outcomes [3]. In order to improve learning outcomes, conventional methods should be complemented by learner-centred methods of learning [28].

Table 5
Similarity of treatment (CS) and control groups (CM) at baseline.

	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95 % C.I of the Difference	
Pre-test							Lower	Upper
Male vs Female CS	0.275	1.321	48	0.193	5.783	4.377	−3.017	14.583
Male vs Female CM	0.302	1.922	38	0.062	10.427	5.426	−0.557	21.411

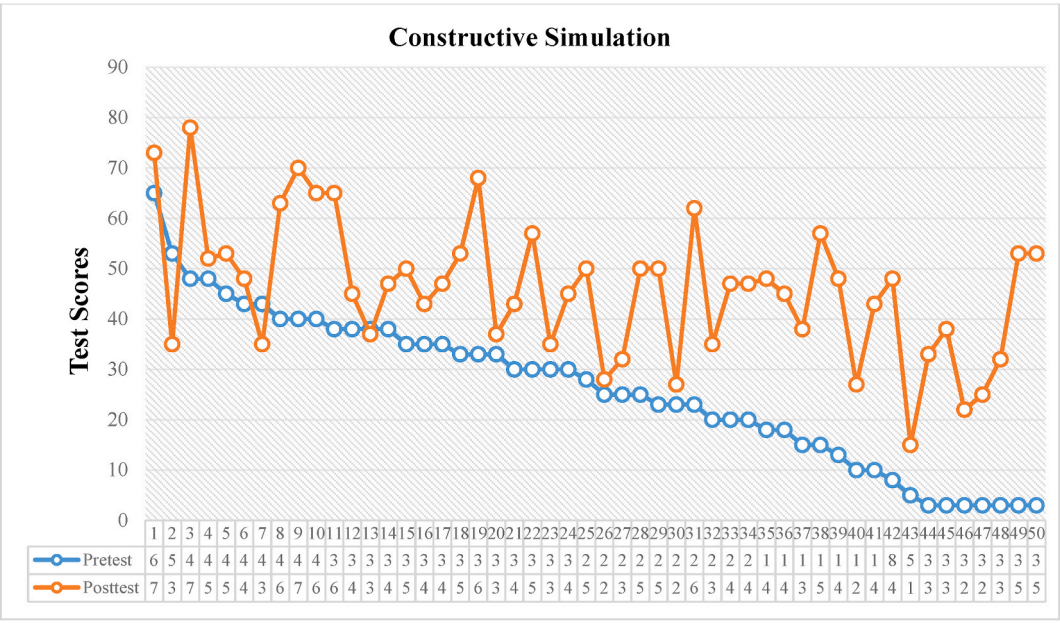

Fig. 1. A visual depiction of test results arranged in descending order, according to pre-test scores of learners in the Treatment Group.

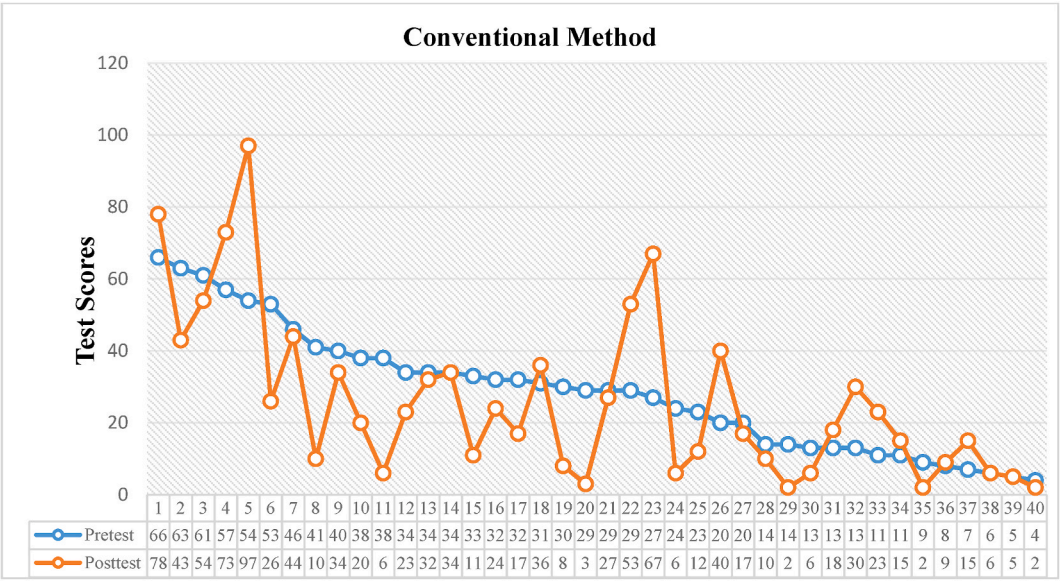

Fig. 2. A graphical representation of test results arranged in descending order, according to pre-test scores of learners in the Control Group.

4.2. Pearson Correlation analysis

Pearson correlation coefficient was computed to calculate the similarity scores between the pre-test and post-test assessments. Results in Table 6 reflect a strong positive link between pre-test and post-test scores of CRE learners taught using Constructive simulation ($r = 0.0510$, $p < 0.01$) and CRE learners taught using the conventional Method ($r = 0.673$, $p < 0.01$)). The positive and significant relationship implies that in both the treatment and control groups, the two tests before and after were positively correlated as explained in Ref. [96].

Pearson's correlation analysis demonstrated that there was a moderate, positive and significant correlation between pre-test and post-test scores of male CRE learners ($r = 0.456$, n = 30, $p < 0.05$) and female CRE learners ($r = 0.692$, n = 20, $p < 0.01$) taught using constructive simulation as presented in Table 7. Further correlation analysis indicated that there was a moderate, positive and significant correlation between pre-test and post-test scores of male CRE learners ($r = 0.531$, n = 25, $p < 0.01$) and female CRE learners (r

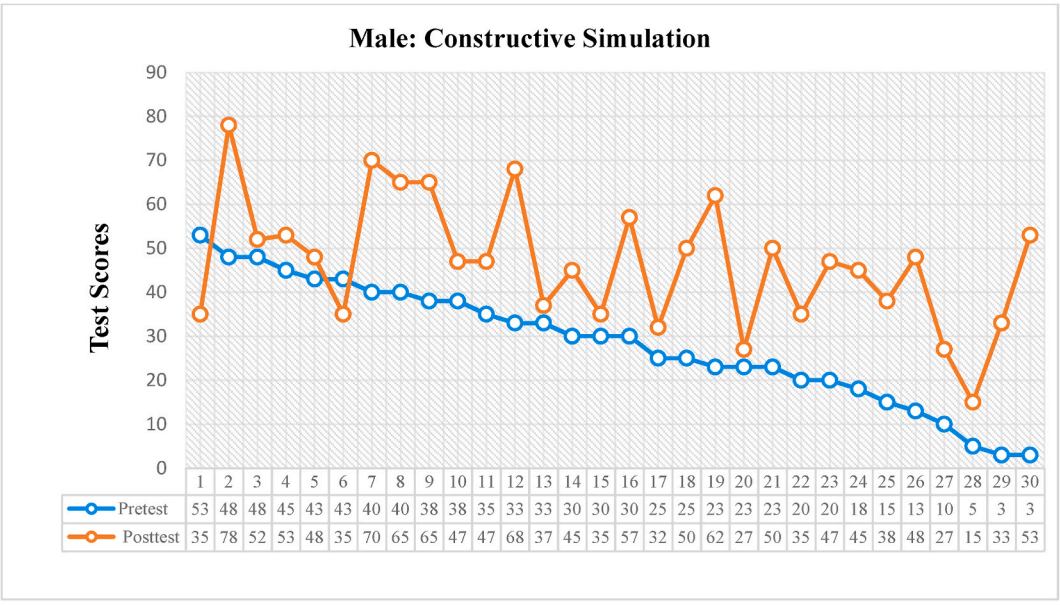

Fig. 3. A graphical representation of test results arranged in descending order, according to pre-test scores of Male learners in Treatment Group.

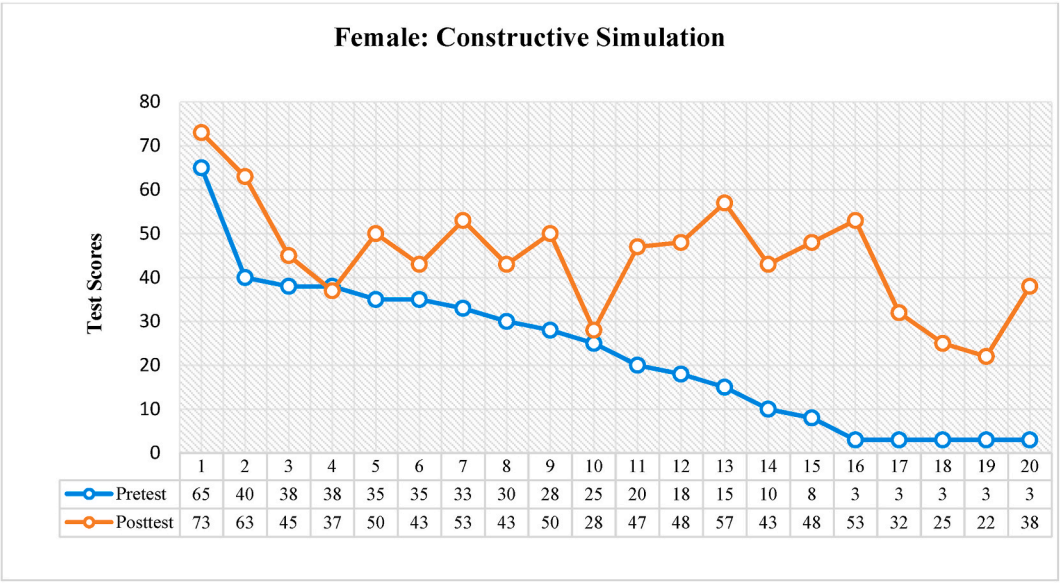

Fig. 4. A visual depiction of test results arranged in descending order, according to pre-test scores of Female learners in Treatment Group.

$= 0.866$, n = 15, $p < 0.01$) taught using Conventional method as shown in Table 8. The results of this correlation test suggested that learners who achieved high learning outcomes in the pre-test would similarly achieve high learning outcomes in the post-test as illustrated by Ref. [97].

4.3. Normality tests

Here, we conducted normality tests to ensure the assumption of normality was not violated. An inspection of histograms suggested that the test scores were normally distributed for both pre-test and post-test scores as illustrated in Figs. 7 and 8 respectively. In line with this, the Shapiro-Wilk test demonstrated in Table 9 suggested that pre-test $W_{(90)} = 0.96$, $p = 0.064$ and post-test $W_{(90)} = 0.98$, $p = 0.102$ were normally distributed. Therefore, the p-value was not statistically significant ($p > 0.05$). This ascertained that pre-test and post-test scores were approximately normally distributed as indicated by Refs. [100,101]. We therefore carried out a Pearson

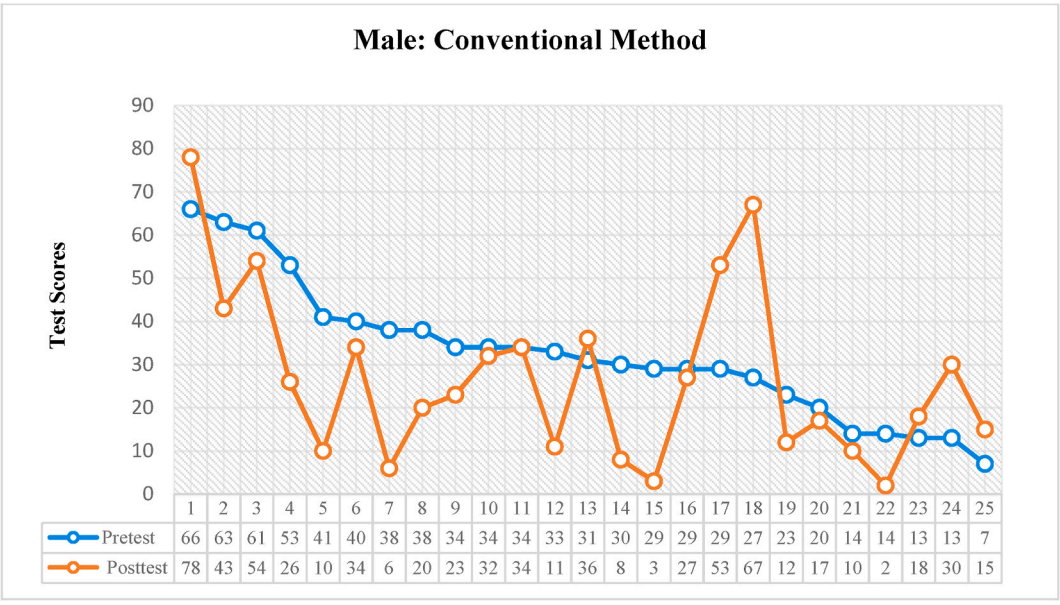

Fig. 5. A visual depiction of test results arranged in descending order, according to pre-test scores of Male learners in Control Group.

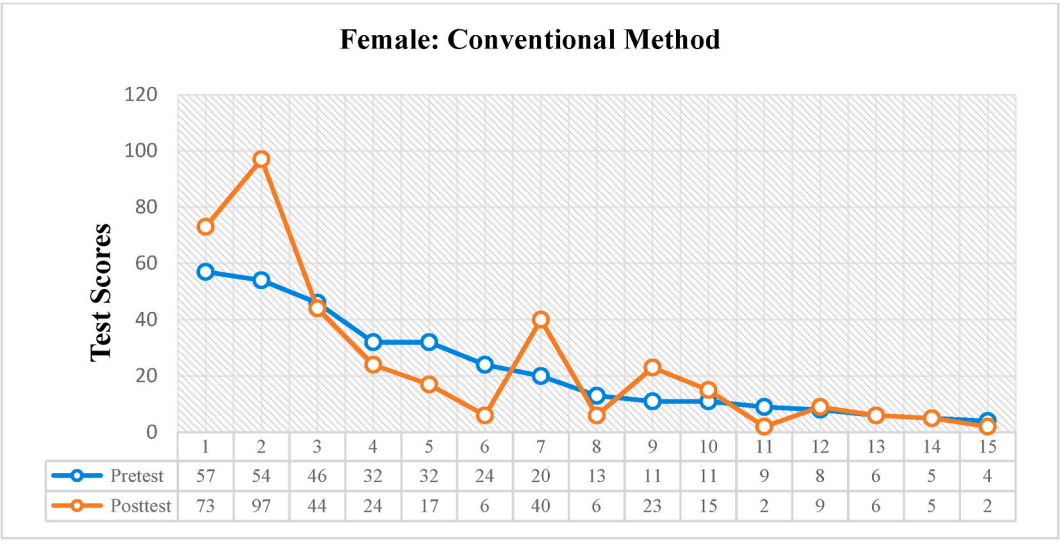

Fig. 6. A graphical representation of test results arranged in descending order, according to pre-test scores of Female learners in Control Group.

Table 6
Pearson's correlation between pre-test and post-test scores in Treatment and Control groups.

Group			Post-test
Constructive simulation	Pre-test	Pearson Correlation	0.510[a]
Conventional method		Sig. (2-tailed)	0.000
	Pre-test	N	50
		Pearson Correlation	0.673[a]
		Sig. (2-tailed)	0.000
		N	40

[a] . Correlation is significant at the 0.01 level (2-tailed).

Table 7
Correlation between pre-test and post-test scores of male and female learners in Treatment group.

Group	Gender		Post-test	Post-test
Constructive simulation	Male	Pre-test	Pearson Correlation	0.456[b]
			Sig. (2-tailed)	0.011
	Female	Pre-test	N	30
			Pearson Correlation	0.692[a]
			Sig. (2-tailed)	0.001
			N	20

[a] . Correlation is significant at the 0.01 level (2-tailed).
[b] . Correlation is significant at the 0.05 level (2-tailed).

Table 8
Correlation between pre-test and post-test scores of male and female learners in the Control group.

Group	Gender		Post-test	Post-test
Conventional method	Male	Pre-test	Pearson Correlation	0.531[a]
			Sig. (2-tailed)	0.006
	Female	Pre-test	N	25
			Pearson Correlation	0.866[a]
			Sig. (2-tailed)	0.000
			N	15

[a] Correlation is significant at the 0.01 level (2-tailed).

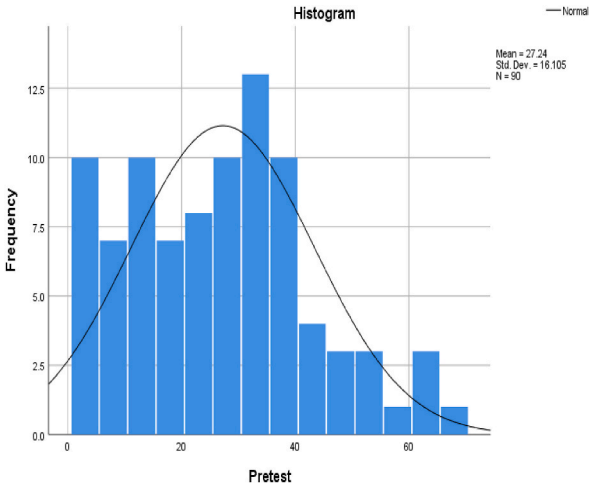

Fig. 7. Histogram for normality test of Pre-test scores.

correlation and *t*-test analysis.

4.4. Paired samples t-test

4.4.1. Paired samples t-test to demonstrate difference in the effectiveness of constructive simulation and conventional method

A paired samples test compares two means from two measurements of the same sample or from two related groups on the same continuous dependent variable. The paired samples *t*-test reveals if there is statistical evidence that the mean difference between the pre-test and post-test scores is significant from zero. This research aimed to examine whether the teaching methods applied were effective. We therefore hypothesised that there was a significant difference between the pre-test and post-test scores of learners taught using constructive simulation and conventional method.

Table 10 indicates the treatment group taught using constructive simulation with a pre-test mean ($\overline{X} = 26.12$) and a standard deviation (SD = 15.28), and a post-test mean ($\overline{X} = 45.94$) with a standard deviation (SD = 13.57). On the other hand, the control group taught using a conventional method had a pre-test mean ($\overline{X} = 28.65$) with a standard deviation (SD = 17.18), and a post-test mean ($\overline{X} = 25.95$) with a standard deviation (SD = 22.99). For treatment group, the mean gain score was 19.82 while the control group dropped by −2.7. These findings are consistent with researchers who indicated that application of constructive simulation in learning discourse results in a higher scores as opposed to the conventional method of teaching [30,44]. The results of the paired samples *t*-test (Table 10)

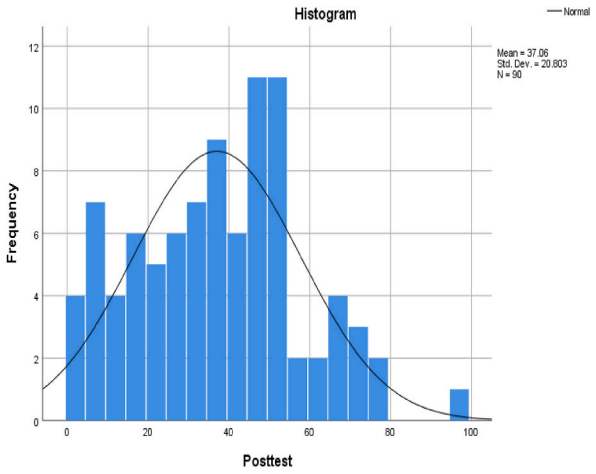

Fig. 8. Histogram for normality test of Post-test scores.

Table 9
Test of normality.

	Shapiro-Wilk		
	Statistic	df	Sig.
Pre-test	0.964	90	0.064
Post-test	0.977	90	0.102

Table 10
Effectiveness of Constructive simulation (CS) and Conventional method (CM).

	Pre-test			Post-test			Mean gain/drop	t-value	p-value
Group	N	Mean	SD	N	Mean	SD			
CS	50	26.12	15.28	50	45.94	13.57	19.82	−9.76	0.000
CM	40	28.65	17.18	40	25.95	22.99	−2.7	0.999	0.324

showed that mean scores differed before treatment (M = 26.12, SD = 15.28) and after treatment (M = 45.94, SD = 13.57) at the 0.05 level of significance, t (49) = − 9.76, n = 50, p < 0.05, 95 % CI for mean difference: −23.90 to − 15.74, r = 0.510. On average, the mean score was about −19.82 points greater than before treatment. In a paired samples test, if the difference between pre-test and post-test is negative, then the intervention had effect. The conclusion was that there was a significant difference between the pre-test and post-test scores in the treatment group (Fig. 9). With reference to this, the results of this study indicated that utilization of constructive simulation was effective. Therefore, we accepted the alternative hypothesis. The paired samples *t*-test (Table 10) further demonstrated that the mean scores in the control group differed in the pre-test (M = 28.65, SD = 17.18) and post-test (M = 25.95, SD = 22.99) at the 0.05 level of significance, $t_{(39)} = 0.999$, n = 40, $p > 0.05$, 95 % CI for mean difference: −2.768 to 8.168, $r = 0.673$. Results reveal that on average, the mean score was about was about 2.7 points less. On the other hand, the difference between the pre-test and post-test in the control group was positive therefore, utilization of conventional method was ineffective. Hence, there was no statistically significant difference between the pre-test and post-test scores in the control group (Fig. 10). For that reason, we failed to accept the alternative hypothesis. This means that constructive simulation, being the treatment administered significantly enhanced the learning outcomes of CRE learners as opposed to the conventional method. Discussions on effectiveness of learner centred methods versus teacher centred methods have been an area of interest for researchers. Some studies have argued that conventional methods of teaching are sufficient and effective in ensuring high learning outcomes [89,102]. However, the results of this research showed constructive simulation to be more effective in positively enhancing learning outcomes in Luke's gospel compared to the conventional methods. These findings are similar to previous studies postulating that constructivist methods and more specifically constructive simulation, leads to better learning outcomes for learners in comparison to conventional methods [30,38,44]. Unlike previous research that focus on the advantages of constructive simulation, the findings of this study results infer that, incorporating constructive simulation as a practical approach facilitates better understanding of concepts in the Gospel of Luke and consequently enhances learning outcomes.

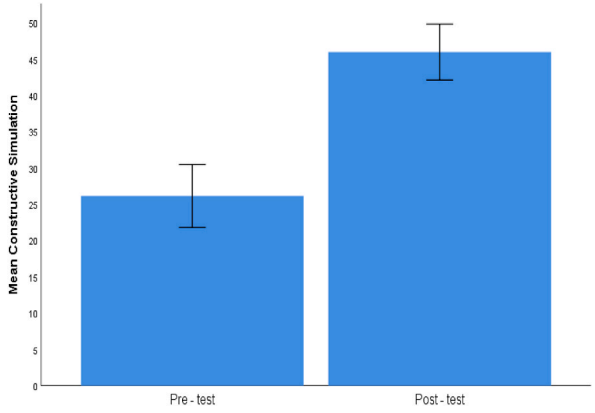

Fig. 9. Mean difference versus statistical significance in treatment group.

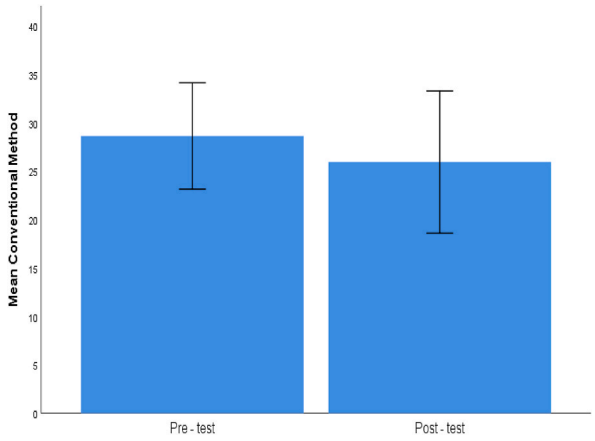

Fig. 10. Mean difference versus statistical significance in control group.

Table 11
Mean gain scores of male and female learners taught using Constructive simulation (CS) and Conventional method (CM).

	Gender	Pre-test			Post-test			Mean gain/drop	t-value	p-value
Group		N	Mean	SD	N	Mean	SD			
CS	Male	30	28.43	13.87	30	46.63	14.42	18.2	−6.752	0.000
	Female	20	22.65	16.95	20	43.90	12.61	21.25	−7.752	0.000
CM	Male	25	32.56	15.68	25	26.76	19.92	−5.8	1.644	0.113
	Female	15	22.13	18.11	15	24.60	28.08	2.47	−0.623	0.543

4.4.2. Paired samples t-test to demonstrate difference in the effectiveness of constructive simulation and conventional method on male and female learners

This research aimed to examine the relationship between gender and teaching method utilized. We therefore hypothesised that there was a significant positive relationship between gender and method of instruction. Findings as presented in Table 11 show male learners in the treatment group with a pre-test mean ($\overline{X} = 28.43$) and a standard deviation (SD = 13.87) and a post-test mean ($\overline{X} = 46.63$) with a standard deviation (SD = 14.42). Their female counterparts had a pre-test mean ($\overline{X} = 22.65$) with a standard deviation (SD = 16.95) and a post-test mean ($\overline{X} = 43.90$) with a standard deviation (SD = 12.61). In the control group, male learners had a pre-test mean ($\overline{X} = 32.56$) with a standard deviation (SD = 15.68) and a post-test mean ($\overline{X} = 26.76$) with a standard deviation (SD = 19.92). Female learners, on the other hand, attained a pre-test mean ($\overline{X} = 22.13$) with a standard deviation (SD = 18.11) and a post-test mean ($\overline{X} = 24.60$) with a standard deviation (SD = 28.08). For treatment group, the mean gain score for male learners was 18.2 while that of their female counterparts was 21.25. For control group, male learners recorded a drop of −3.19 while female learners dropped by −2.16. Based on the results, when the constructive simulation teaching method was applied, female learners achieved a higher mean gain score than male learners by 3.05. Similarly, female learners taught using the conventional method had a higher mean gain score

than male learners by 1.03. This shows that female learners performed better in Luke's gospel compared to male learners irrespective of the two teaching methods. Female learners have been shown to record higher scores in liberal arts [53]. CRE is a humanities subject under the liberal arts and the results of this research collaborated the previously mentioned study. Further studies revealed that female learners often excel when taught with both teacher centred and learner centred methods [52–54]. Findings of this research imply that female learners understand the concepts in the Gospel of Luke better than male leaners.

The paired-sample *t*-test (Table 11) revealed the mean score of male learners differed before treatment (M = 28.43, SD = 13.87) and after treatment (M = 46.63, SD = 14.42) at the 0.05 level of significance, $t_{(29)} = -6.752$, n = 30, $p < 0.05$, 95 % CI for mean difference: −23.713 to − 12.687, $r = 0.456$. In addition, the mean score of female learners differed before treatment (M = 22.65, SD = 16.95) and after treatment (M = 43.90, SD = 12.61) at the 0.05 level of significance, $t_{(19)} = -7.752$, n = 20, $p < 0.05$, 95 % CI for mean difference: −26.99 to − 15.51, $r = 0.692$. For treatment, the mean score of male learners was −18.2 points greater than before treatment while that of their female counterparts was −21.25 points greater than before treatment. The difference between pre-test and post-test of male and female learners was negative indicating that the intervention had a positive effect. With reference to this, the results of this study indicated that utilization of constructive simulation was effective on male and female learners. The conclusion is that there was a significant difference between the pre-test and post-test scores of both male and female learners in the treatment group (Fig. 11). Therefore, we accepted the alternative hypothesis. Constructive simulation, therefore, significantly improved learning outcomes for male and female learners in Luke's gospel.

The mean score of male learners in the control group (Table 11) differed in the pre-test (M = 32.56, SD = 15.68) and post-test (M = 26.76, SD = 19.92) at the 0.05 level of significance, $t_{(24)} = 1.644$, n = 25, $p > 0.05$, 95 % CI for mean difference: −1.481 to 13.081, $r = 0.456$. Furthermore, the mean scores of their female counterparts differed in the pre-test (M = 22.13, SD = 18.11) and post-test (M = 24.6, SD = 28.08) at the 0.05 level of significance, $t_{(14)} = -0.623$, n = 15, $p > 0.05$, 95 % CI for mean difference: −10.961 to 6.027, $r = 0.456$. In the control group, therefore, the mean score of male learners was 5.8 points less while the mean score of the female learners was – 2.47 points greater. The difference between the pre-test and post-test scores for male learners in the control group was positive while that of female learners negative but insignificant ($p > 0.05$). Therefore, the conventional method of teaching was ineffective on male and female learners. These results revealed that there was no significant difference between the pre-test and post-test scores of both male and female learners in the control group (Fig. 12). For that reason, we failed to accept the alternative hypothesis. The study results show that unlike constructive simulation, the conventional method was unsuccessful in enhancing learning outcomes for male learners and ineffective in significantly enhancing learning outcomes for female learners in Luke's gospel. Previous research has indicated the importance of teachers embracing teaching methods that accommodate and improve learning outcomes for both male and female learners in CRE [30,45,54]. Based on the findings of this research, when male and female learners were taught Luke's gospel using Constructive simulation, learning outcomes improved. On the contrary, when male and female learners were taught Luke's gospel using the conventional method, there was a drop in their learning outcomes. This study, therefore, demonstrated constructive simulation was accommodative and effective on both male and female learners in the area of Luke's gospel. Furthermore, some studies show that learners taught in the same learning environment and with the same teaching method should have balanced learning outcomes [23,89]. The study results are inconsistent with these aforementioned studies.

4.5. *Independent samples t-test*

An independent samples test compares mean scores between two different groups for one continuous variable. We sought to establish the difference in the mean scores of male and female learners in the treatment and control groups. Therefore, we hypothesised that there was a significant magnitude of difference in the mean scores between male and female learners when taught using Constructive simulation and Conventional methods. Table 12 demonstrates an independent samples test conducted to compare the

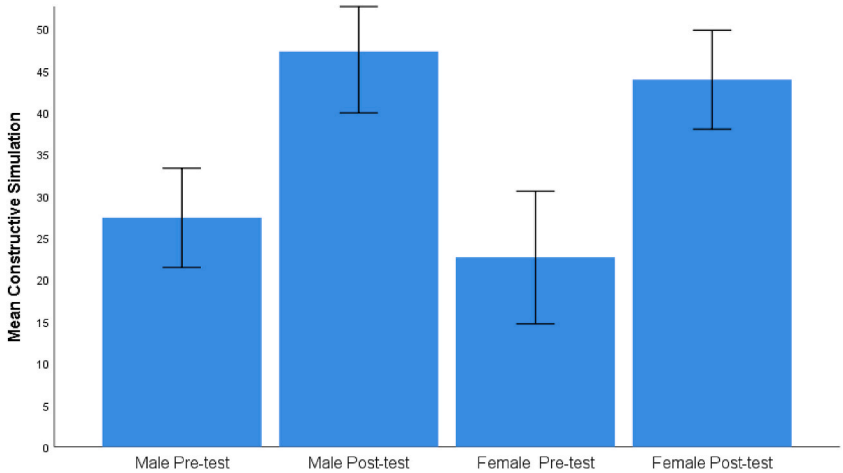

Fig. 11. Mean difference versus statistical significance of male and female learners in treatment group.

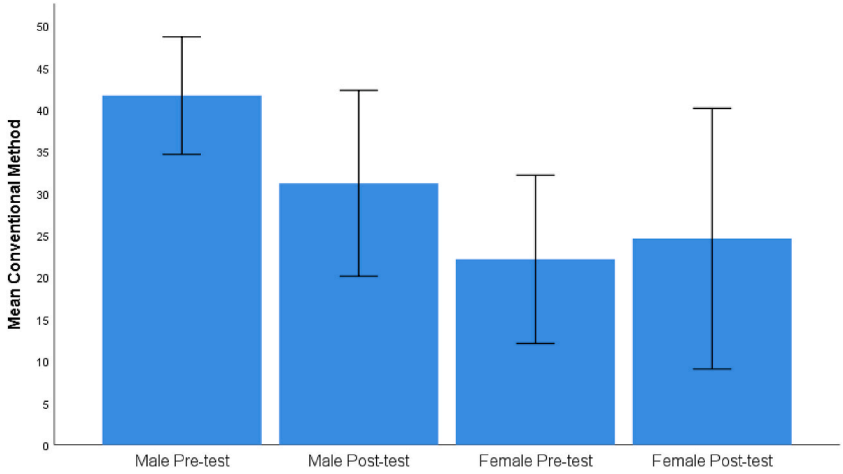

Fig. 12. Mean difference versus statistical significance of male and female learners in control group.

Table 12
Independent Samples Test to compare post-test scores of male and female learners in the Treatment (CS) and Control (CM) groups.

Levene's test for Equality of Means								
	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95 % C.I of the Difference	
							Lower	Upper
Male Vs Female CS	0.461	0.439	48	0.663	1.733	3.951	−6.210	9.464
Male Vs Female CM	0.278	0.284	38	0.778	2.160	7.598	−13.221	17.541

magnitude of the mean difference between male learners and female learners who received treatment. There were no significant differences (t (48) = 0.439, p = 0.663) in post-test scores for males (M = 46.63, SD = 14.416) and females (M = 44.90, SD = 12.490). The magnitude of differences in means (Mean Difference = 1.733, 95 % CI: −6.210 to 9.464) was very small. In addition, posttest scores for control group (Table 12) established no significant differences (t (38) = 0.302, p = 0.778) in scores for male learners (M = 26.76, SD = 19.923) and female learners (M = 24.60, SD = 28.078). This indicated that the magnitude of differences in means (Mean Differences = 2.160, 95 % CI: −13.221 to 17.541) was very small. For this reason, we failed to accept the alternative hypothesis. Notably, at baseline, there was no significant magnitude of difference in test scores of male and female learners. Likewise, when the two teaching methods were utilized in teaching the Gospel of Luke, there was no significant magnitude of difference between male and female learners. These results imply teaching method did not influence learning outcome of leaners in the four topics of Luke's gospel that were examined, irrespective of gender or the method of teaching [53,54]. However, the results are inconsistent with findings that indicated female learners underperform compared to their male counterparts, even when conditions are seemingly equivalent [49]. Furthermore, studies that established that female learners thrive more than male learners when learner-centred methods are utilized while male learners succeed in comparison to female learners when taught using a teacher-centred method have been contradicted [56,57].

5. Conclusion and policy recommendations

This study assessed the impact of constructive simulation on the learning outcomes of CRE by conducting a quasi-experimental study, comparing it to the conventional teaching method. The findings of the research revealed that constructive simulation enhances learning outcomes in CRE, particularly the gospel of Luke, suggesting its potential applicability in various subjects and contexts. These findings are pertinent for a diverse range of stakeholders, including educators, policymakers, and scholars advocating for evidence-based approaches like constructive simulation in education. Based on the findings, researchers have put forward three policy recommendations.

It is imperative for policymakers, including entities like the Ministry of Education and KICD, to incorporate constructive simulation into curriculum design and when formulating educational policies, prioritizing learner centred approaches. Vygotsky's social cognitive theory underscores the significance of active learner involvement and peer interaction within the learning environment. Given the ongoing transition towards a Competency-Based Curriculum, integrating more learner centred methods becomes essential to ensure learners acquire the requisite knowledge, skills, and attitudes for holistic societal participation.

In addition, educators must embrace teaching methods that foster active learner participation. In the recent past, educators have often been perceived as the primary knowledge providers. John Dewey elucidates the importance of reflective practice among educators to tailor learning experiences to individual learner needs. Encouraging learner engagement enables them to build upon their

existing knowledge while constructing new insights, fostering inclusive and productive teaching-learning interactions, ultimately resulting in enhanced learning outcomes. Furthermore, there is pressing need to institute pre-service and in-service training programs geared towards enriching educators' grasp of learner centred techniques, with particular emphasis on constructive simulation. Educators must be educated on the benefits and impact of such approaches to the teaching-learning dynamic and learner development. Educators must also familiarize themselves with the learning theories of Vygotsky and Dewey to enhance their proficiency and competence. Equipped with this knowledge, educators can effectively cater to diverse learning styles and establish inclusive learning environments.

Nonetheless, the research does come with certain limitations. Potential bias in the findings may arise due to differential attrition in the response rates across the treatment and control conditions. Furthermore, the study did not consider other school characteristics that were not accounted for in the analysis. In view of this, subsequent research should undertake similar studies using more robust designs such as randomized trials at the classroom level, larger samples permitting regression analysis and quasi-experimental designs incorporating more sophisticated controls. Additionally, future research to explore the most effective mechanisms within the constructive simulation method and assess its efficacy in various subjects and contexts.

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Data availability statement

Data will be availed upon request.

CRediT authorship contribution statement

Annis Muthoni Mugo: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Milcah N. Nyaga:** Writing – review & editing, Writing – original draft, Validation, Investigation, Formal analysis. **Zachary N. Ndwiga:** Writing – review & editing, Writing – original draft, Validation, Investigation, Formal analysis. **Edwine Atitwa:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

[1] W. Leal Filho, S. Raath, B. Lazzarini, V.R. Vargas, L. de Souza, R. Anholon, O.L.G. Quelhas, R. Haddad, M. Klavins, V.L. Orlovic, The role of transformation in learning and education for sustainability, J. Clean. Prod. 199 (2018) 286–295, https://doi.org/10.1016/j.jclepro.2018.07.017.
[2] F.A. Forman, C. College, Article Journal of Education and Educational Developement Activity-Based Teaching, Student Motivation and Academic Achievement, 2019.
[3] R. Lavi, M. Tal, Y.J. Dori, Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning, Stud. Educ. Eval. 70 (2021), https://doi.org/10.1016/j.stueduc.2021.101002.
[4] UNESCO, Right to Education Handbook, 2019.
[5] M. Elfert, Lifelong learning in Sustainable Development Goal 4: what does it mean for UNESCO's rights-based approach to adult learning and education? Int. Rev. Educ. 65 (2019) 537–556, https://doi.org/10.1007/s11159-019-09788-z.
[6] KICD, Report on 3rd National Conference on Curriculum Reforms, 2019.
[7] E. international and UNESCO, Global Framework of Professional Teaching Standards, 2019.

[8] Z. Anselmus Dami, M. Butarbutar, S.W. Kusradi, Two different models of pedagogy: rethinking teachers' pedagogy competency in Christian religious education, Int. J. Christ. Educ. 27 (2023) 142–167.
[9] G.B. Mayende, Emerging trends in the performance of christian religious education in the Kenya certificate of secondary education examination, J. Adv. Educ. Philos. 6 (2022) 51–62, https://doi.org/10.36348/jaep.2022.v06i02.002.
[10] J. Situma, Methods used by teachers to teach Christian religious education in secondary schools in Kimilili in Bungoma County, Kenya, Br. J. Educ. 4 (2016) 1–8.
[11] W. Arnodah Itolondo, The role and status of christian religious education in the school curriculum in Kenya, J. Emerg. Trends Educ. Res. Policy Stud. 3 (2012) 721–729. http://www.opsi.gov.uk/acts/ukga.
[12] Mardia Hi Rahman, Professional Competence , Pedagogical Competence and thePerformance of Junior High School of Science Teachers, Online) 5 (2014) 75–80. www.iiste.org.
[13] V.O. Saoke, C.M. Musafiri, Z.N. Ndwiga, P.W. Githaiga, The christian religious education teachers' attitudes toward the five-stage lesson plan framework in Kenya: a gender-based analysis, Heliyon 9 (2023) e19104, https://doi.org/10.1016/j.heliyon.2023.e19104.
[14] H.A. Othoo, O.G. Aseu, Role of christian religious education in the moral values formation of secondary school students in teso south sub - county , busia county , Kenya, J. Res. Innov. Implic. Educ. 6 (2022) 307–317.
[15] V.O. Saoke, Z.N. Ndwiga, P.W. Githaiga, C.M. Musafiri, Determinants of awareness and implementation of five-stage lesson plan framework among Christian Religious Education teachers in Meru County, Kenya, Heliyon 8 (2022) e11177, https://doi.org/10.1016/j.heliyon.2022.e11177.
[16] W.A.P. Otieno, Effectiveness teacher-centered method of teaching christian religious education in instilling respect among students in public secondary schools in rachuonyo North sub-county, Kenya, African J. Educ. Pract. 7 (2021) 41, https://doi.org/10.47604/ajep.1209.
[17] I.D. Nawose, J. Musamas, M. Kerich, Assessment strategies adopted by christian religious education teachers in assessment of learner value acquisition in secondary schools in Kenya, Educ. A J. Sch. Educ. Moi Univ. 3 (2023). https://journals.mu.ac.ke/index.php/edj/.
[18] H.H. Murundu, N.W. Jesse, T. Mboya, P.O. Box, Factors influencing media integration in teaching and learning of christian religious education, vol. 3, 2022, pp. 4402–4408.
[19] K, Kenya Institute of Curriculum Development, Engaged , Empowered & Ethical Citizen Engaged , Empowered & Ethical Citizen, 2019.
[20] R.W. Gitiha, P. Rugano, S. Wakhu, C.G. Muriithi, Students' Perceptions towards the Uptake of Educational Technologies in Christian Religious Education, vol. 11, Cogent Educ, 2024, https://doi.org/10.1080/2331186X.2024.2310968.
[21] P.A. Odundo, S.O. Gunga, Effects of application of instructional methods on learner achievement in business studies in secondary schools in Kenya, Int. J. Educ. Res. 1 (2013) 1–22.
[22] KNEC, 2019 KCSE Christian Religious Education CRE (313) KNEC Report, 2019.
[23] L. Cheng, A.D. Ritzhaupt, P. Antonenko, Effects of the flipped classroom instructional strategy on students' learning outcomes: a meta-analysis, Educ. Technol. Res. Dev. 67 (2019) 793–824, https://doi.org/10.1007/s11423-018-9633-7.
[24] I. Magfirah, M. Chairul, B. Umanailo, W. Malmia, S.H. Makatita, S. Lisaholit, A. Azwan, H. Tinggapi, M. Chairul, Problem-based learning as an effort to improve student learning outcomes, Volume 8, Issue 09, artic, Int. J. Sci. Technol. Res. (2019). www.ijstr.org.
[25] D.G. Erbil, A review of flipped classroom and cooperative learning method within the context of vygotsky theory, Front. Psychol. 11 (2020), https://doi.org/10.3389/fpsyg.2020.01157.
[26] S. Srikoon, T. Bunterm, T. Nethanomsak, K.N. Tang, Effect of 5P model on academic achievement, creative thinking, and research characteristics, Kasetsart J. Soc. Sci. 39 (2018) 488–495, https://doi.org/10.1016/j.kjss.2018.06.011.
[27] R. Kumar Shah, Effective constructivist teaching learning in the classroom, Shanlax Int. J. Educ. 7 (2019) 1–13, https://doi.org/10.34293/education.v7i4.600.
[28] S. Chuang, The applications of constructivist learning theory and social learning theory on adult continuous development, Perform. Improv. 60 (2021) 6–14, https://doi.org/10.1002/pfi.21963.
[29] S. Mueke, P.H. Embeywa, P.D. Mulwa, Assessment of Difference in Self-Efficacy Among Students Taught Using Eclectic Learning Approach and those Taught Using Conventional Method in cre in 5 (2023) 4220–4224.
[30] K. Bakhsh, M. Arshad, S. Rasool, The role of constructive simulation towards students ' academic performance in secondary schools, Int. J. Innov. Creat. Chang. 14 (2020) 841–854.
[31] J. Jin, K.E. Hwang, I. Kim, A study on the constructivism learning method for BIM/IPD collaboration education, Appl. Sci. 10 (2020), https://doi.org/10.3390/app10155169.
[32] G. Mwanda, P. Odundo, R. Midigo, Application of constructivist instructional approach in Kenya ; focus on learner achievement in different class categories, Imp. J. Interdiscip. Res. 3 (2017).
[33] C.L. Goi, The use of business simulation games in teaching and learning, J. Educ. Bus. 94 (2019) 342–349, https://doi.org/10.1080/08832323.2018.1536028.
[34] J. Sierra, The importance of simulation in teaching and learning economics: the students' perspective, Innov. Educ. Teach. Int. 57 (2020) 521–531, https://doi.org/10.1080/14703297.2019.1647268.
[35] P. Jančič, V. Hus, Representation of Teaching Strategies Based on Constructivism in Social Studies, 2019.
[36] M. Milad, The International Journal of Humanities Education Translating Constructivism into Pedagogy from Philosophy to Practice Active Project-Based Learning, 2023.
[37] M. Kallestrup, Learning effects of negotiation simulations: evidence from different student cohorts, in: Simulations Decis. As Act. Learn. Tools, Springer, 2018, pp. 165–182.
[38] A. Charania, U. Bakshani, S. Paltiwale, I. Kaur, N. Nasrin, Constructivist teaching and learning with technologies in the COVID-19 lockdown in Eastern India, Br. J. Educ. Technol. 52 (2021) 1478–1493, https://doi.org/10.1111/bjet.13111.
[39] N.A. Ahmad, F.L. Azizan, N.F. Rahim, N.H. Jaya, N.M. Shaipullah, E.S. Siaw, Relationship between students' perception toward the teaching and learning methods of mathematics' lecturer and their achievement in pre-university studies, Int. Educ. Stud. 10 (2017) 129, https://doi.org/10.5539/ies.v10n11p129.
[40] Ndwiga & Odundo, Appropriateness of explicit teaching methods on learners. Achievement in Kiswahili Composition Writing, 2020, pp. 1–9.
[41] H.T.L. Nguyen, G. Austin, On invoking third parties in Vietnamese medical communication, Theory Pract. Lang. Stud. 8 (2018) 713, https://doi.org/10.17507/tpls.0807.01.
[42] H.M. Kassem, The impact of student-centered instruction on EFL learners' affect and achievement, English lang, Teach 12 (2018) 134, https://doi.org/10.5539/elt.v12n1p134.
[43] R. Koross, Micro teaching an efficient technique for learning effective teaching skills: pre-service teachers' perspective, IRA Int. J. Educ. Multidiscip. Stud. (ISSN 2455–2526) 4 (2016) 289, https://doi.org/10.21013/irajems.v4.n2.p7.
[44] C. Okeke, Effects of Constructive Simulation Teaching Strategy on Students' Achievement and Retention in Christian Religious Studies, University of Nigeria, Nsukka, 2015.
[45] M. Irfan, D.R. Khuda Bakhsh, Student Performance And Constructive Simulation: An Experimental Study, Vol. 7 No. 1 (2023)n.d. http://journalppw.com.
[46] I. Dahlia Yuliskurniawati, N. Ika Noviyanti, W. Rosyadah Mukti, S. Mahanal, S. Zubaidah, Science process skills based on genders of high school students, in: J. Phys. Conf. Ser., Institute of Physics Publishing, 2019, https://doi.org/10.1088/1742-6596/1241/1/012055.
[47] Arjen EJ. Wals, United Nations Decade of Education for Sustainable Development (Shaping the Education of Tomorrow: 2012 Full-Length Report on the UN Decade of Education for Sustainable Development DESD Monitoring & Evaluation-2012 UNESCO Education Sector, 2012.
[48] M. Restivo, J.M. Shandra, J.M. Sommer, The United States Agency for International Development and forest loss: a cross-national analysis of environmental aid, Soc. Sci. J. 55 (2018) 171–181, https://doi.org/10.1016/j.soscij.2017.09.001.
[49] S. Andayani, H. MuchtarYufiarti, E. Susanto, The profile of critical thinking and learning outcomes of teacher candidates viewed from gender differences, in: J. Phys. Conf. Ser., Institute of Physics Publishing, 2020, https://doi.org/10.1088/1742-6596/1567/4/042072.
[50] M. Asy'ari, H. Fitriani, S. Zubaidah, S. Mahanal, The science process skills of prospective biology teachers in plant cell material based on gender, Int. J. Emerg. Technol. Learn. 14 (2019) 168–178, https://doi.org/10.3991/ijet.v14i19.11208.

[51] J.N. Akhigbe, A.E. Adeyemi, Using gender responsive collaborative learning strategy to improve students' achievement and attitude towards learning science in virtual and hands-on laboratory environment, J. Pedagog. Res. 4 (2020) 241–261, https://doi.org/10.33902/JPR.2021063948.
[52] F. Chang, M. Luo, G. Walton, L. Aguilar, J. Bailenson, Stereotype threat in virtual learning environments: effects of avatar gender and sexist behavior on women's math learning outcomes, Cyberpsychology, Behav. Soc. Netw. 22 (2019) 634–640, https://doi.org/10.1089/cyber.2019.0106.
[53] R. Sagala, R. Umam, A. Thahir, A. Saregar, I. Wardani, The effectiveness of stem-based on gender differences: the impact of physics concept understanding, Eur. J. Educ. Res. 8 (2019) 753–761, https://doi.org/10.12973/eu-jer.8.3.753.
[54] T.L. Hsieh, P. Yu, Exploring achievement motivation, student engagement, and learning outcomes for STEM college students in Taiwan through the lenses of gender differences and multiple pathways, Res. Sci. Technol. Educ. 41 (2023) 1072–1087, https://doi.org/10.1080/02635143.2021.1983796.
[55] Z. Yu, The effects of gender, educational level, and personality on online learning outcomes during the COVID-19 pandemic, Int. J. Educ. Technol. High. Educ. 18 (2021), https://doi.org/10.1186/s41239-021-00252-3.
[56] A. Anggrawan, N. Ibrahim, S. Muslim, C. Satria, Interaction between learning style and gender in mixed learning with 40% face-to-face learning and 60% online learning. www.ijacsa.thesai.org, 2019.
[57] R. Adiansyah, A. Muh Amin, A. Yani, D. Safitri, The correlation between metacognitive awareness and cognitive learning outcomes based on gender of biology education students, Biosfer 16 (2023) 244–259, https://doi.org/10.21009/biosferjpb.26765.
[58] B.H. Siswati, A.D. Corebima, The effect of education level and gender on students' metacognitive skills in malang, Indonesia, Adv. Soc. Sci. Res. J. 4 (2017), https://doi.org/10.14738/assrj.44.2813.
[59] L.S. Vygotsky, M. Cole, Mind in Society: Development of Higher Psychological Processes, Harvard university press, 1978.
[60] J. Dewey, Experience and education, in: Educ. Forum, Taylor & Francis, 1986, pp. 241–252.
[61] B. Eun, Adopting a stance: bandura and Vygotsky on professional development, Res. Educ. 105 (2019) 74–88, https://doi.org/10.1177/0034523718793431.
[62] L. Watts, Reflective practice, reflexivity, and critical reflection in social work education in Australia, Aust. Soc. Work 72 (2019) 8–20, https://doi.org/10.1080/0312407X.2018.1521856.
[63] I. Supena, A. Darmuki, A. Hariyadi, The influence of 4C (constructive, critical, creativity, collaborative) learning model on students' learning outcomes, Int. J. Instr. 14 (2021) 873–892, https://doi.org/10.29333/iji.2021.14351a.
[64] Y. Ye, Y.H. Shih, Development of John Dewey's educational philosophy and its implications for children's education, Policy Futur, Educ. Next 19 (2021) 877–890, https://doi.org/10.1177/1478210320987678.
[65] Ş.S. Anagün Assoc, E. Osmangazi Üniversitesi, Teachers' perceptions about the relationship between 21st century skills and managing constructivist, Learning Environments, International Journal of Instruction 11 (4) (2018) 825–840.DOI, https://doi.org/10.12973/iji.2018.11452a.
[66] S. Newman, A. Latifi, Vygotsky, education, and teacher education, J. Educ. Teach. 47 (2021) 4–17, https://doi.org/10.1080/02607476.2020.1831375.
[67] S. Monteiro, M. Sibbald, Aha! Taking on the myth that simulation-derived surprise enhances learning, Med. Educ. 54 (2020) 510–516, https://doi.org/10.1111/medu.14141.
[68] M. Schmidt, R.E. Allsup, John Dewey and teacher education, in: Oxford Res. Encycl. Educ., Oxford University Press, 2019, https://doi.org/10.1093/acrefore/9780190264093.013.475.
[69] M.G. Saudelli, R. Kleiv, J. Davies, M. Jungmark, R. Mueller, PhET simulations in undergraduate physics: constructivist learning theory in practice. https://journals.library.brocku.ca/brocked, 2021.
[70] C. Nyakito, Baraton interdisciplinary research, Journal 1–10 (8) (2018) 1–10, 2018), 8(Special Issue.
[71] O. Vasileva, N. Balyasnikova, (Re)introducing vygotsky's thought: from historical overview to contemporary psychology, Front. Psychol. 10 (2019), https://doi.org/10.3389/fpsyg.2019.01515.
[72] L.S. Vygotsky, The Role of Play in Development, 1978.
[73] S.W. Greenberger, J. Or, Cultivating faculty readiness to reflect: reconstructing Dewey's attitudes for reflection as character strengths, Reflective Pract. 23 (2022) 291–304, https://doi.org/10.1080/14623943.2021.2015685.
[74] R. of Kenya, Republic of Kenya Ministry of Education, Science and Technology Volume One:, 2018, pp. 1–251.
[75] D. Hamilton, J. McKechnie, E. Edgerton, C. Wilson, Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design, J. Comput. Educ. 8 (2021) 1–32, https://doi.org/10.1007/s40692-020-00169-2.
[76] S. Yang, X. Yu, Y. Zhou, LSTM and GRU neural network performance comparison study: taking yelp review dataset as an example, in: Proc. - 2020 Int. Work. Electron. Commun. Artif. Intell. IWECAI 2020, Institute of Electrical and Electronics Engineers Inc., 2020, pp. 98–101, https://doi.org/10.1109/IWECAI50956.2020.00027.
[77] R. Ardi, D. Budiarti, The role of religious beliefs and collective narcissism in interreligious contact on university students, Heliyon 6 (2020) e04939, https://doi.org/10.1016/j.heliyon.2020.e04939.
[78] R.E. O'Dea, M. Lagisz, M.D. Jennions, S. Nakagawa, Gender differences in individual variation in academic grades fail to fit expected patterns for STEM, Nat. Commun. 9 (2018), https://doi.org/10.1038/s41467-018-06292-0.
[79] C.E. Ogheneakoke, S. Obro, J. Benike, In search of a more effective strategy: using simulation games instructional strategy for the teaching and learning of social studies in secondary school, J. Int. Soc. Stud. (2019) 53–71, iajiss.org.
[80] P.Y.A. Dewi, K.H. Primayana, Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts, Int. J. Educ. Learn. 1 (2019) 19–26, https://doi.org/10.31763/ijele.v1i1.26.
[81] A. Harris, Teaching and Learning in the Effective School, Routledge, 2019.
[82] L. Ciechanowski, A. Przegalinska, M. Magnuski, P. Gloor, In the shades of the uncanny valley: an experimental study of human–chatbot interaction, Futur. Gener. Comput. Syst. 92 (2019) 539–548, https://doi.org/10.1016/j.future.2018.01.055.
[83] R.C. Gale, J. Wu, T. Erhardt, M. Bounthavong, C.M. Reardon, L.J. Damschroder, A.M. Midboe, Comparison of rapid vs in-depth qualitative analytic methods from a process evaluation of academic detailing in the Veterans Health Administration, Implement. Sci. 14 (2019), https://doi.org/10.1186/s13012-019-0853-y.
[84] E. Ibe, J. Abamuche, Effects of audiovisual technological aids on students' achievement and interest in secondary school biology in Nigeria, Heliyon 5 (2019) e01812, https://doi.org/10.1016/j.heliyon.2019.e01812.
[85] Z. Khayyer, R. Saberi Azad, Z. Torkzadeh Arani, R. Jafari Harandi, Examining the effect of stress induction on auditory working memory performance for emotional and non-emotional stimuli in female students, Heliyon 7 (2021) e06876, https://doi.org/10.1016/j.heliyon.2021.e06876.
[86] J. Musengimana, E. Kampire, P. Ntawiha, Rwandan secondary school students' attitudes in learning chemistry: explored with task-based instruction, Heliyon 8 (2022) e10509, https://doi.org/10.1016/j.heliyon.2022.e10509.
[87] R. Yang, An empirical study on the scaffolding Chinese university students' English argumentative writing based on toulmin model, Heliyon 8 (2022) e12199, https://doi.org/10.1016/j.heliyon.2022.e12199.
[88] & S.S, H. White, Quasi-Experimental Design and Methods, 2014.
[89] R.W.S. Vitorino, Célia, C. Fornaziero, E.V. Fernandes, Evaluation of performance and perception of learning in teaching human anatomy: traditional method vs constructivist method, Int. J. Morphol. 38 (2020) 74–77.
[90] Embu County Government, Embu County Integrated Development Plan, 2018.
[91] K. Bidwell, L. Watine, Exploring early education programs in peri-urban settings in Africa, Optimus Impact (2014) 3–19.
[92] E.K. Murimi, L.K. Njeru, B.M. Gichimu, S.N. Ndirangu, Effects of urban expansion on agricultural resources: a case study of Embu town in Kenya, Asian J. Agric. Extension, Econ. Sociol (2019) 1–11, https://doi.org/10.9734/ajaees/2019/v33i430186.
[93] J.P.T. Nyeko, A. Pence, G.E. Barnes, Home environment factors and ecd exposure predict school entry and grade progression: a study from a peri-urban community in Central Uganda, Africa, Int. J. Child Youth Fam. Stud. 6 (2015) 662–679, https://doi.org/10.18357/ijcyfs.641201515051.
[94] M. Gopalan, K. Rosinger, J. Bin Ahn, Use of quasi-experimental research designs in education research: growth, promise, and challenges, Rev. Res. Educ. 44 (2020) 218–243, https://doi.org/10.3102/0091732X20903302.

[95] T. Winarsunu, B.S. Iswari Azizaha, S.S. Fasikha, Z. Anwar, Life skills training: can it increases self esteem and reduces student anxiety? Heliyon 9 (2023) e15232 https://doi.org/10.1016/j.heliyon.2023.e15232.
[96] F.A. Hidajat, A comparison between problem-based conventional learning and creative problem-based learning on self-regulation skills: experimental study, Heliyon 9 (2023) e19512, https://doi.org/10.1016/j.heliyon.2023.e19512.
[97] D.H. Tong, B.P. Uyen, N.V.A. Quoc, The improvement of 10th students' mathematical communication skills through learning ellipse topics, Heliyon 7 (2021) e08282, https://doi.org/10.1016/j.heliyon.2021.e08282.
[98] M.C. Gamboa Mora, S.P. Vera-Monroy, A. Mejía-Camacho, W.J. Guerrero Rueda, Perception channels and cognitive styles: opponents, followers or learning allies? Heliyon 7 (2021) e06242 https://doi.org/10.1016/j.heliyon.2021.e06242.
[99] G.A. Johanson, G.P. Brooks, Initial scale development: sample size for pilot studies, Educ. Psychol. Meas. 70 (2010) 394–400, https://doi.org/10.1177/0013164409355692.
[100] M.M. Hamasha, H. Ali, S. Hamasha, A. Ahmed, Ultra-fine transformation of data for normality, Heliyon 8 (2022) e09370, https://doi.org/10.1016/j.heliyon.2022.e09370.
[101] Kadir Dafik, T.K. MaryatiSufirman, Z.R. Ridlo, The analysis of the implementation of RBL-STEM learning materials in improving student's meta-literacy ability to solve wallpaper decoration problems using local antimagic graph coloring techniques, Heliyon 9 (2023) e17433, https://doi.org/10.1016/j.heliyon.2023.e17433.
[102] M. Pande, S.V. Bharathi, Theoretical foundations of design thinking – a constructivism learning approach to design thinking, Think. Ski. Creat. 36 (2020), https://doi.org/10.1016/j.tsc.2020.100637.