The Role of Constructive Simulation Towards Students' Academic Performance in Secondary Schools

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The main intention of the study was to determine the effect of teachers' use of constructive simulation upon students' performance. It has been argued that constructive-oriented strategies encourage teachers' commitment and students' active participation in the teaching-learning process. Moreover, it has been argued that students can learn effectively using constructive-oriented methods. On this basis, it becomes worthwhile to explore how teachers' use of constructive simulation will affect students' achievement. A sample of two hundred secondary school students participated. It was an experimental study using pre-test and post-test modes regarding the traditional lecture method simulation skills performed by the teachers. It was concluded that the simulation method is better than the lecture method, as seen in the experiment. The findings of this study have obvious educational implications for students, teachers, and other stakeholders in education. The use of constructive simulation in this study was proven to be effective in facilitating greater achievement in mathematics. This implies that the use of a constructive simulation instructional model would enhance students' performance in mathematics. Several bold recommendations were also fore grounded to ensure students are more satisfied and motivated.

Introduction

Simulation can be referred to as the state of artificial construction of a particular set of conditions to study a concept that can exist in reality. It can be defined as the imitation of a real thing, situation or procedure. Nwafor (2017) described it as an on-going process that represents central features of reality or a real situation. The act of simulating generally implies representing certain important characteristics or behaviour of a selected physical or abstract system. Shukla (2014) presented that simulation creates a realistic model of an actual situation or environment. Use a computer modeling programme incorporating multiple dimensions and perspectives to illustrate complex scenarios.

Simulation, as a concept in education, can be defined as a method of instruction whereby learners are encouraged to imitate a certain situation or characters with a view to build knowledge. It is described as an instructional strategy that provides an opportunity for learners to construct reality or a real-life situation as closely as possible (NERDC, 2018). Similarly, Ndu (2010) described simulation as a concept in teaching whereby learners are engaged in a world of pretense or imitation. It is a concept in the teaching learning process where the teacher and the students contribute significantly to get the concepts clear by doing the numerical as hands on practices.

Here, the students are physically involved to solve the assignments with due interest and delight (Retteberg, 2014). Simulation involves feigning or imitation of a real thing or situation to achieve joyful results.

Constructive simulation entails a situation where motivated learners utilize a simulator in a simulated environment (Aldrich, 2014). Motivated learners, in the context of teaching and learning, can be referred to as students who are simulated to imitate characters, states of affairs, abstracts and processes or use models of real materials. A simulator is referred to as an abstract or model of real materials that is produced to be similar to the real object and as closely as possible. When a simulator is operated, it provides a result which is close to the real situation (Tanveer, 2002). In the context of learning, the constructive simulation instructional model entails a learning process that involves simulated activities, which can represent real world situations. It features a combination of constructive teaching and the simulation instructional model in the learning process. Obiekwe (2008) stated a feature of constructive teaching includes the active involvement of the learner in the teaching and learning process. Here we impose upon the students to solve algebra and arithmetic problems. The principle involves supporting learning as an active process, whereby learners are to be allowed to discover principles, concepts, and facts for themselves (Ogbonna, 2017).

The learner is viewed as the owner of the learning situation. The principle holds that the learner is perceived as a unique individual with unique needs, experience, and from a

particular background and culture. The learner harnesses experiences from the environment, while the teacher assumes the role of a facilitator. The principle considers the teacher as a coach, who is expected to monitor the learning process. The teacher considers the background and culture of the learner in guiding the learner throughout the learning process and encourages the learner to interact with the physical environment. The teacher is expected to allow the learner's ownership of the learning situation. Furthermore, the teacher is to provide a learning environment that supports and challenges the learner's thinking. The major task of the teacher is to adapt the learner's learning experiences by reflecting on them and using their initiative to steer the learning experiences where the learner wants to create value. The teacher is expected to provide the learner with meta cognitive skills that can help the learner to produce new knowledge. Shams, Arshad and Ahmed (2019) pointed out that the students taught through accelerated learning perform better compared to the students taught via traditional methods. Iqbal, Noreen and Arshad (2020)portrayed that those students who were exposed to the cooperative learning technique obtained better results than those exposed to traditional teaching methods.

Jong (2005) highlighted the characteristics of simulation to involve problem-solving, learner centered activities, experiential-based activities, observation, continuous monitoring, evaluation of activities, and feedback. Other characteristics include reliability, validity of the decision taken, and the reflective practices involved (Obiukwu, 2010). Reflection is central to the constructive and simulation instructional model, for it aids the teacher to provide learning opportunities or individual learners (Dogru & Kalender, 2007, Hmelo-Silver 2006). It is acclaimed that constructive simulation encourages a learner's active participation in the teaching-learning process and has an overwhelming effect on learning activities (Goldenberg, Andusyszyn, & Iwasiwu, 2005, Onyejiaka, 2004;Aldrich,2014).The provision of basic physical facilities in the institutions is also directly related to learning activities which leads to good academic achievement (Arshad, Qamar, Gulzar & Ahmed, 2019).

It will be a welcome change if students can find out facts for themselves through teachers' guidance. When the findings are their own handiwork, there will be re-enforcement of lessons learnt in their minds and lives (Arshad, Qamar & Gulzar, 2018).However, the facilitation of students' active participation in the learning process lies mainly on the hands of teachers. Teachers are expected to be abreast of their specializations by attending seminars and workshops in order to be models to their students (Ezeani, 2015). There is the utmost necessity for teachers to update their cognitive, affective, and psychomotor knowledge constantly in the various aspects of education (Okeke, 2007). When teachers are well equipped, they will be able to guide students towards achieving the desired educational goal.

Most times, the teaching and learning process is not interactive. Some teachers neither review their teaching practices nor employ teaching methods that can foster learner's interaction with learning activities and environments. In this case, the teaching-learning process becomes

teacher-centered since the learner plays a passive role in the process. Teachers cannot improve upon their performance if they cannot reflect on their teaching sessions. As a result, students cannot develop generic skills required for life-long learning. The consequence is ineffective teaching and learning.

On this basis, the hand note is developed to provide hints for teachers on the constructive simulation method of teaching based upon reflective teaching practice skills. The content areas of the hand note include the meaning of reflective teaching practice features of reflective teaching, models of reflective teaching, advantages and disadvantages of reflective teaching, the meaning of constructive teaching, principles of constructive teaching, advantages and disadvantages of constructive teaching, and the concept of constructive simulation.

Dewey believes that reflection is an important human activity in which people recapture their experiences, think about it critically, analyze, and evaluate it. In the process, the practitioner generates knowledge continuously by applying prior knowledge on the existing knowledge. The activity-oriented method of teaching is considered an ideal instruction.

Review of Related Literature
Constructive Teaching

The term 'constructive' deals with effectiveness, while 'teaching 'refers to the process of imparting knowledge, skills, attitude, and values. Therefore, constructive teaching entails the meaningful generation of knowledge or information. The idea of constructive teaching emanates from psychological theory, which holds that individuals process knowledge and meaning from their experiences (Turab, 2019; Ali, 2019). Constructive teaching involves a teacher's ability to reflect on experiences and to learn from them. It implies a teacher's ability to determine how a lesson is going, where the pit falls are, and how to regulate teaching behaviour in the learning process. For a student, it is the ability to monitor how he or she is performing in the learning process. The success of constructive teaching depends on the extent to which the teacher adopts its principles.

Constructive Teaching Principles

The principles of constructive teaching include:

- Active involvement of learners in the learning process.
- It is learner-centered.
- The learner is viewed as having ownership of the learning process.
- The learning experience of the learner is to be adapted in the learning situation.

- The learning environment is democratic. Learners are to discover their own principles, concepts, and facts. It emphasizes shared responsibilities and decision-making.
- Learning is collaborative and cooperative.
- The learner is perceived as a unique individual.
- The teacher assumes the role of a coach or a facilitator.
- The teacher's role is to provide opportunities for the learner to practice the knowledge and skills in various environments, such as where the learner is expected to apply such knowledge.
- The teacher is expected to encourage the learner by showing a practical example of knowledge and skill application for the learner to observe and be challenged to discuss issues or problems.
- The teacher's role is to give hints or prompts to challenge the learner.
- Cognitive apprenticeship is proposed to being an effective constructivist model of learning. The expectation is to challenge the learner to be involved in authentic practices through activity and social interaction in the learning situation, while the teacher watches, asks questions, and listens.
- The principle also holds that learning is dynamic, which takes place in a continuous interaction between task, teacher, and learner. Both the teacher and the students are expected to acknowledge each other's viewpoint and accept their own beliefs, standards, and values.
- Knowledge is perceived to be reflective and it rests on the learner's existing knowledge. The teacher's task is to reintroduce the learner's relevant prior knowledge before the new information. The teacher is also expected to provide aspects of subject areas relevant to what is to be learned, and encourage the learners to use various ways to tackle the problems. The teacher is expected to guide the students by asking questions that can lead them to produce their own conclusion on the subject.

Constructive teaching is especially important in the learning process, as it has many advantages.

Advantages of Constructive Teaching

- Constructive teaching encourages learning through transaction rather than through transmission. Students learn by negotiation and the exchange of ideas.
- Learners are actively involved.
- It fosters critical thinking, retention of knowledge, creativity, and transfer of knowledge that leads to life-long learning.
- Learners are easily motivated.

- Teachers create an environment for knowledge construction and students work harder.
- Learners are simulated to become autonomous and inquisitive thinkers.
- Learners are spurred to questioning, investigating, and reasoning.
- Learning is student-centered instead of teacher-centered or subject–centered.
- Human experiences are acknowledged.
- It accommodates individuals, groups, and the whole class during the instruction and learning process.
- It leads to the learning of a variety of skills.

Despite its merits, constructive teaching has several disadvantages.

Disadvantages of Constructive Teaching

- It is tasking. It places a heavy workload on teachers.
- It is time-consuming, both in planning and in execution.
- The slow learners may draw back the more progressive learners in a teamwork scenario.

Nevertheless, constructive teaching is encouraged for its qualities.

Modes of Assessment of Constructive Teaching

The principle of assessment in constructive teaching holds that assessment is continuous. The teacher facilitates the assessment by being in continuous dialogue with the learner (Rhozles & Bellamy, 1999). As the learner progresses, the teacher provides opportunities for formative evaluation in the process to attend to individual learners, according to their pace (Tanveer, 2018; Turab, 2019; Zaigham, 2019).

The constructive mode of assessment includes the following, and it is based on tests and observations. Several strategies involved are discussed below:

- *Oral discussion:* The teacher can present students with a 'focus' question on the topic under study. The teacher watches, listens, and assesses students while they discuss. The teacher also guides and modifies the discussion. In addition, the teacher records their observations as a feedback for reflection and correction.
- *Pre-test:* This provides an opportunity for the teacher to determine the knowledge students bring to a particular learning topic. The teacher's awareness of the learner's prior knowledge will guide them in directing the course of study.
- *Mind-mapping:* In this type of assessment, students will be asked to list and categorize concepts and ideas relating to a topic. The teacher facilitates and modifies students' activities.

- *Hand-on-activities:* This type of assessment tool involves students' manipulation of their environment or a particular learning material.

The teacher can use a check list and observations to assess students' success. The teacher is to observe relevant aspects of the situation to indicate the desired attributes that are present or absent in the setting.

The constructive mode of assessment rarely involves paper and pencil methods of assessment. It comprises various activities, such as observations, monitoring, questioning discussion, listening, manipulation, recording, and the like.

Constructive Simulation Instructional Model

The constructive simulation instructional model refers to the process of teaching and learning that considers the principles of constructive simulation in the instructional process. In the application of constructive simulation, the students under the guidance of the teacher engage to imitate real things, abstracts or states of affairs and processes as closely as possible and strive to construct new information from their experiences. Effective use of constructive simulation principles includes:

- Asking probing questions to motivate individual students and identifying their experiences.
- Asking questions that connect the student's existing knowledge.
- Involving students actively in the instructional and learning process.
- Asking questions that stimulate students cognitively.
- Creating a democratic classroom environment that encourages free expression, collaboration, and the exchange of ideas.
- Caring for students by accepting individual students' problems.
- Challenging students with tasks and providing them with prompts for support.
- Asking questions that require the application of knowledge to another situation.
- Continuous monitoring of the learning process, evaluating, and revising practices based on the feedback.

In the application of constructive simulation as a method of instruction, students are to be engaged in a world of imitation or pretense (Ibekwe, 2005). The constructive simulation instructional model seems to consider a learner's experiences and appears to inspire both teachers and learners to be committed in the instructional process. Its approach can be in game or play form, and in card or real human play (Ndu, 2010). Moreover, Nwafor (2017) added that several of its approaches can be in the forms of a puzzle, colleague consultation or role playing, and inquiry. It appears that the constructive simulation instructional model offers students opportunities to work together and participate dynamically in the teaching and

learning process. It has been established that constructive-oriented methods of teaching emphasizes the practical involvement of students (Goldenberg et al., 2005; Aldrich, 2014). Constructive instructional approaches are student-centered and encourage the active participation of learners in the learning process.

Numerous researchers have asserted that the constructive simulation instructional model fosters active learning in various subjects, and in all levels of educational institutions, but little has concerned the subject of mathematics. There is need to investigate the effect of constructive simulation on students' performance and retention in mathematics. Hence, the study of the role of teachers' use of constructive simulation upon students' achievement in mathematics appears desirable.

Statement of the Problem

There are certain factors which cause students' poor performance and failure in exams. The dishonesty of the teachers in the classroom, besides the persistent use of the lecture method of teaching, may be predictors of student failure in annual exams conducted by the boards of intermediate and secondary education. The lecture method appears to have rendered the students passive and encourages the rote memorization of the curriculum contents. A lack of success in academic performance can result to inapt behaviour and frustration on the part of students. It is likely that such an unsuccessful situation can lead to the burnout or dropout of students. It can be observed that rote learning does not foster the transfer of knowledge, which occurs as a result of the retention of the information learned. As such, it can be noted that the lecture method is not as effective, and as a result, affects the performance of students in public examinations. The foregoing therefore underscores the need to explore other teaching methods that can enhance students' cognitive achievement and retention of the subject matter, and possibly motivate students to commit themselves in the learning of mathematics. In addition, teachers being the implementers of any educational policy on school curriculum require being highly committed in guiding the students towards achieving the desired educational objectives.

The main target of the study is to ascertain the effect of teachers' use of constructive simulation towards student performance.

Research Questions

- Is there any difference in the mean achievement scores of students who are taught mathematics using constructive simulation and students taught using the conventional (lecture) method in a mathematics test?

- What difference exists in the mean achievement scores of male and female students who are taught mathematics with constructive simulation?

Research Methodology

The research featured a quasi-experimental design, with a sample drawn from the government secondary schools of Khyber Pakhtunkhwa. A sample of two hundred students from five secondary schools participated in the study. The research tool used for the study was student achievement for ninth class students in mathematics. The experiment continued for five weeks.

Data Analysis and Presentation of Results

Research Question 1: Is there any difference in the mean achievement scores of students taught mathematics using constructive simulation and students taught using the conventional (lecture) method in a mathematics test?

Table 1: Mean Achievement Scores of Students in Experimental and Control Groups

Groups	Pre-Test		Post-Test		Mean Gain Score
Constructive Simulation	N 100	X 18.87	N 100	X 76.96	58.09
Conventional Lecture Method	N 100	X 12.83	N 100	X 20.02	7.19

The Table 1 indicated that the experimental group taught with the constructive simulation method had a post-test mean score of 76.96, while the control group taught with the conventional method had a post-test mean score of 20.02. The mean difference for the experimental group is 58.09, while that of the control group is 7.19. This shows that the constructive simulation group has a higher achievement score than the group taught with the lecture method.

Research Question 2: What difference exists in the mean achievement scores of male and female students who are taught mathematics with constructive simulation?

Table 2: Mean Gain Score of the Students regarding Constructive Simulation Vs Lecture Method

Groups	Gender		Pre-Test X	Post-Test X	Mean Gain Score
Constructive Simulation	Male	50	20.17	85.81	65.12
	Female	50	18.15	72.59	55.14
Lecture Method	Male	50	15.29	21.68	6.39
	Female	50	11.34	19.02	7.68

Table 2 showed that male students taught with constructive simulation had a post-test mean score of 85.81, while female students had a post-test mean score of 72.59. The male students had a mean gain of 65.12, while the female students had a mean gain of 55.14. This is an indication that male students performed better than female students.

The major findings of this study are as follows:

1. Students taught using constructive simulation performed better than students taught using the conventional lecture method in their overall performance in mathematics.

2. Male students in both the experimental and control groups performed better than their female counterparts in the mathematics achievement test.

Conclusions

The result of this study provides empirical evidence that the constructive simulation instructional model enhanced students' achievement in mathematics.

The students taught using the conventional or lecture model (control groups) achieved less than the students taught using constructive simulation (experimental groups). Hence, high achievement in mathematics can be enhanced by using an appropriate instructional strategy.

The constructive-oriented method, such as constructive simulation, seems to be an effective instrument for students' active participation in the teaching and learning process. Many educators believe that the use of constructive–oriented methods in the teaching and learning process are superior to other methods. The approach can be used to create scenes and characters for meaningful learning. The approach is useful for teaching and learning at all levels of education, and its purpose is for effectiveness and reinforcing knowledge.

Secondly, the male and female students exposed to both constructive simulation and the conventional method performed better than their control group counterparts in the test. The combined effect of constructive simulation and gender on students' cognitive achievement was significant. Male students performed better than the female students for both instructional methods.

Recommendations

The research featured a quasi-experimental design, with sample drawn from the government secondary schools of Khyber Pakhtunkhwa. The researcher designed an instrument used to determine the performance of the students in mathematics. The subjects were divided into constructivist instructional model groups, and traditional method groups. The results revealed that the constructivist instructional model was more effective in facilitating students' achievement and retention. The findings showed that there was a significant difference between the mean achievement scores of mathematics students taught with the constructivist instructional model and those taught with the traditional model. The students taught with the constructivist instructional model scored higher than the group taught with the traditional model. The researcher recommended that teachers should be confident to use the constructive instructional model to teach mathematics. The lecture method appears to have rendered the students passive and encourages the rote memorization of the curriculum contents. A lack of success in academic performance can result in inappropriate behaviour and frustration on the part of students. The following recommendations were prepared based on the conclusions of the study:

- The use of the constructive simulation instructional model has been found to enhance the quality of students' achievement and retention in mathematics. The subject teacher should be encouraged to employ the method more in the teaching of the subject. Using the method, the students' interest in the subject would be aroused, and they would be committed in learning the subject, with their increasement in achievement and retention of the subject content.

- With high mean achievement scores recorded using constructive simulation, it calls for teachers to be abreast with the distinctive characteristics of this novel teaching method, with the view to enhance students' cognitive learning outcomes.

- Pre-service teachers should be trained on how to use the method. The constructive simulation instructional model must be included in the curriculum of teacher training institutions, as a core element.

- Teacher training tertiary institutions should train student educators on current teaching methods.

Since the efficacy of the constructive simulation instructional model in improving students' achievement and retention in mathematics has been indicated in this study, the Ministry of Education, teacher training institutions, supervisory bodies, curriculum planners sitting in Khyber Pakhtunkhwa textbook board, and authors of textbooks can adopt and popularize the method to ensure meaningful learning of mathematics in government secondary schools.

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