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Improving Students' Evaluation and Explanation Skills in Statistics using 9 E Teaching and Learning Model: an Experimental Study

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ARTICLE INFO

A B S T R A C T

The study was designed to compare the effectiveness of 9E teaching and learning model with Induction and Deduction Method (IDM). In this study the sample size of 124 students of Bachelor of Science (BS) 4 years (62 boys and 60 girls) was randomly selected. The experimental and control group design was used with pretest and posttest to observe the evaluation and explanation skill of the learners by Critical Thinking Skills (CTS). The selected students were divided into two groups i.e. experimental and control group. Experimental group was comprised of 62 students (31 boys and 30 girls) control group was consisted of 62 students (31 boys and 30 girls) teaching with IDM. The students were given treatment of 9E teaching and learning (elicit, engage, explore, explain, echo, elaborate, evaluate, emend and E-search) method. SPSS (V-23) data analysis was used in pretest and posttest for ANCOVA and independent sample t-test. It was observed that in posttest results of students (9ETLM). A significance difference was observed in the 9ETLM. The findings of the research indicate that the performance of the experimental group was better than the performance of the control group. However, there was some interaction between gender of EES and effect of conduct. It was strongly recommended to adopt and teach with 9 E teaching and learning model in different science and statistics subject during teaching in general and especially in statistics.

1. Introduction

In is an admitted fact that the best learning method, with better strategy play a vital role in the process of learning. Teachers' role is very important in this regards. Khan and Khan (2019) expressed that a constructive learning helps the students to acquire knowledge of statistics content during learning method. Harris

and De Bruin (2018) expressed that a teaching and learning of CTS, be considered vital role in statistics. Teaching of statistics a leading starring role in the period of modern global world, and prepare the students for future remarkable knowledge with evaluation and explanation skills (Kennedy & Sundberg, 2020). Hence its need to adopt the 9ELTM to create ability in students EES.

Learning Model

Different teachers adopt different teaching and learning methods from many decade for better learning of their learners. These are 3E (Bybee, 1997; Karplus & Thier, 1967)E (Bybee, 1997), and 7E (Eisenkraft, 2003). (Kaur & Gakhar, 2014) present 9E teaching and learning model. The 9 e have nine dimensions i.e., elicit, engage, explore, explain, elaborate, echo, evaluation, emend, and e-search. The English word E indicates the phases of teaching and learning process. The primary objective of this research was to explore the students' evaluation and explaining skills in regards to Critical Thinking Skills (CTS) with the help of these 9 E teaching learning model (9ELTM).

In 9ELTM the first step elicit, where teacher assess the students' misconception before understanding the content. Teacher are well aware about their student's pervious content knowledge of statistics. In second step of 9ELTM is engage, in this dimension, teacher apprehensions were students by discrepant, with short questions and engage their attention. The third dimension teachers help the students to explore and look over the subject content by emerging the questioning method. The next dimension explain, in which students were able to infer what they got knowledge in the previous dimension. In elaborate dimensions teacher encourage the students to apply their thought in new dimensions or in the others content knowledge. By this dimension students explore questions and educate new hypothesis. In the evaluate dimensions students learn about summative and formative evaluation; so the teachers adopt this dimension during teaching for better evaluation of students. In emend dimension teacher strengthen the students learning by practice and in revision of content. Emend and E-search dimension was first time introduced by Kaur and Gakhar (2014). While teaching the emend dimension, students improve their learning flaws in content and can be eradicated, if any ambiguities in content learning then progression carry on. The E-search paly major role between the others 9E's in this teaching and learning model. Teacher adopt E-search dimension during teaching with different knowledge and at different level, according to students' interest. Students using E-searching strategy or method to develop the evaluation and explanation skills.

The 9E Teaching and Learning Model

Kaur and Gakhar (2014) stated nine prominent fundamentals: elicit, engage, explore, explain, elaborate, echo, evaluation, emend, and e-search were main dimensions of the model.
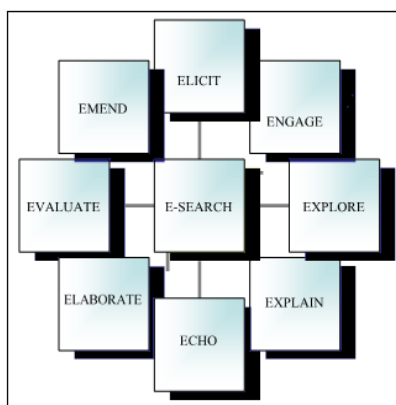
Figure 1. 9 E teaching and learning model

In the elicit essential, students learn to revise and linked with pervious learning knowledge. The next engage essential, teachers keep interest and attention towards lesson content of students to carry on the learning. At the explore stage, teachers create the situation with review content and past knowledge understanding, for exploring the content knowledge.

In the elicitation stage, teacher's effort to link through past knowledge, with new learning circumstances, so students can learn better. In engagement stage teacher create interest of students in learning and motivate to acquire the content knowledge successively. In exploratory stage teacher create better atmosphere for the students which make them able for distinct variables, make the hypotheses, and intensity of the scientific method, for finally results preparation. In the explanation stage, teacher try to explain the content, produce criticism and command for better students learning. At interpretation stage, teacher create ability in students for clear vision, define science terms, and implement these term, finally students able to interpretation content. The elaboration stage, teacher help the students in execution the past knowledge and focus content task. At the evaluation essential, teacher evaluate the students during the study, with different method. In this regard teachers are originator to create the learning ability in students with 9ETLM.
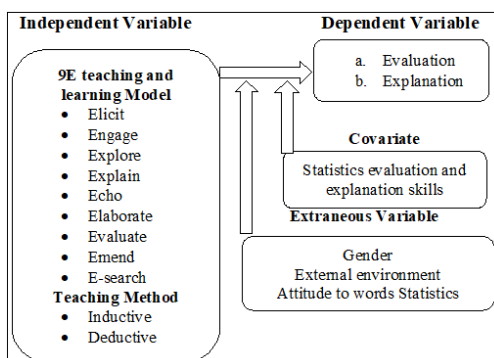
Conceptual Framework

Figure 2. Conceptual framework of the study

Evaluation and Explanation Skills

Evaluation and explanation skills (EES) can be develop by learning 9ETLM to evaluate students in control and experimental class. 9ETLM were independent variable and evaluation and explanation were dependent variable, statistics evaluation and explanation skills also covariant. One class taught with IDM teaching and other class taught by 9ELTM.

Critical thinking skills develop through learning and evaluation in the class. Students CTS improved in the class i.e. IDM teaching, learning model, also by evaluating and reducing the concerns which were affect (Shahid et al., 2019). Teaching CTS have a tool in our teaching, to resolve the problems with evaluating and explanation with positively resolved problem during the content teaching (Yağcı, 2019). In content statistics learning, CTS highlight problem and made solution. Consequently students are able to apply, to improve their performance and logically abilities by evaluating and explaining skills (Rahman, 2019).

With the firm base statistics knowledge in statistics, BS students will be organized to run into CTS EES in college education and the new epidemic world situations. Though, there is little research that refer to or searches how BS statistics teachers to teach the CTS to promote the EES to statistics students. Consequently, the purpose of this article was to improve the statistics content in the area about how EES, BS statistics teachers are using the 9ELTM to improve the content knowledge regarding statistics. Therefore students could have the ability to critical innovations in learning. In executing the statistics learning, it is hoped that students able to bettering learning statistics.

In fact, the students evaluating and explaining skills of CTS in statistics subject are still poor (Din, 2020). Statistics learning commonly in Pakistan, students stress on calculating, and applying simple aspects of formula with a simple way (Arif, Ammen & Rafiq, 2018). Student should be determined on EES with logical, analysis and reasoning prospective. Students are very infrequently adopt the learning method, to improving the evaluating and explaining skills (Bibi, Butt, & Reba, 2020).

Induction and Deduction Method

Statistics and science subjects are entangled and not correlated, that is some increases the knowledge of learning by induction method. At the same time, somehow the deduction method of teaching also increase the thinking about statistics and statistically logically proofs (Salsabila, Rahayu, & Sampoerno, 2021). The teaching with induction and Deduction Method (IDM), both are part and parcel during teaching. Gagani and Misa (2017) emphasized that mostly teacher adopted IDM in statistics teaching several decade.

Inductive teaching method help out in experiments, also help out in theories. In this teaching method, teacher help theoretical inferences by collecting the data for process. IDM help in statistically problems, theory foundation and data collection

while leads to formation and testing of hypothesis. So that IDM help in study design and problem solving and controlled experiments for further investigation (Chang & Hwang, 2018). Induction method of teaching dodgier, which leads to uncertainty. Inductive method based on the indication, which derive common methods form the statistically observation. Deduction method of teaching based on the inquiry and logics. The deduction method is totally different from inductive method. This method logical conclusion not followed at any results.

In fact, most of the students at college level have face problem in evaluation and explanation skills of the answer while solving the questions (Persky, Medina, & Castleberry, 2019). A small number of researcher to work for improving this abilities especially in statistics subject of EES. They determined that huge number of students face problem to evaluation and explanation skills (Changwong, Sukkamart, & Sisan, 2018; Surya, Syahputra, & Juniati, 2018; Taber, 2018).

In induction teaching method students build a concrete knowledge to generalize content and draw the conclusions, while teaching with deduction method, students are able to progression to more precise and more general. In broader term, inductive method of teaching is a way in which students are develop knowledge and innovate (Fraser, 2019). The induction ability in students are only to manage in organize manner to investigate the unknown fact (Maree, 2019). This relate with the problem solving and positively relevancy of content knowledge. Widana et al, (2018) approve that teaching statistics with IDM create thinking skills in students positively way. Teaching with induction and education method to proof in statistics subject so acute for the students (Al Shabibi & Silvennoinen, 2018).

To make over this deficiencies, teachers helps the students for improving the EES by 9ETLM. These skills could be developed by 9 E learning and teaching model optimally. Quite lot of learning method and ploys adopted the teachers to develop statistical analysis or other skills for students during studied ever before.

Evaluation and Explanation Skills

Kour and Gkhar (2014) present a teaching learning model for development of learning skills in students. In addition to 9 E teaching and learning methods adopt for assessing students learning and also knowing the EES and effect of improvement students learning. Also find out the statistically knowing skills in students how they improve, and 9ETLM effectiveness. This explored out the teaching 9ETLM of BS statistics teachers, which they would run into miscellany learning improvement of students and support EES.

According to Basri (2019) critical thinking have four steps i.e. inference, explaining, evaluation, and approaches which based on students critical thinking level, its differ student to students. Agreeing Renatovna and Renatovna (2021) that situation of CTS raised in the students at a distinctive level. Level of critical thinking are three i.e. quite critical, less critical and not critical (Paul & Elder, 2019). These level effect the critical thinking at each level of learning statistics.

Several researcher conducted research studies relate to CTS containing Nauman (2017); Din (2020) and Qamar (2016). Male student performed in evaluation and explanation skills then the female students (Kumar & James, 2015). CTS of teachers at BS level were medium but not high level (Erdoğan, 2020).

CTS having evaluation and explanation skills in order to evaluate and explain questions (Harjo, Kartowagiran, & Mahmudi, 2019). These skills could be incorporated in student through teaching learning model (Erdogan, 2019). CTS play a vital role for students better learning statistics (Setambah, Tajudin, Yaakob, & Saad, 2019), however a few research accompanied in Pakistani context which showed learning skills of students were insufficient (Malik, Qin, & Ahmed, 2020). Likewise teaching and learning model as a result, students of BS class in Pakistan, especially in Statistics subject lies into low class of CTS (Khanum, 2019). Some learning models improve the learning skills in students for evaluation and explanation skills (Putri, Roza, & Maimunah, 2020), teachers engage the students to encourage them in learning EES. Yet, the realities illustrate that having statistics subject students not to able in developing the EES with learning.

According to Erdogan (2019) learning skills is related with the CTS. Students who have not enough knowledge for better treating the problem, on the bases of EES. The relationship between the learning and EES yet not to be clear expressed in previous studies. The different researcher studies expressed that CTS of students who have the learning ability were better than the students, which have the poor learning ability (Din, 2020; Lubis, Irwanto, & Harahap, 2019; Saleh, 2019).

CTS are major skills for the students learning because they increase their learning skills through development of thinking. CTS are the basic for students learning and intellectual requirement of each learner (Elder & Paul, 2020; Mahanal, Zubaidah, Sumiati, Sari, & Ismirawati, 2019). CTS enhance the students learning skills but students are not able to become a critics in their study.

Objective of the Study

This study have the following objectives:
1. To compare the effectiveness of teaching, based on induction, deduction method and 9 E teaching and learning Model.
2. To investigate the effective of students, 9 E teaching and learning in evaluation and explanation skills

Hypotheses of the Study

Ho1: There is no significant difference in the mean score of students based on IDM and 9 E teaching and learning Model, when integrated process of teaching statistics with 9 E teaching and controlled as covariant.

Ho2: There is no significant difference in the mean score of students 9 E teaching and learning in evaluation and explanation skills, when integrated process of teaching statistics with 9 E teaching and controlled as covariant.

2.   Methodology

Following method was adopted during the research study.

This study was experimental research. Experimental research design was in quantitative research where researcher took the population of Bachelor of Science students. The research objectives were, to compare the effectiveness of teaching, based on IDM and 9ETLM. The second objective was to investigate the effective of students, 9 E teaching and learning in evaluation and explanation skills. Therefore, the use 9ETLM students learning EES, educationist assessment students' performance in EES. There was resolve important concern in education sector to be answer back and be well prepared students to live in the 21st century.

Population of The Study

All the Bachelor of Sciences (B.S) four year students of the district Bahawalpur, Punjab Pakistan whose studied statistics paper as subject were well-defined population of the research study.

Sample of The Study

Two colleges, Govt. SE College Bahawalpur and Govt. Post Graduate Dubai College for women Bahawalpur were randomly selected for conduct experimental research study. Random sampling was adopted for the selection of sampled of control and experimental class. Four classes of BS four year statistics students (two boys and two girls' classes) were randomly selected.

Table 1. Calcification of Sample

College	Experimental Class	Control Class	Total
Boys	32	32	64
Girls	30	30	60

Research Design

This research study was designed to examine the effectiveness of Kaur and Gakhar, 9ETLM. The researcher applied experimental research design during study, pretest posttest control class design. The organized research designed detail as:
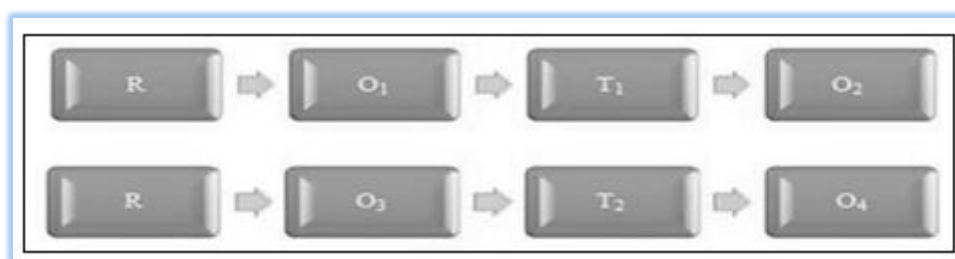
Figure 3. Research design of the study

In the figure random assignment of statistics subjects to classes "R'', Pre-tests "O_1" and "O_3" and Post Test O_2 and O_4. Treatment with the 9ETLM "T_1" and treatment with IDM "T_2".

The experimental class was taught with 9ETLM while the control class was taught with IDM teaching. Teacher having the six years' experience and same qualification M.Sc. (Statistics) and having proficient degree Bachelor of Education (B.Ed.) in the selected sample school. Teacher were briefed in detail about aims and objective of the research study, and customized teaching of 9ETLM, IDM teaching. Students taught both classes six weeks. Teacher took session of each class forty five minutes per day, and five days in a week. Total thirty sessions were taken of both classes (Experiment and control). The objective types pretest about inferential statistics was conducted before the teaching 9ETLM both classes (Experiment) and IDM both classes (Control).

Table 2. Research Design and instrument

Classes	Pre Test	Treatment	Post Test
Control Experiment	Obj. Inferential statistics (OIS)	9 E teaching and learning model (9ETLM)	OIS

Instruments

The Objective Inferential Statistics (OIS) test made by researcher and researcher adapted questionnaire Turgut, Colak, and Salar (2017) to measure the change in 9 E teaching and learning in students (experimental class), IDM learning class (Control). Following table 3 shows the information about instruments which was used in the study.

Table 3. Instrument used, for reliability coefficient values

Instruments used & reliability coefficient values	No. of items	Measurement	Reliability Cronbach-Alpha
IDM	25 items	IDM learning	$\alpha=0.73$
9ETLM	25items	9 E learning	$\alpha =0.81$

Data Analysis and Results

The researcher analyzed data of pretest score OIS control and experimental classes were as:

Table 4. Pre-Test OIS Descriptive statistics

Classes	N	Min	Max	Mean	SD	Skewness	Kurtosis
Control	62	5	22	12.13	3.805	0.57	1.012
Experimental	62	5	22	12.13	3.805	0.57	1.012

According to pretest results of control and experimental classes, there was mean and standard deviation was same and there was no difference between control and experiment classes, students were equally distribution in two classes. The mean and SD (Mean = 12.13, SD = 3.805) of experimental control classes, and mean and SD (Mean = 12.13, SD = 3.805) control classes.

Table 5. T-test: pretest of score OIS

	Equality of Variances Levene's Test		t Equality of Means by t-test		
	F	Sig.	*t*	*d f*	*p*
Equality of variances assumed	0.00	1.00	0.00	121	1.00
Equality of variances not assumed			0.00	121	1.00

In table 5 results showed that the independent sample t-test analysis of pretest scores of OIS. The equality variance and equal variance were hypotheticals. There were no significant difference between independent sample t-test of the control class (Mean = 12.13, SD = 3.805) and experimental class (Mean = 12.13, SD = 3.805), (t $(_{121})$ = 0.00, p= 1.00) before the treatment.

b) 9ETLM using as a covariate

Table 6. Descritive Statistcs: 9ETLM

Classes	N	Min	Max	Mean	SD	Skewness	Kurtosis
Control	62	11	26	17.27	3.72	0.315	-0.853
Experimental	62	12	26	19.63	3.098	0.257	-0.775

According to the results table 6, students in the experiment class (M = 19.63, SD = 3.098 had more skills to solve EES to compare the students control class (M = 17.27, SD = 3.72).

Table 7. T-test Score of 9ETLM

Variances	Levene's Test		Equality of Means t-test		
	F	Sig.	*t*	*df*	*p*
Equality of variances assumed	1.267	0.245	-3.557	120	0.001
Equality of variances not assumed			-3.557	115.578	0.001

In table 7 results showed that on the basis of independent variable (IV) sample t-test analysis, 9 E Teaching and Learning Model (9ETLM) score. In Levene's Test expressed dynamic results, the variances were assumed equality of Variances. Results of IV sample t-test showed that there was no significant meaning full difference with students 9 E Teaching and Learning Model score of the control class (M= 17.27, SD= 3.72) and experimental class (M=19.62, SD = 3.098) , (t (121) = -3.557, p = .001) before the treatment. To control difference existing already in the statistical analysis, student evaluation and explain skills was decided to be used as a covariant.

Testing Null Hypotheses Post-test

İn this research study testing the null Hypotheses, ANCOVA and t-test were used.

Ho1: There is no significant difference between mean score of students based on IDM and 9 E teaching and learning Model, when integrated with teaching statistics process with 9 E teaching and controlled as covariant.

The first null hypotheses was tested by using Analysis of covariance (ANCOVA). It was used before the analysis increased. ANCOVA norms were complete before, so the detail of ANCOVA were in table 8 below.

Table 8. ANCOVA: Post SSE score of Control and Experimental Classes

Source	df	F	p
9ETLM	1	2.382	0.125
Classes	1	53.727	0
Error	120		

The results (f (1.120) = 53.727, ρ = 0.00) deep out that there was significant mean difference between mean score of students statistics evaluation and explanation (SEE) when 9ETLM was controlled as a covariant. The experimental class (N=61, M= 17.27, SD= 3.72) scored on significantly high level as compare to the experimental class (N= 61, M = 22.11, SD = 3.098)

Ho2: There is no significant difference in the mean score of students 9 E teaching and learning in evaluation and explanation skills, when integrated process of teaching statistics with 9 E teaching and controlled as covariance.

The second null hypothesis results showed that there was no significant difference in the mean score of both gender (Boys, Gilrs) with respect to statistics students EES was controlled as a covariate. This hypothesis was tested with ANCOVA. As above in the first hypothesis, similarly needfull assumptions of ANCOVA complete. The results of the inferred of ANCOVA as shown in table 9.

Table 9. ANCOVA Post Gender Scores of The 9ETLM

Source	df	F	p
Gender	1	5.732	0.017
9ETLM	1	13.066	0
Error	122		

According to the results (F (1,122) =5.732, p = 0.017 of above table, there was a significant difference in the mean score of both gander in terms of their 9ETLM was controlled as a covariate. The girls (N =62, M= 19.78, SD = 4.345) scored significantly better than boys (N =62, M= 18.68, SD = 4.657).

3.   Results and Discussion

The learning process and results concerned outcome with in an IDM of teaching in students is passive learning (Aljaberi & Gheith, 2019). Lai, Qi, Lü, and Lyu (2020) gathered the similar concepts. He believed that teaching and learning succeeds to involved and follow the 9ETLM by students. The teacher is acquired how to learn and teach students. Subsequently create skills in students of EES learning for the content, and find with fact figure.

Teacher taught teaching with 9ETLM, students' ultimate fully involved in developing their EES. In other words students searching for fact and figure with their deficiency in thinking. According to the Sulianto et al., (2020) approaches of teaching in students' able to develop their knowledge in EES and reasonable supremacy in learning. According to the statistical analysis that 9ETLM significantly showed better results than the IDM of teaching.

While the posttest analysis results also strengthened the assertion. Teachers are to be adopt about the choice of one more stages of 9ETLM presentation.(Zhang & Nouri, 2019). Though there are further confirmations in the past, which support the effectiveness methods of teaching models (Bybee, 1997; Bybee et al., 2006; Saraç, 2018; Shaheen & Kayani, 2015; Taguiam, 2015)

Teaching of statistics play a central role to promote the EES with the 9ETLM for understanding. Therefore, teaching with the inductive and deductive method students to rebuild their better knowledge and more effective with 9ETLM in EES of statistics. Consequently the method of 9 E teaching and learning model developed the students learning and liable they gain better evaluation and explanations skills and able them new thought about the content. Finally educationist should be awareness about the model of 9ETLM in statistics teaching. The school education department are encourage the administration to hold the workshop as well as teachers to adopt the 9ETLM and improve their teaching skills. Students improve their evaluation and explaining skills in statistics. School Education Department (SED) implement the 9 E teaching and learning model to develop the student's evaluation and explaining skills. Teacher concentrate on 9ETLM as compared to IDM of teaching.

4.   Conclusion

1. Students pre-test result showed that no difference in the mean scores of subject achievement test (Pre-EES) in both control and experimental class was observed. This means that both classes consisted of equal distribution of students, in addition, the data was distributed normally.
2. Statistics subject (treatment class) continued more skills regarding EES which was in control class students, even that data was circulated normally.
3. A significant gap was between post-test average scores of students' evaluation and explanation skills (EES), which based on 9ETLM and induction and deduction method was perceived while students'. 9ETLM was controlled as a covariate. The experimental class significantly showed better scores than the control class.
4. It also observed that significant variation in boys and girls average with contract student evaluation and explanation skills. Whereas students' EES under control as variation factor.

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