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EVALUATING THE 5E MODEL'S EFFECT ON SPATIAL INTELLIGENCE AND GEOGRAPHY PERFORMANCE

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ABSTRACT

The purpose of this research is to determine the impact of using the 5E Instructional Model in development of 9th-grade students' spatial intelligence as well as their achievement in geography when compared to conventional approaches in Hyderabad District, Telangana. The 5E model, particularly the absorption based on inquiry learning characteristics, has been beneficial in improving the learners' knowledge, thinking skills, and interest levels in matters within numerous fields. The research aims at determining the effectiveness of this model towards the acquisition of spatial intelligence particularly in geography and general performance in the subject. This research adopts a pre- and post-test control group quasi-experimental design where one group is taught using the 5E model while the other group is taught under normal practice. The research design implemented in the study involved the use of pretest and posttest data of academic achievement, spatial ability, and motivational instrument. The findings also revealed that there were increased changes in both groups; however the use of 5E model of teaching did not prove more beneficial than the traditional method in increasing the spatial intelligence and the academic performance of the students. This means that although 5E model, as an innovative teaching model, has virtues that enable interaction amongst the learners, its effectiveness could be determined by factors such as teacher's professional development, time spent on the lesson and the use of technology. It adds to the knowledge about the five-e model for geography education and points out the further research possibilities touching upon the use of technology in the process and motivation of students.

Keywords: 5E Instructional Model, Spatial Intelligence, Academic Achievement, Geography Education, Inquiry-Based Learning, Student Engagement

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1. INTRODUCTION

Geography curriculum and learning is very important in the process of developing the students' space quotient levels and making them aware of the world around them. Nonetheless, the approach to teaching in geography could be stereotyped and may not capture students' interest or foster critical thinking skills in as far as the subject matter is concerned. The 5E Instructional Model which Cette contains specific teaching phases such as engage, explore, explain, elaborate and evaluate can be identified as a useful tool in promoting activity within the learning-teaching processes, and helping students develop a much deeper understanding of the different areas of the knowledge, including geography. In this study, the effectiveness of the 5E Instructional Model in enhancing the interest, spatial intelligence and achievement scores of the 9th grade students in geography will be determined and compared to the 9th grade traditional teaching and learning approaches in the secondary schools in Hyderabad District, Telangana.

Therefore, this research will seek to establish whether there is an improvement in students' spatial intelligence which is an important factor in understanding geography and their performance in geography if the 5E model is

implemented compared to the traditional approach. In this work, it is planned to analyse the results of the experimental and control groups in order to understand the use of the 5E model for the development of critical thinking, expansion of space intelligence, and increase students' achievements in geography. In addition, further the study sought to establish the level of students' interest enhanced by this model as a key element of continued student success.

2. LITERATURE REVIEW

2.1. THE 5E INSTRUCTIONAL MODEL AND ITS APPLICATION IN EDUCATION

This paper aims at discussing the utilization of the 5E Instructional Model, which has been widely described by many educators as suitable for teaching and learning of various subjects. The model once again holds the advantages of supporting student activism; promoting student participation; and improving knowledge enhancement (Abdulbaqi, 2019; Joswick & Hulings, 2021). In their study, Chan et al. (2021) underscore the experimental nature of 5E model in increasing the motivation of students, especially if supported by multimedia elements that are now a part of geography curriculum. Besides, other researches of the 5E model have indicated that it enhances critical thinking and inquiry-based learning and enables them to establish relations with prior learning (2020; Kulapian et al., 2020). This aspect has made the 5E model versatile to be used in any subject including geography whereby the subject requires space intelligence as well as critical thinking skills. The model's inquiry-based structure can also be quite useful in geography classrooms where students have to make use of such elements as the maps and spatial skills in understanding various concepts (Hassan et al., 2021; Wang et al., 2021). This is quite different from the conventional style of learning where a teacher passes information to the learners, a process which fails to stimulate the learners' thinking faculties, or the critical thinking capacity and thereby fails to enable learners to analyze geography on their own (EDWIN, 2017).

2.2. SPATIAL INTELLIGENCE IN GEOGRAPHY EDUCATION

One of the most important factors to learn about in geography is known as spatial intelligence, which is the ability of visual and spatial thinking in presenting, transforming or interpreting the geographic ideas such a maps, models and data. This serves a very important purpose in geographical literacy and academic achievement in the subject. Wang et al. refer to spatial intelligence as the way understand geographic phenomena, and one reasons for increasing it is effective problem solving in geography. Cao et al. (2021) established from their findings that the 5E model, which students attend to during their learning, enhances the spatial intelligence due to the way students work on geographical data with an active view. Another study has also suggested an association between students' spatial type of learning and performance in geography class. For instance, Somantri & Hamidah (2021) attributed enhanced spatial intelligence positively and noted that it enhances the understanding of geographic cues in students to produce excellent results. In the same way, Nwana and Okeke (2021) have established that the teaching of geography with an inclusion of spatial intelligence leads to higher results in general knowledge and understanding of geographical knowledge. Therefore, it can be argued that, the implementation of structured instructional practices that develop spatial intelligence can produce positive learning related behaviours that advance student interest and learning outcomes in geography class.

2.3. IMPACT OF TRADITIONAL VS. INNOVATIVE TEACHING METHODS ON GEOGRAPHY PERFORMANCE

In conventional presentation of content on geography, there is mostly an instructor who delivers information to learners with little or no participation from the learners. Although, this method can give the base knowledge for students, but cannot challenge their and or even deepen their spatial intelligence. According to the studies done by EDWIN (2017) and Fort (2021) show that methods used in traditional geography involves knowledge acquisition through lectures, which although knowledgeable, lacks an active kind of learning that could be required to teach students complex geographical analysis. Furthermore, such approaches may prove to be inefficient in engaging the students towards the subject matter which is significantly vital for their growth and success (Ahmad, 2019). On the other hand, the pedagogy that is employed, for instance; the 5E model is engaging to the students and provides exploration and active participation of the concept in class that enhance the students' performance rather than a passive manner. Various research findings reveal that 5E model is beneficial to learning depending on the subject, in this case, those that require more of conceptual and spatial content. For example, in their study, Chan et al. (2021) established that the 5 E Model of Instruction integrated

with technology enhanced students' interest and achievement in geography lesson. In addition, in the study done by Kulapian et al. (2020), they proposed that the type of approach where the model presented in this study involve requires students to reason out, hence improving the way they solve problems which is an essential area in geography.

2.4. GEOGRAPHY EDUCATION AND TECHNOLOGICAL INTEGRATION

The implementation of technology in schools particularly in the teaching and learning of geography has continued to receive impetus through use of tools including GIS, and The World Wide web as well as multimedia. According to the work done by Elvia et al. (2017), Nwana, and Okeke (2021), utilization of technology helps in the visualization of the geographic information that leads to an increased spatial intelligence and the academic performances. Google Maps and GIS facilitate the presentation of abstract geographical concepts in such a manner that enables students to apply traditional concepts into practice as proposed by Musa and Sa'ad (2015). Also, integration of technology in the 5E model helps to reinforce spatial thinking in a class activity. Joswick and Hulings (2021)'s findings show that adopting multimedia and technology within the 5E model not only supports students in learning and understanding geographical content but also enhances their engagement in this particular subject. When applied in the 5E framework, spatial intelligence training tools and webGIS has been known to enhance both the spatial thinking abilities and geographical content knowledge of students as stated by Somantri and Hamidah (2021). Therefore it is indicatively that the integration of the 5E model with technological tools could be seen as an effective implementation to improve the spatial intelligence and the geography performance.

3. METHODOLOGY

This research aims to establish the effects of the 5E Instructional Model in enhancing the interest, spatial intelligence and academic achievement of the ninth grade students in geography than with the traditional approach of teaching in the Hyderabad District, Telangana.

3.1. JUSTIFICATION

The study looks at the application of 5E model of teaching that encourages students' participation and, in general, critical thinking against what may not engage the students in an active manner. This paper is useful for enhancing the course of geography and the development of spatial thinking.

3.2. RESEARCH DESIGN

An experimental design with a control group and experimental group was used to observe the effects of the 5E model on students. Pretests and posttests assessed interest, spatial intelligence, and academic achievement in geography.

3.3. VARIABLES

- **Independent Variable:** Method of teaching (5E model vs. traditional methods).
- **Dependent Variables:** Student achievement, interest in geography, and spatial intelligence.
- **Intervening Variables:** Mental ability and previous geography experiences.

3.4. EXPERIMENTAL DESIGN

A quasi-experimental design compared two pre-existing groups, one taught with the 5E model and the other with traditional methods. Pretest and posttest measurements were used.

3.5. POPULATION & SAMPLE

The study focused on 9th-grade students from 100 secondary school students in Hyderabad District, divided into control and experimental groups of 50 students each.

3.6. TOOLS

- **5E-Based Lesson Plan:** For the experimental group.
- **Traditional Lesson Plan (Herbert's):** For the control group.
- **Intelligence Assessment Tool:** To measure spatial intelligence.
- **Pretest/Posttest Questionnaires, Observation Checklists, Student Reflection Logs, Teacher Feedback Forms:** To collect data on student outcomes.

3.7. STATISTICAL TECHNIQUES

Statistical methods include:

- **Independent Samples t-test:** To compare the control and experimental groups.
- **Paired Samples t-test:** To measure within-group changes.
- **Descriptive Statistics:** To summarize data and performance.

3.8. OPERATIONAL DEFINITIONS

Defines key terms such as "Engage," "Explore," and "Elaborate" in the 5E model, as well as the traditional teaching approach and the measurement of academic achievement in geography.

3.9. DELIMITATIONS

- Study limited to secondary schools in Hyderabad District.
- Focused on government, English-medium schools, and 9th-grade students.

The research assesses the impact of the 5E Instructional Model on student outcomes in geography education in Hyderabad, Telangana, using pre- and post-tests and a variety of data collection tools to compare both teaching methods.

4. "DATA ANALYSIS

Objectives 1. To find out the impact of 5Es Instructional Model of Teaching on Spatial intelligence towards Geography between pretest and posttest of control group among Secondary School Students.

Hypothesis I:

Null Hypothesis (H_0): There is no significant difference in the Spatial Intelligence towards Geography between pretest and posttest of control group taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.1: Paired Samples Statistics of Pretest and Posttest Spatial Intelligence in Control Group

Paired Samples Statistics					
		Mean	N	Std. Deviation	t-value
Pair 1	Pre-Test	61.0800	50	5.50265	1.73
	Post-Test	62.3200	50	4.55999	

For the control group, the t-value for the comparison between pretest and posttest spatial intelligence scores is 1.73. This value suggests a moderate difference between the pretest and posttest results in the control group. Given that the t-value is above 1.96 (the typical threshold for significance in a two-tailed test at the 0.05 level), it implies that the difference between the pretest and posttest is statistically significant. Therefore, we reject the null hypothesis, meaning

that there is a significant difference in spatial intelligence between the pretest and posttest for the control group. This suggests that the control group experienced a measurable change in spatial intelligence, potentially due to factors other than the 5Es Instructional Model, such as time, natural learning, or external influences.

Objectives 2. To find out the impact of 5Es Instructional Model of Teaching on Spatial intelligence towards Geography between pretest and posttest of experimental group among Secondary School Students.

Hypothesis II:

Null Hypothesis (H_0): There is no significant difference in the Spatial Intelligence towards Geography between pretest and posttest of Experimental group taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.2: Paired Samples Statistics of Pretest and Posttest Spatial Intelligence in Experimental Group

Paired Samples Statistics					
		Mean	N	Std. Deviation	t-value
Pair 1	Pre-Test	62.3200	50	5.43398	0.33
	Post-Test	62.7200	50	5.43248	

For the experimental group, the t-value for the comparison between pretest and posttest spatial intelligence scores is 0.33. This t-value indicates that the difference between the pretest and posttest scores in the experimental group is very small, suggesting that the intervention had little to no effect on their spatial intelligence. Since this t-value is well below the critical value of 1.96 for statistical significance, it is highly likely that the p-value associated with this test will be greater than 0.05. As a result, we accept the null hypothesis, meaning that there is no significant difference in the spatial intelligence of the experimental group between the pretest and posttest. This suggests that the 5Es Instructional Model did not significantly impact the spatial intelligence of students in the experimental group.

Objectives 3. To find out the impact of 5Es Instructional Model of Teaching on Achievement towards Geography between control group and experimental group of pretest among Secondary School Students.

Hypothesis III:

Null Hypothesis (H_0): There is no significant difference in Achievement towards Geography between the control group and experimental group of pretest taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.3: Group Statistics of Achievement in Geography for Pretest Scores

Group Statistics					
	Group	N	Mean	Std. Deviation	t-value
Pre-Test	Control	50	63.5200	5.03960	1.30
	Experimental	50	61.9200	6.38186	

For the pretest scores of Achievement in Geography, the t-value between the control group and the experimental group is 1.30. While this t-value indicates some difference between the two groups, it is not large enough to be statistically significant, as the t-value is less than the critical value needed for significance at 0.05 (which is 1.96). Therefore, we accept the null hypothesis, indicating that there is no significant difference in the achievement scores of geography between the control and experimental groups at the pretest stage. This suggests that the students in both groups had similar levels of achievement before any instructional intervention, and thus, the 5Es Instructional Model did not show a discernible effect on achievement at the pretest phase.

Objectives 4. To find out the impact of 5Es Instructional Model of Teaching on Achievement towards Geography between Control group and experimental group of posttest among Secondary School Students.

Hypothesis IV:

Null Hypothesis (H_0): There is no significant difference in Achievement towards Geography between the control group and experimental group of Posttest taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.4: Group Statistics of Achievement in Geography for Posttest Scores

Group Statistics					
	Group	N	Mean	Std. Deviation	t-value
Post-Test	Control	50	61.8000	6.67007	-0.53
	Experimental	50	62.3600	4.33194	

In the case of the posttest scores for Achievement in Geography, the t-value for the comparison between the control group and the experimental group is -0.53. This t-value is very small and suggests that the difference between the two groups is not significant. Since the t-value is close to zero and the p-value is likely to be greater than 0.05, we accept the null hypothesis. This means there is no significant difference in the achievement scores between the control and experimental groups on the posttest. This indicates that the 5Es Instructional Model did not significantly improve achievement in geography for the experimental group compared to the control group after the intervention.

Objectives 5. To find out the impact of 5Es Instructional Model of Teaching on Achievement towards Geography between pretest and posttest of control group among Secondary School Students.

Hypothesis V:

Null Hypothesis (H_0): There is no significant difference in Achievement towards Geography between pretest and posttest of control group taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.5: Paired Samples Statistics of Pretest and Posttest Achievement in Control Group

Paired Samples Statistics					
		Mean	N	Std. Deviation	t-value
Pair 1	Pre-Test	63.5200	50	5.03960	-2.10
	Post-Test	61.8000	50	6.67007	

The paired samples t-test comparing the pretest and posttest scores of the control group reveals a t-value of -2.10. This value is statistically significant, as it is greater than the critical value of 1.96 for a two-tailed test at the 0.05 significance level. The negative sign indicates that the posttest mean score of 61.80 is lower than the pretest mean score of 63.52, which suggests a decrease in achievement after the intervention. Given that the t-value exceeds the threshold for significance, we reject the null hypothesis. This indicates that there is a significant difference in the achievement levels of the control group between the pretest and posttest, suggesting that the 5Es Instructional Model of Teaching may have had an effect, but in this case, it appears to have led to a decline in achievement. The result implies that further exploration into the reasons for this decrease is necessary, and it may also highlight that external factors or issues in the implementation of the instructional model may have influenced the outcome.

Objectives 6. To find out the impact of 5Es Instructional Model of Teaching on Achievement towards Geography between pretest and posttest of experimental group among Secondary School Students.

Hypothesis VI:

Null Hypothesis (H_0): There is no significant difference in Achievement towards Geography between pretest and posttest of Experimental group taught using the 5Es Instruction model of teaching among secondary school students.

Table 4.6: Paired Samples Statistics of Pretest and Posttest Achievement in Experimental Group

Paired Samples Statistics					
		Mean	N	Std. Deviation	t-value
Pair 1	Pre-Test	61.9200	50	6.38186	-0.58
	Post-Test	62.3600	50	4.33194	

For the experimental group, the paired samples t-test comparing the pretest and posttest achievement scores results in a t-value of -0.58. This value is not statistically significant because it is well below the critical threshold of 1.96. This suggests that the difference between the pretest and posttest achievement scores in the experimental group is very small and likely due to random variation. As the t-value does not meet the threshold for significance, we accept the null hypothesis. This indicates that there is no significant difference in achievement towards geography between the pretest and posttest for the experimental group. The lack of significant change in the experimental group's scores implies that the 5Es Instructional Model of Teaching did not have a measurable effect on their achievement in geography, and further investigation may be needed to understand why this intervention did not produce the desired impact. It could be that the model was not effectively applied or that other factors played a role in maintaining stable achievement levels."

5. DISCUSSION

The purpose of this study was to determine the impact of 5E Instructional Model on students' spatial intelligence and their achievement in geography class, particularly, 9th grades, compared to the usual method of teaching. Geography education has been shown to enable the development of spatial–teaching approach is vital for developing geographic learning. The 5E model that describes Engagement, Exploration, Explanation, Elaboration, and Evaluation as its phases has been considered as the comprehensive model for positive changes in a students' thinking and their active involvement in the learning process (Abdulbaqi, 2019; Joswick & Hulings, 2021). In this discussion, the findings of this study will be looked at together with the data from the literature and the findings will then be compared. When testing results, shown in tables 3, it is possible to assume that the experimental and control groups did undergo changes in terms of spatial intelligence and academic achievement; however, the overall results did not rise to the levels expected, especially in the experimental group that was taught through the 5E model of instruction. Altogether, no significant difference was observed on the spatial ability or academic performance of the experimental group in the pre and post-test. This was rather a curiosity since other researchers did find certain positive results concerning how the 5E model contributed to the students' engagement and critical thinking skills (Chan et al., 2021; Kulapian et al., 2020). This result may be due to an insufficient implementation of the 5E model or its implementation in the classroom has not been carried out enough thoroughly to strengthen the cognitive aspect of spatial intelligence (Jiang et al., 2016; Somantri & Hamidah, 2021).

Research that has been conducted in the past by Hassan et al. (2021) and Wang et al. (2021) has also established that the 5E model offers a positive impact on spatial intelligence and academic performance learning when learner-centered activities and inquiry is incorporated. For instance, in their study, Cao et al. (2021) showed that the utility of the 5E model in combination with proper teaching and learning tools such as GIS, and spatial intelligence training has the potential to improve students' abilities to develop spatial mental imagery. Therefore, the absence of positive results as obtained in this research might be attributed to certain conditions that include the aspect of teaching context, students' preparedness and the difficulty level of geography content knowledge. It may also be argued that competence differences of the teachers in the classroom in using the model could have dictated the results (Musa & Sa'ad, 2015). The children that received traditional instruction, but whose teaching methods were recorded in this study, improved a little on the spatial intelligence and not in the same magnitude as the experimental group. This is in consonance with the notion held by EDWIN (2018) that geography instruction which delivers specific facts is not only feasible but may also be devoid of students' enthusiasm and critical thinking skills. The control group, however, did indicate a statistically significant increase in achievement from pretest to posttest and other factors such as, for instance, increased time on task, or the general learning development of students might have accounted for this increase (Fort, 2021). The fact that the scores

of the control group reduced slightly between the pre and post test could be due to some factors namely test-weariness or other variables that may have affected student's enthusiasm and concentration levels (Ahmad, 2019; Nwana & Okeke, 2021).

Geographical learning, in this context, involves spatial intelligence and this simply entails the ability to understand and manipulative spatial information such as maps and geography data (Somantri & Hamidah, 2021). Despite positive results of the 5E model in training students' spatial intelligence in other subjects (as pointed out by Cao et al., 2021), it has produced less significant improvements in geography in this research. This may imply that in spatial intelligence the students may perform as per prior knowledge, cognitive developments and the quantity of the amount that practical actual use is made of geographical concepts in classrooms (Wang et al., 2021). Kiş (2016) and Nwana & Okeke (2021) have particularly stressed the need for ensuring use of technology along with practical manipulatives in teaching the geography subject in an effort to enhance the learners' spatial perspective. Hence, geography education that involves tools such as GIS and utilization of web platforms in the class enables the feel of the geographic patterns and concepts and may explain the success of the 5E model when incorporated with these technologies (Musa & Sa'ad, 2015; Joswick & Hulings, 2021). The existence of small differences in academic achievements of the first and the second group of students gives rise to the questions of the nature of the geography and ways to increase the level of achievements. It should be noted that geography as a subject has a rather unique approach to learning since it is quite different from such subjects as science as it entails memorization of facts and theoretical knowledge as opposed to the practical approaches and critical thinking that is required in this subject area (EDWIN, 2017). Probably, it is necessary for the 5E model which facilitates the more inquiry and exploration, to use supplemental instruction types, for example, the use of real data or the field activities, in order to facilitate students' engagement and improve the academic achievement in geography (Kanapi et al., 2021). In the case of students' interest and motivation, it is demonstrated that they are key sources of the performance in class, and the 5E model for learning while enhancing the student interest may lead to loss of their motivation over time as noted by Elvia et al in their research in 2017 and Fort in 2021.

Technological integration has been evidenced in the contexts of GIS, multimedia use where the scholars found that enhancing geographical education enhanced spatial IQ and learning outcomes (Somantri and Hamidah, 2021; Joswick & Hulings, 2021). The group of students which did not apply GIS or web-based tools as the part of the 5E model might not have been provided with the technological boost to fully enhance their learning of geography concepts. According to Chan et al. (2021) and Elvia et al. (2017), multimedia and technology-enriched instructional materials improve understanding of such issues to the students and make them more engrossed in the subject. More research should be conducted to establish the combined role of the 5E model of instruction and use of technology for instance, GIS or interactive maps on students' performance and spatial facilities in the teaching of geography. Thus, it is recommended that more research is conducted regarding factors that may act as a positive or negative factor with regard to the utilisation of the 5E model in geography education. Joswick & Hulings (2021) and Kulapian et al. (2020) in their literature reveal that the level of effectiveness of the 5E model may depend upon the teachers' trainings on how to use the model properly and its integration in the curriculum. The findings also suggest that it is necessary to take into account other factors, including motivation, prior knowledge and use of IT in learning when evaluating the effects of instructional models on the students' improvement with regard to geography (Somantri & Hamidah, 2021, Wang et al., 2021).

6. CONCLUSION

The purpose of this study was to evaluate the effectiveness of 5E Instructional Model on spatial intelligence as well as achievement of 9th grade students in geography. Analyzing the results of the study that has been based on this promising theoretical framework of this inquiry-based instructional approach suggests that the application of the 5E model was not much more effective than the traditional methods on the aspects of Spatial intelligence or the academic achievements. Although the two groups proved to have a slight improvement, the 5E model teaching method used on the experimental group gave posttest results almost similar to that of the control group. This implies that some other aspects like, the degree of technology, the trainer's competency in implementing the model and the duration of the intervention, may have a more significant effect as compared to the type of intervention. The outcomes also suggest difficulties that are associated with the implementation of the 5E model in geography education, especially in developing the spatial aspect of students' intelligence. Perhaps the purpose of the 5E model, as an effective tool in other topics, calls for minor changes when applying it to teaching of geography, such as embodied instruction and the use of GIS tools or fieldwork. However, it is concerning that there are very few studies that could establish the long-term effects of the proposed model

and practical research is needed to implement the model to facilitate geographic learning outcomes. Thus, although introducing the 5E model may bring certain benefits to the learning-teaching process, its effectiveness when applied in the organization of geography lessons has not yet been explored to the extent possible.

CONFLICT OF INTERESTS

None.

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