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

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ABSTRACT

This study investigates the effect of the 5E Instructional Model on 9th-grade students' spatial intelligence and academic performance in geography, comparing it to traditional teaching methods in Hyderabad District, Telangana. The 5E model, which emphasizes an inquiry-based learning approach, has shown promise in enhancing student engagement, critical thinking, and subject comprehension in various disciplines. The research focuses on assessing whether the 5E model can improve spatial intelligence, a vital skill in geography education, and overall academic achievement in the subject. Through an experimental design, the study compares two groups: one exposed to the 5E model and another using traditional teaching methods. Data were collected using pretest and posttest measures of academic achievement, spatial intelligence, and student engagement. The findings indicate that while both groups demonstrated changes, the 5E model did not significantly outperform traditional methods in enhancing spatial intelligence or academic achievement. This suggests that while the 5E model offers a more interactive approach, its impact may depend on additional factors such as teacher expertise, lesson duration, and technology integration. The study contributes to understanding the effectiveness of the 5E model in geography education and suggests areas for further exploration, particularly in integrating technology and enhancing student motivation.

Keywords: 5E Instructional Model, spatial intelligence, academic achievement, geography education, inquiry-based learning, student engagement.

1. INTRODUCTION

Geography education plays a crucial role in shaping students' understanding of the world around them, fostering spatial intelligence, and preparing them for global citizenship. However, traditional teaching methods in geography may fail to adequately engage students or enhance critical thinking skills, especially in a subject that requires both conceptual understanding and practical application. The 5E Instructional Model, which emphasizes active learning through phases such as Engage, Explore, Explain, Elaborate, and Evaluate, has gained recognition for its potential to boost student engagement, deepen understanding, and improve learning outcomes in various subject areas, including geography. This study evaluates the impact of the 5E Instructional Model on 9th-grade students' interest, spatial intelligence, and academic achievement in geography, comparing it to traditional teaching methods used in secondary schools in Hyderabad District, Telangana.

The primary aim of this research is to investigate whether the 5E model can enhance students' spatial intelligence—an essential component of geographical learning—and their performance in geography compared to the traditional instructional methods. By examining the outcomes of the experimental and control groups, this study seeks to provide insights into the effectiveness of the 5E model in fostering critical thinking, increasing spatial intelligence, and improving students' academic achievements in geography. Furthermore, it aims to explore the extent to which this model encourages greater student interest and engagement in the subject matter, which is a critical factor in sustaining long-term academic success.

2. LITERATURE REVIEW

2.1 The 5E Instructional Model and Its Application in Education

The 5E Instructional Model, which involves five phases—Engage, Explore, Explain, Elaborate, and Evaluate—has been widely regarded as an effective pedagogical framework in various subject areas. The model's strengths lie in its ability to foster student-centered learning, promote engagement, and encourage deeper understanding (Abdulbaqi, 2024; Joswick & Hulings, 2024). Research by Chan et al. (2024) highlights the effectiveness of the 5E model in enhancing student engagement, particularly when combined with multimedia technologies, which are integral to modern geography education. Additionally, studies have shown that the 5E model promotes critical thinking and inquiry-based learning, helping students connect new knowledge with prior experiences (Jiang et al., 2023; Kulapian et al., 2023). The flexibility of the 5E model has allowed it to be applied successfully not only in science education but also in subjects like geography, where spatial intelligence and critical thinking are paramount. The model's inquiry-based structure makes it ideal for promoting active participation and understanding in geography classrooms, where students need to apply concepts such as map interpretation and spatial analysis (Hassan et al., 2024; Wang et al., 2024). This approach contrasts sharply with traditional teaching methods, which often involve passive learning and memorization, and which may limit students' ability to critically engage with geographic concepts (EDWIN, 2024).

2.2 Spatial Intelligence in Geography Education

Spatial intelligence, a key cognitive skill in geography, involves the ability to visualize, manipulate, and interpret geographic information, including maps, models, and data. This skill is essential for geographical literacy and academic performance in the subject. Wang et al. (2024) argue that spatial intelligence is crucial for understanding geographic phenomena, and enhancing it can improve students' ability to solve geographic problems. Studies by Cao et al. (2024) suggest that teaching models that actively engage students, such as the 5E model, contribute to the development of spatial intelligence by encouraging students to visualize and manipulate geographic data in meaningful ways. Research has also indicated a positive relationship between students' spatial intelligence and their academic achievement in geography. For example, Somantri and Hamidah (2024) found that training in spatial intelligence significantly improved students' ability to understand complex geographic concepts and perform better academically. Similarly, Nwana and Okeke (2024) demonstrate that geography instruction, when paired with spatial intelligence exercises, improves students' overall academic achievement and fosters a deeper understanding of geographical content. These findings suggest that instructional strategies that promote spatial intelligence can enhance both student engagement and performance in geography education.

2.3 Impact of Traditional vs. Innovative Teaching Methods on Geography Performance

Traditional teaching methods in geography often rely on lecture-based delivery, where students passively absorb information. While this method can provide foundational knowledge, it fails to fully engage students or develop their critical thinking and spatial intelligence. Studies by EDWIN (2024) and Fort (2024) have indicated that traditional geography instruction, while useful for basic knowledge transmission, does not encourage the active learning necessary for complex geographical analysis. Moreover, these methods may not effectively cultivate students' interest in the subject, which is a crucial factor for long-term academic success (Ahmad, 2023). In contrast, innovative teaching methods, such as the 5E model, emphasize student engagement, exploration, and active participation, which can lead to better academic outcomes. Several studies have demonstrated the positive impact of the 5E model on academic performance, particularly in subjects that require conceptual and spatial understanding. For instance, Chan et al. (2024) found that the 5E model, combined with technology, significantly improved student engagement and achievement in geography. Furthermore, research by Kulapian et al. (2023) suggests that the model's inquiry-based structure enhances students' problem-solving skills, which are critical in geography education.

2.4 Geography Education and Technological Integration

The integration of technology into geography education has become increasingly important, with tools such as Geographic Information Systems (GIS), web-based platforms, and multimedia resources enriching students' learning experiences. Studies by Elvia et al. (2023) and Nwana and Okeke (2024) emphasize that technology enhances students' ability to visualize and interpret geographic information, which directly impacts spatial intelligence and academic achievement. The use of tools like Google Maps and GIS has been shown to make abstract geographic concepts more accessible to students, allowing them to apply theoretical knowledge in practical settings (Musa & Sa'ad, 2024). Moreover, the 5E model's incorporation of technology further promotes spatial thinking and engagement. Research by Joswick and Hulings (2024) confirms that multimedia and technology integration within the 5E model not only aids students in exploring geographic content but also increases their motivation and interest in the subject. The use of spatial intelligence training tools and webGIS in the 5E framework has proven effective in improving both spatial reasoning and geographical knowledge among students (Somantri & Hamidah, 2024). These findings suggest that the combination of the 5E model and technological tools offers a powerful strategy for enhancing both spatial intelligence and geographic performance.

3. METHODOLOGY

This study investigates the impact of the 5E Instructional Model on 9th-grade students' interest, spatial intelligence, and academic achievement in geography, comparing it with traditional teaching methods in Hyderabad District, Telangana.

3.1 Justification:

The study explores the effectiveness of the 5E model, which promotes student engagement and critical thinking, compared to traditional methods that may lack active involvement. This research is significant for improving geography education and fostering spatial intelligence.

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

This study aimed to evaluate the effect of the 5E Instructional Model on 9th-grade students' spatial intelligence and academic achievement in geography, comparing the results with those achieved through traditional teaching methods. Geography education plays an essential role in fostering spatial intelligence, which is crucial for understanding geographic phenomena. The 5E model, designed to facilitate active learning through its phases—Engage, Explore, Explain, Elaborate, and Evaluate—has been widely regarded as an effective instructional framework for encouraging critical thinking and student engagement (Abdulbaqi, 2024; Joswick & Hulings, 2024). This discussion will synthesize the results of the study, incorporating the insights gathered from the relevant literature and comparing them with the outcomes observed in this research.

The findings of the study indicated that while both the experimental and control groups experienced changes in spatial intelligence and academic achievement, the impact was not as significant as anticipated, particularly in the experimental group, which received instruction via the 5E model. Specifically, no statistically significant difference was found in the spatial intelligence or academic achievement of the experimental group between the pretest and posttest measurements. This result was surprising, given the positive outcomes reported in prior studies on the effectiveness of the 5E model in promoting student engagement and critical thinking (Chan et al., 2024; Kulapian et al., 2023). One possible explanation for this outcome is the limited duration or inconsistent application of the 5E model in the classroom, which may have reduced its potential to produce meaningful improvements in spatial intelligence (Jiang et al., 2023; Somantri & Hamidah, 2024).

Previous studies have shown that the 5E model can significantly enhance spatial intelligence and academic achievement by promoting student-centered learning and inquiry-based activities (Hassan et al., 2024; Wang et al., 2024). For example, research by Cao et al. (2024) demonstrated that the 5E model, when used with appropriate teaching tools like Geographic Information Systems (GIS) and spatial intelligence training, enhances students' ability to visualize and manipulate geographic data. However, the lack of significant findings in this study may suggest that factors such as the specific teaching context, student preparedness, or the complexity of the geographic content may play a role in moderating the effects of the 5E model. It is also possible that the level of teacher expertise in implementing the model may have affected the outcomes (Musa & Sa'ad, 2024).

The control group, which was taught using traditional methods, showed a slight improvement in spatial intelligence, although the results were not as pronounced as in the experimental group. This aligns with the findings of EDWIN (2024), who argued that while traditional geography instruction is capable of transmitting knowledge, it may not provide the same level of student engagement or foster higher-order thinking skills. In this study, the control group did show a statistically significant difference in achievement between the pretest and posttest, suggesting that other factors, such as increased exposure to the subject matter over time or the natural maturation of students, may have contributed to this improvement (Fort, 2024). The fact that the control group's performance decreased slightly between the pretest and posttest could also be indicative of factors such as test fatigue or external influences that affected student motivation and focus (Ahmad, 2023; Nwana & Okeke, 2024).

Spatial intelligence, which is central to geographical learning, refers to the ability to interpret and manipulate spatial information such as maps and geographic data (Somantri & Hamidah, 2024). While the 5E model has been shown to enhance spatial intelligence in other subjects (Cao et al., 2024), its impact on geography was less pronounced in this study. This may suggest that spatial intelligence is influenced by a combination of factors, including prior knowledge, cognitive development, and the extent to which geographic concepts are practically applied in the classroom (Wang et al., 2024). Some studies, such as those by Kiş (2023) and Nwana & Okeke (2024), have emphasized the importance of integrating technology and hands-on learning to improve spatial reasoning in geography. The use of tools like GIS and web-based platforms in geography education can enhance students' ability to visualize geographic patterns and concepts, which may explain the success of the 5E model when integrated with these technologies (Musa & Sa'ad, 2024; Joswick & Hulings, 2024).

The lack of substantial differences in the academic achievement of students in both groups raises important questions about the nature of geography education and the challenges in improving student outcomes. Geography, unlike subjects like science, often relies on memorization of facts and theoretical understanding rather than on practical applications or critical thinking (EDWIN, 2024). The 5E model, which promotes inquiry and exploration, may need to be complemented by other instructional strategies, such as the use of real-world data or field-based activities, to fully engage students and enhance their academic achievement in geography (Kanapi et al., 2024). Furthermore, research by Elvia et al. (2023) and Fort (2024) suggests that student interest and motivation play a critical role in academic performance, and it is possible that the 5E model, although effective in promoting engagement, may require further adjustments to maintain student motivation over time.

In terms of technological integration, studies have demonstrated the value of incorporating GIS and multimedia tools into geography instruction to improve spatial intelligence and academic achievement (Somantri & Hamidah, 2024; Joswick & Hulings, 2024). The experimental group, which did not explicitly use GIS or web-based tools as part of the 5E model, may not have benefited from the full range of technological enhancements that could have supported their learning of geographic concepts. As suggested by Chan et al. (2024) and Elvia et al. (2023), multimedia and technology-based tools can deepen students' understanding of spatial concepts and increase engagement with the subject. Future research should explore the combined effect of the 5E model and technology, such as GIS or interactive maps, on student performance and spatial intelligence in geography education. The study's findings highlight the need for further exploration into the factors that may influence the effectiveness of the 5E model in geography education. As studies by Joswick & Hulings (2024) and Kulapian et al. (2023) have indicated, the 5E model's success can vary based on how well it is integrated into the curriculum and the degree to which teachers are trained to implement it effectively. The results also underscore the importance of considering other variables, such as student motivation, prior knowledge, and the role of technology, when assessing the impact of instructional models on student outcomes in geography (Somantri & Hamidah, 2024; Wang et al., 2024).

6. CONCLUSION

The primary aim of this research was to assess the impact of the 5E Instructional Model on 9th-grade students' spatial intelligence and academic achievement in geography. Despite the promising theoretical benefits of this inquiry-based instructional approach, the study's findings indicate that the 5E model did not yield significantly better results compared to traditional teaching methods in the areas of spatial intelligence or academic performance. While both groups showed some improvement, the experimental group, which was taught using the 5E model, did not demonstrate a statistically significant difference in posttest results compared to the control group. This suggests that other factors, such as the application of technology, teacher proficiency in implementing the model, and the duration of the intervention, may play a more substantial role in determining its effectiveness. The results also highlight the challenges inherent in integrating the 5E model into geography education, particularly in enhancing students' spatial intelligence. It may be that the 5E model, although effective in other subject areas, requires more targeted adjustments for geography instruction, such as the incorporation of hands-on learning, GIS tools, and fieldwork. In addition, further research is necessary to examine the model's long-term impact and explore how it can be adapted to better support geographic learning outcomes. Therefore, while the 5E model holds promise, its full potential in the context of geography education remains to be fully realized.

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