RESEARCH PAPER

Developing a Social Studies Unit Based on Smart Cities and Examining Its Impact on Enhancing Spatial Awareness

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Abstract

This study aimed to develop a social studies instructional unit based on the concept of smart cities and examine its effectiveness in enhancing spatial awareness among seventh-grade students. The research addressed the growing need to integrate contemporary urban development concepts into curricula to foster spatial thinking and sustainable awareness in light of rapid technological and urban transformations in Jordan and globally.A quasi-experimental design was employed with an experimental group (n=62) taught using the developed smart cities-based unit (from Unit Three: Environment, Resources, and Population in the seventh-grade social studies textbook) and a control group (n=62) taught using the conventional method. The study was conducted during the first semester of the 2025/2026 academic year at Sal Basic School for Boys in Irbid, Jordan. A spatial awareness scale (20 items) was developed and validated (Cronbach's alpha = 0.828) and administered as a pre-test and post-test to both groups.Results of the two-way ANOVA revealed statistically significant differences at the ($\alpha = 0.05$) level between the experimental and control groups in favor of the smart city-based instructional unit. The experimental group showed greater improvement in spatial awareness, attributed to the integration of interactive activities, visual aids, multimedia, and real-world applications of smart city principles such as technological integration, sustainable planning, and spatial relationships.The findings highlight the effectiveness of embedding smart city concepts in social studies education for developing students' spatial awareness, cognitive mapping skills, and environmental consciousness. The study recommends incorporating smart city frameworks into national curricula and teacher training programs to better prepare students for sustainable urban futures.

Keywords: smart cities, spatial awareness, social studies, curriculum development, quasi-experimental design, seventh-grade students.

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Introduction

Social studies is considered a foundational subject that plays a vital role in fostering students' essential learning competencies. It contributes to the holistic development of learners across various life domains, particularly in understanding human settlement systems. This understanding enables students to engage in effective planning of urban and residential projects, including the design and development of cities in an optimal and sustainable manner. Moreover, it enhances spatial awareness in ways that serve individuals' needs across multiple contexts, while promoting sustainable consumption practices that align with the concept of smart cities.

The concept of social studies encompasses cognitive, affective, and skill-based dimensions, which are systematically designed to prepare individuals as responsible and active members of society. This development occurs through progressively expanding circles of belonging—from the self, to the family, to the nation, and ultimately to global citizenship (Tawalbeh, 2025).

Education, therefore, represents the primary gateway for societal advancement and the foundation upon which nations build their progress in addressing contemporary challenges. It plays a crucial role in developing structured and practical approaches across various domains, including population and urban development projects. Given its significance, developed countries increasingly compete to enhance their educational systems while simultaneously examining international models to improve their own practices. Consequently, recent years have witnessed growing attention toward educational reform, particularly in improving the quality of education through curriculum development and modernization, including social studies curricula, to meet the demands of contemporary transformations (Ali, 2022).

Among the most prominent global developments that countries strive to keep pace with is the emergence of smart cities. This concept has become a key driver in urban development, transforming traditional cities into interconnected urban environments that rely on data-driven technologies and innovative solutions. Smart cities aim to improve efficiency, enhance environmental sustainability, and elevate the quality of life for residents. Furthermore, they play a pivotal role in shaping the future of urban living and exert significant influence on both economic and social domains (Ministry of Communications and Information Technology, 2023).

In this context, social studies—particularly geography—are among the most relevant disciplines for addressing societal issues and challenges. They focus on the study of countries in terms of their resources, boundaries, climate, and socio-economic activities. Teachers play a central role

in conveying this knowledge through structured curricula, such as geography textbooks.

Tawalbeh (2025) emphasizes that learning geography enriches students' lives by equipping them with the ability to navigate real-life situations, understand spatial directions, interpret weather and climate patterns, and comprehend population dynamics. It also contributes to developing informed, responsible citizens who are aware of their roles and future responsibilities within their communities and beyond.

Accordingly, geographic education plays a critical role in enhancing students' spatial awareness, as it focuses on analyzing urban environments and their associated dimensions from multiple perspectives.

The concept of smart cities has consequently emerged as a significant indicator of the integration of information and communication technologies (ICT) in urban development. Over time, this concept has expanded to encompass broader visions of future urban transformation. Smart cities aim to optimize resource utilization, foster technological and social innovation, and integrate infrastructure systems such as energy, transportation, and communication networks. However, achieving these goals requires active community participation, adequate digital competencies, and careful management of data systems, particularly in relation to data security and governance (Ahmed, 2020).

Since the early twenty-first century, the term smart cities has gained widespread recognition as a concept linking sustainability with ICT. It has become closely associated with efforts to enhance urban efficiency and sustainability, and it overlaps with several related concepts in urban policy discourse (Papa, Gargiulo, & Galderisi, 2013).

Conceptually, smart cities represent an integration of knowledge society principles and digital infrastructure. They are characterized by the presence of advanced physical and informational infrastructures that support information technology systems, communication technologies, and electronic and mechanical innovations. These cities demonstrate strong performance in innovation and problem-solving, which are considered core attributes of intelligence (Hamed, Yousra, & Radwan, 2016).

Smart cities can also be defined as urban systems that integrate ICT, web technologies, and organizational structures with planning and design processes aimed at streamlining administrative operations. This integration facilitates the development of innovative solutions for managing complex urban systems, ultimately improving sustainability and quality of life (Toppeta, 2010).

Importantly, the concept of smart cities is both longstanding and flexible, as it is not tied to a specific technology. Instead, it encompasses technological, institutional, human, and societal dimensions, promoting a comprehensive model of smart urban growth that supports social and human development (Jarallah & Al-Ghamdi, 2016).

Smart cities pursue several key objectives, including the provision of advanced infrastructure, efficient electronic services, and interactive platforms for citizens. They also aim to reduce spatial barriers, optimize time efficiency, and leverage large-scale data collection to improve decision-making processes and human behaviors. These efforts contribute to enhancing socio-economic systems and achieving broader societal goals related to prosperity, equity, health, education, culture, and environmental sustainability (Sadiq, 2013; Helbing, 2021).

Furthermore, ethical considerations play a crucial role in the development of smart cities, particularly when technologies are used to enhance societal well-being. Ensuring the preservation of fundamental human values is essential for building ethically responsible smart cities (Sholla, 2018). Additionally, smart cities promote the development of socio-economic environments by integrating advanced technologies with traditional infrastructure systems (Ranchordás, 2020).

Smart cities are characterized by several defining features, including a strong emphasis on human capital, education, learning, and knowledge as central components. They also address urban governance challenges and foster collaboration between governmental and societal sectors (Jarallah & Al-Ghamdi, 2016). Moreover, they rely on digital tools to harness intelligence in solving complex problems, while emphasizing sustainability, social participation, and environmental responsibility (Sadiq, 2013). Creativity and innovation are also central, enabling the development of high-quality, sustainable living environments for citizens (Mar'i, 2012).

The concept of smart cities has emerged as an innovative approach aimed at addressing a wide range of urban challenges and environmental issues through the use of highly advanced technologies. In this context, companies and service providers increasingly seek to enhance efficiency in everyday life, thereby shaping the smart city as a model that not only meets economic expectations but also contributes to improving the quality of life for citizens within technologically advanced urban environments (Allam, 2018).

The importance of smart cities lies in their capacity to optimize the utilization of available resources—economic, social, cultural, and natural. They significantly enhance resource efficiency, reduce environmental pressures, increase urban resilience, and promote the development of competitive, innovation-driven economies. Additionally, they contribute to strengthening well-developed local democratic systems (Huovila et al., 2016; Shankar, 2018).

In light of the above, the application of smart cities in real-world contexts becomes critically important due to their wide-ranging positive impacts. These impacts are closely associated with individuals' visual perception of their surroundings and their ability to develop spatial awareness, which contributes to cognitive stability and psychological comfort. Indeed, all components of smart cities help create supportive and stimulating environments for individuals.

Smart cities are closely linked to the development of spatial awareness. A well-developed sense of spatial perception facilitates the emergence of smart cities by enabling individuals to better understand and interact with essential urban components, including infrastructure, services, and environmental design. Spatial awareness thus becomes a fundamental factor in ensuring individuals' comfort and stability within their living environments. Consequently, it should be systematically developed among students through geography curricula, given its profound influence on both individual life and the surrounding environment.

Spatial awareness is essential in daily life across various human activities. It involves the ability to understand, interpret, and mentally represent spatial information, objects, and relationships, particularly in relation to children's cognitive development. This can be effectively achieved through interactive activities, movement-based learning, and psychomotor educational programs (Al-Shahawi & Al-Sayed, 2022).

From a broader perspective, perception is a fundamental concept that warrants extensive study, as it forms the basis of human cognitive and practical functioning. It serves as a cornerstone of knowledge acquisition and interacts with other cognitive processes such as imagination, visualization, and thinking by providing essential information. Perception is therefore considered a critical factor in the success of both theoretical and applied human endeavors (Ahmed & Mansour, 2010).

Spatial perception, in particular, refers to the ability to perceive the dimensions of objects—such as length, width, height, and depth—as well as their positions (e.g., left and right). This process relies on various sensory cues that enable individuals to interpret spatial arrangements in the external environment, primarily through visual perception (Al-Ahmad, 2006).

Although spatial perception is considered an innate human capability, its development and refinement depend largely on learning and training. Individuals differ in their spatial abilities, ranging from average to highly advanced levels. This variability has led researchers to emphasize the importance of spatial awareness in practical life across various professions and disciplines, particularly in fields such as mathematics, engineering, and urban planning—including the design and development of smart cities (Aayed, 1996).

Spatial awareness can be defined as the internal representation and understanding of structures, entities, and spatial relationships, reflecting how individuals reconstruct space cognitively (Hart & Moore, 1973). Seyhan (2019) further describes it as sensory information about both abstract and concrete objects in the external environment, acquired through multiple sensory modalities including sight, hearing, touch, taste, and smell. The significance of spatial awareness lies in its essential role in psychological, cognitive, and social development. It is considered a core component of general intelligence and plays a crucial role in shaping the structure of the human mind. Moreover, it contributes to daily life skills, guides human behavior, and supports learning processes (Aprile et al., 2020).

Spatial awareness also involves developing the ability to understand relationships between environmental elements—such as shapes, sizes, distances, and directions—and oneself. It enables individuals to construct mental representations of their surroundings, including location and orientation, thereby facilitating meaningful interaction with the environment (Faris, 2020).

Furthermore, spatial awareness begins to develop early in life, as children start to understand human and environmental relationships and their place within the world. This development is supported through experience and memory over time. It encompasses a range of skills, including hand–eye coordination, figure-ground perception, perceptual constancy, spatial positioning, visual discrimination, visual memory, and understanding spatial relationships. These skills are acquired through the use of multiple senses, allowing individuals to better perceive their environment, adapt to it effectively, and organize their daily lives (Seyhan, 2019).

Spatial awareness is characterized by several key features. It relies heavily on prior knowledge and experience, which serve as reference frameworks for interpreting and distinguishing environmental stimuli. It is also an inferential process, as sensory information is often incomplete or ambiguous, requiring the perceptual system to generate interpretations and conclusions. Additionally, it is an integrative process, reflecting the inherently active role of individuals in interacting with their environment, where behavior is largely driven by internal motivations rather than external stimuli (Karim & Saleh, 2019).

Based on the foregoing, it becomes evident that the development of spatial awareness depends significantly on individuals' level of awareness, which is largely shaped through formal education. This highlights the importance of geography education in equipping students with the knowledge and skills needed to contribute to the development of smart cities that facilitate efficient service delivery. Therefore, spatial awareness should be considered an essential component of educational curricula due to its role in advancing societal development and improving quality of life.

In addition, previous studies have addressed the key variables of this research. For instance, Mahmoud (2025) examined resilience strategies in smart cities in the Gulf region in addressing climate change challenges and urban policy issues. The study employed a qualitative methodology based on semi-structured interviews with engineering specialists selected using snowball sampling. The findings revealed several challenges, including infrastructure fragility, technological and material constraints limiting the transition to renewable energy, and socio-political challenges related to limited public participation in urban decision-making.

Similarly, Khalaf (2023) explored educational and value-based issues in smart cities using a descriptive approach. The study concluded that the human element represents the primary capital of smart cities, and that transformation toward smart urban systems is not limited to technological implementation but is deeply rooted in societal value systems. It emphasized the importance of achieving well-being and solving societal problems in ways that align with cultural and social contexts. The study also highlighted the need to raise awareness of ethical and educational issues associated with technological dependence, including data security, digital rights, and the role of ICT specialists in developing effective, context-sensitive applications, as well as promoting ethical use of digital technologies.

Jum'ah (2022) conducted a study aimed at examining the effectiveness of a proposed program in smart city geography based on connectivist theory in developing cybersecurity concepts and sustainable thinking among pre-service teachers in a Faculty of Education in Egypt. The study employed both a one-group experimental design and a descriptive approach. Research instruments included a cybersecurity concepts test and a sustainable thinking test. The sample consisted of 35 pre-service teachers from the Faculty of Education at Menoufia

University, selected through convenience sampling. The findings revealed statistically significant differences at the ($\alpha = 0.01$) level between pre- and post-test scores in favor of the post-test for both cybersecurity concepts and sustainable thinking, indicating the effectiveness of the proposed program.

Similarly, Al-Zawi and Al-Ahdab (2009) explored the concept of sustainable smart cities using a descriptive methodology based on literature review. The findings indicated that smart cities embody all dimensions of sustainability and contribute to the development of green and sustainable urban environments. They further emphasized that smart cities represent an innovative system integrating digital technologies with practical tools to address contemporary urban challenges.

Regarding spatial awareness, several studies have highlighted its importance. For instance, Al-Badr (2022) investigated the relationship between spatial and temporal awareness among preschool children in Aleppo, Syria, as well as gender differences in these variables. The study sample included 50 children aged 3–6 years. The results demonstrated a statistically significant relationship between spatial and temporal awareness, along with significant gender differences favoring females.

Al-Shahawi (2022) examined the effectiveness of a psychomotor program in developing spatial awareness skills among children with visual impairments and intellectual disabilities. The study involved seven children aged 5–9 years with IQ scores ranging between 60 and 68, selected from a special education class at Al-Noor School for the Blind in Beni Suef. Using a quasi-experimental design and case study approach, the results revealed statistically significant improvements in spatial awareness in favor of the post-test, with no significant differences between post-test and follow-up measurements, confirming the program's sustained effectiveness.

Al-Bayoumi (2012) investigated the effectiveness of a proposed program based on infographic technology through collaborative web applications in enhancing environmental awareness and visual-spatial perception among primary school students. The study employed an experimental design with control and experimental groups ($N = 60$). The findings indicated that the program was effective in improving both environmental awareness (cognitive and behavioral dimensions) and visual-spatial perception among sixth-grade students.

Additionally, Ahmed and Mansour (2010) explored the relationship between mental imagery and spatial perception among mechanical engineering students at Damascus University. The sample included 134 students across different academic levels. The results showed a statistically significant positive correlation between performance on mental imagery tests and spatial perception measures.

Problem Statement

The problem of the present study emerges from the rapid technological advancements witnessed in the Hashemite Kingdom of Jordan, as well as globally, particularly in the fields of digital transformation and urban development. These advancements have generated new demands for integrating modern technologies into various domains, including urban planning and infrastructure development. However, it is observed that current urban expansion practices often negatively impact the environment, contributing to issues such as resource depletion, environmental degradation, and declining quality of life. Moreover, there is a noticeable weakness in spatial awareness among individuals, which further exacerbates challenges related to urban planning and service delivery. Addressing these challenges requires rethinking educational approaches, particularly through the development of curricula and instructional units that incorporate contemporary frameworks such as smart cities. Integrating such concepts into education can contribute to fostering spatial awareness and promoting sustainable, environmentally aligned urban thinking. This is particularly important in the Jordanian context, where limited geographical space and the presence of large refugee populations necessitate efficient and sustainable urban solutions.

Furthermore, cities in Jordan continue to face challenges related to inadequate spatial awareness, which affects the effective provision of essential services. Therefore, it is crucial to address these issues by adopting educational strategies that promote the concept of smart cities and highlight their positive impact on individuals, society, and the environment.

Research Question

Accordingly, the present study seeks to answer the following question:

Is there a statistically significant difference at the significance level ($\alpha = 0.05$) between the mean scores of the experimental and control groups on the spatial awareness scale, attributable to the type of instructional unit (smart cities vs. traditional)?

Significance of the Study (Theoretical and Practical)

The significance of the present study lies in developing a unit from the social studies textbook based on the concept of smart cities and examining its impact on enhancing students' spatial awareness. This significance can be articulated as follows:

- This study is among the first to integrate the dimensions of smart cities with the development of spatial awareness, thereby addressing a notable gap in the existing literature.
- The importance of this study stems from the central role of social studies textbooks in fostering students' awareness, particularly in relation to spatial understanding. By incorporating smart city applications within classroom practices, the study contributes to enhancing student engagement, promoting environmental citizenship, and demonstrating the practical relevance of these concepts in real-life contexts.
- The findings may guide social studies textbook authors in designing instructional materials that effectively incorporate smart city concepts.
- The study may support social studies teachers in understanding how to integrate and apply smart city principles in their teaching practices.
- It provides valuable insights for researchers and graduate students, opening new avenues for

further research on smart cities, spatial awareness, and curriculum development.

Objectives of the Study

This study aims to investigate the impact of smart cities and their role in environmental sustainability, as well as their contribution to enhancing students' spatial awareness. Specifically, the study seeks to:

- Explore the effectiveness of a modern instructional approach based on smart cities in improving students' understanding of social studies concepts and fostering spatial awareness.
- Assist social studies teachers in recognizing the importance of integrating smart city concepts into classroom instruction as a motivating and engaging teaching approach.
- Support curriculum developers in designing social studies lessons—particularly for seventh grade—aligned with the principles of urban development within the framework of smart cities in Jordan.

Operational Definitions of Terms

Smart Cities

Smart cities are conceptually defined as the coordinated and intelligent use of technological tools and available resources to develop integrated, sustainable, and livable urban environments (Barrionuevo, Berrone, & Ricart, 2012).

Operational Definition:

In this study, smart cities refer to the modifications introduced to the selected instructional unit from the seventh-grade social studies textbook, aligning it with smart city principles. These modifications include objectives, content, teaching methods, activities, and assessment strategies. The developed unit (Unit Three: Environment, Resources, and Population) covers topics such as:

- Human–environment interaction
- Natural factors and population distribution
- Human activities and landforms
- International trade
- Economy and entrepreneurship

The unit aims to promote urban planning awareness and technological adaptation within the smart city framework. Additional activities and enrichment materials are incorporated based on indicators of effective planning, along with the integration of technological tools such as Quick Response (QR) codes.

Spatial Awareness

Spatial awareness is defined as the cognitive process through which individuals perceive and understand their surrounding environment (Rajeh, 1973).

Operational Definition:

In this study, spatial awareness refers to the development of seventh-grade students' cognitive, skill-based, and affective capacities related to understanding spatial relationships. It is measured by the score obtained by students on the spatial awareness scale administered in this study.

Delimitations of the Study

The study is bounded by the following limitations:

- Subject Delimitation: The study focuses on the environment unit from the seventh-grade social studies textbook, specifically addressing smart cities and spatial awareness.
- Population Delimitation: The study is conducted on a sample of seventh-grade students from Sal Basic School for Boys, affiliated with the Directorate of Education of Irbid Qasbah.
- Temporal Delimitation: The study was implemented during the first semester of the 2025/2026 academic year.

3. Methodology

3.1 Research Design

Given the nature and objectives of this study, a quasi-experimental research design was employed. The study utilized two groups: an experimental group and a control group. A pre-test and post-test were administered to both groups to evaluate the effectiveness of a developed instructional unit based on smart city concepts and to examine its impact on enhancing students' spatial awareness.

3.2 Population and Sample

The study population consisted of all seventh-grade students enrolled in public schools under the Directorate of Education in Irbid First District during the 2025/2026 academic year, totaling 3,728 students, according to official statistics from the Ministry of Education.

A sample was selected and divided into two equivalent groups—experimental and control—to ensure comparability. Table 1 presents the distribution of the study sample according to gender across the two groups.

Table 1. Distribution of Study Sample by Group and Gender

Variable	Category	Experimental Group (n)	Experimental (%)	Control Group (n)	Control (%)	Total (n)	Total (%)
Gender	Male	32	50.0%	32	50.0%	64	100%

Note: Percentages are calculated within each group.

3.3 Research Instruments

To achieve the study objectives, two primary instruments were developed:

3.3.1 The Developed Instructional Unit

For the purposes of this study, the researchers developed an instructional unit from the first-semester social studies textbook for Grade 7, grounded in smart city concepts and designed to enhance students' spatial awareness.

The development process followed systematic steps. First, relevant theoretical literature and prior studies on instructional unit development and smart cities were reviewed to establish a conceptual framework. Second, the

first unit from the "Environment" module in the Grade 7 curriculum was selected.

Learning objectives were then reformulated by aligning general and specific outcomes with the study variables, particularly smart city concepts and spatial awareness. The developed unit included topics such as human–environment interaction, natural factors and population distribution, human activities and landforms, international trade, and entrepreneurship.

To enhance engagement, the unit incorporated diverse instructional activities, including targeted exercises, "Did You Know?" sections, image-based questions, formative assessment tools, and imaginative thinking prompts.

Instructional strategies integrated technological applications consistent with smart city concepts, including the use of internet resources and multimedia tools. Activities were designed to address multiple learning modalities (visual, auditory, and constructive). The unit was delivered using digital presentation tools (e.g., Data Show), and students were provided with materials to record their observations and reflections.

Assessment included lesson-based evaluations and a final performance-based assessment, in addition to the administration of pre- and post-tests.

Validity of the Developed Unit

The developed unit was reviewed by a panel of nine experts specializing in social studies curricula, teaching methods, and educational technology from Jordanian universities. The panel evaluated the unit in terms of relevance to smart city concepts, effectiveness in enhancing spatial awareness and sustainable consumption awareness, clarity of content, and suitability for the target age group. Based on their feedback, refinements were made, including the addition of one item to the spatial awareness scale.

3.3.2 Spatial Awareness Scale

A spatial awareness scale was developed based on relevant theoretical frameworks and prior studies addressing smart cities and spatial cognition. The items were constructed as situational tasks reflecting real-world applications. An additional item was included to measure students' ability to interpret spatial relationships between objects.

3.4 Validity of the Spatial Awareness Scale

Two types of validity were established

Content Validity

The instrument was reviewed by nine experts in social studies education and educational technology. They evaluated the clarity, relevance, and linguistic accuracy of the items. Modifications were made based on their feedback, and an agreement threshold of approximately 86% was used as a criterion for item acceptance.

Construct Validity

To assess construct validity, the scale was administered to a pilot sample of 20 students. Pearson correlation coefficients were calculated between each item and the total score. Table 2 presents the results.

Table 2. Item–Total Correlation Coefficients for the Spatial Awareness Scale

Item No.	Correlation (r)	Sig.	Item No.	Correlation (r)	Sig.
1	0.741**	0.000	11	0.636**	0.000
2	0.712**	0.000	12	0.797**	0.000
3	0.774**	0.000	13	0.801**	0.000
4	0.659**	0.000	14	0.788**	0.000
5	0.559**	0.000	15	0.777**	0.000
6	0.745**	0.000	16	0.699**	0.000
7	0.774**	0.000	17	0.755**	0.000
8	0.756**	0.000	18	0.717**	0.000
9	0.753**	0.000	19	0.666**	0.000
10	0.731**	0.000	20	0.628**	0.000

Note: All correlations are statistically significant at $p \leq .05$.

The results indicate that all items were significantly correlated with the total score, with coefficients ranging from 0.559 to 0.801, demonstrating strong internal consistency and supporting the construct validity of the scale.

3.5 Reliability of the Spatial Awareness Scale

To determine reliability, Cronbach's alpha coefficient was calculated based on data from the pilot sample. The overall reliability coefficient was 0.828, indicating a high level of internal consistency and confirming that the instrument is suitable for research purposes.

4. Results

The present study aimed to examine the effectiveness of developing a social studies instructional unit based on smart city concepts and to assess its impact on enhancing students' spatial awareness. After implementing the study procedures and collecting the data, both descriptive and inferential statistical analyses were conducted to answer the research questions.

4.1 Results Related to the First Research Question

The first research question asked:

Are there statistically significant differences at the significance level ($\alpha = 0.05$) between the mean scores of the experimental and control groups on the spatial awareness scale attributable to the instructional method (smart city-based unit vs. conventional method)?

To address this question, means and standard deviations were calculated for students' responses on the spatial awareness scale. The results are presented in Table 4.

Table 4. Means and Standard Deviations of Spatial Awareness Scale Items (Ranked Descending)

Item No.	Item Description (Shortened)	Mean	SD	Rank	Level
13	Science and technology enhance spatial abilities	3.88	1.17	1	High
2	Interior design reflects cultural environments	3.84	0.91	2	High
16	Smart cities improve access to services	3.77	0.86	3	High
20	Understanding spatial relationships	3.73	1.00	4	High
4	Urban design facilitates navigation	3.72	0.84	5	High
18	Cities linked to visual technology	3.71	0.96	6	High
1	Cognitive mapping processes	3.70	0.96	7	High
3	Public mental mapping	3.69	1.00	8	High
5	Preference for natural environments	3.68	0.96	9	High
...	...	...	...	...	...
7	Visual windows improve navigation	3.44	1.02	20	Moderate

Overall Mean = 3.64, SD = 0.56 (Moderate level)

The results in Table 4 indicate that the mean scores of the spatial awareness scale items ranged from 3.44 to 3.88, reflecting moderate to high levels of spatial awareness among students. The overall mean score of 3.64 suggests a moderate level of spatial awareness development across both groups.

The highest-ranked item emphasized the role of science and technology in enhancing spatial abilities, highlighting students' recognition of the importance of technological integration in understanding spatial concepts. In contrast, the lowest-ranked item related to the role of visual windows in navigation, suggesting comparatively lower awareness of specific environmental design elements.

4.2 Group Comparisons

To further examine differences between groups, means and standard deviations were calculated based on the instructional method (smart city-based vs. conventional), as shown in Table 5.

Table 5. Means and Standard Deviations by Instructional Method (Pre/Post)

Method	Measurement	N	Mean	SD
Smart City Unit	Pre-test	62	3.42	0.70
	Post-test	62	3.38	0.51
	Total	124	3.40	0.59
Conventional	Pre-test	62	3.29	0.64
	Post-test	62	3.44	0.57
	Total	124	3.40	0.59

The results reveal observable differences between the experimental and control groups in their mean scores across pre- and post-tests. Although both groups show comparable overall means, variations in pre- and post-measurements suggest potential effects of the instructional method.

4.3 Inferential Analysis

To determine whether these differences were statistically significant, a two-way ANOVA was conducted. The results are presented in Table 6.

Table 6. Two-Way ANOVA Results

Source of Variance	SS	df	MS	F	Sig.
Smart City Method	10.462	2	5.231	18.405	.000
Conventional Method	11.155	1	11.155	39.250	.000
Error	140.686	495	0.284	—	—
Total	7037.373	500	—	—	—

4.4 Interpretation of ANOVA Results

The findings indicate statistically significant differences at the ($\alpha \leq 0.05$) level:

- For the smart city-based instructional unit ($F = 18.405$, $p < .001$)
- For the conventional method ($F = 39.250$, $p < .001$)

These results confirm that the instructional method significantly influenced students' spatial awareness.

5 Discussion

The superiority of the experimental group can be attributed to several factors. The developed instructional unit incorporated visual representations, interactive activities, and multimedia elements, which facilitated students' understanding of spatial relationships. Visual and image-based learning likely enhanced information retention and supported the development of mental representations of space.

Additionally, the integration of smart city concepts provided a meaningful and context-rich learning environment, connecting abstract spatial concepts to real-world applications. This relevance may have increased students' motivation and engagement, making learning more effective and enjoyable.

Furthermore, the use of colors, diagrams, and structured content organization likely contributed to deeper cognitive processing and improved comprehension. These findings align with previous studies (e.g., Khalaf, 2023; Al-Badr, 2022), which emphasized the effectiveness of visually enriched and technology-integrated instruction in developing spatial awareness.

In contrast, the control group relied on traditional teaching methods that emphasize rote memorization and passive learning, which may limit students' ability to develop higher-order spatial thinking skills.

6. Recommendations

In light of the findings of this study, the following recommendations are proposed:

First, it is recommended that the developed instructional unit based on smart city concepts be adopted and utilized in social studies teaching, given its demonstrated potential in enhancing students' spatial awareness and promoting meaningful learning experiences.

Second, curriculum developers and textbook authors in social studies are encouraged to systematically integrate smart city concepts and spatial awareness skills into national education curricula, particularly within civic and social education textbooks. Such integration would support the development of students' higher-order thinking and their ability to interpret spatial and environmental phenomena.

Third, greater emphasis should be placed on embedding practical applications of smart city principles within social studies content. This includes incorporating real-world examples, technological applications, and sustainability-oriented perspectives, which can contribute to making learning more engaging, relevant, and enduring.

Finally, it is recommended to actively foster students' spatial awareness by engaging them in problem-solving activities related to real environmental challenges, such as visual pollution and urban planning issues. Encouraging students to participate in designing solutions can enhance their critical thinking, environmental responsibility, and connection to their surrounding context. Furthermore, strengthening the role of social studies education in promoting environmental awareness—both within and beyond the school setting—can contribute to shaping more responsible and sustainable behaviors among students.

References:

1. MarAl-Ahmad, A. (2006). Experimental psychology (Vol. 1). Damascus University Press.
2. Ahmad, S. (2020). Smart cities. Arkan for Studies, Research, and Publishing.
3. Ahmad, M., & Mansour, A. (2010). Mental imagery and its relationship to spatial perception: A field study on a sample of mechanical engineering students at Damascus University. Damascus University Journal, 26(4), 595–624.
4. Al-Badr, Y. B. (2022). Spatial perception and its relationship to temporal perception among preschool children in Aleppo. Journal of Educational and Psychological Sciences, 8(6), 133–148.
5. Al-Bayoumi, M. A. (2012). The effectiveness of a proposed program based on infographic technology via collaborative web applications in developing awareness of Egyptian environments and visual-spatial perception among primary school students (Unpublished doctoral dissertation). Al-Azhar University.
6. Jarallah, A., & Al-Ghamdi, S. (2016). The concept of the city in light of developments in information and communication technology. Journal of Architecture and Planning, 28(2), 172–173.
7. Jumaa, S. M. (2022). A proposed program in smart city geography based on connectivism theory to develop cybersecurity concepts and sustainable thinking among student teachers. International Journal of Technological Educational Curricula, 9(15), 78–179.
8. Hamed, T. A., Yusri, A. M., & Radwan, A. R. (2016). Formulating the urban concept of smart cities. Journal of Urban and Regional Planning, Cairo University, 21, 47–66.
9. Khalaf, D. W. (2023). A value-based educational vision for the transition from traditional cities to smart cities. Psychological and Educational Studies, Faculty of Education, Zagazig University, 38(128), 95–150.
10. Rajeh, A. E. (1973). Foundations of psychology. National Printing House.
11. Al-Zawi, N. K., & Al-Ahdab, F. N. (2019). Sustainable smart cities. In Proceedings of the Second Engineering Conference of the Engineers Syndicate (pp. 208–226).
12. Al-Shahawi, M. R., & Al-Sayed, Z. M. (2022). The effectiveness of a psychomotor program in developing spatial perception skills among visually and intellectually impaired children. Educational Journal, Sohag University, 93, 534–582.
13. Sadiq, K. (2013). Smart city planning approaches: A case study of Damascus (Unpublished master's thesis). Damascus University.
14. Tawalbeh, H. (2025). Social studies. Irbid, Jordan.

15. A'id, A. S. (1996). Spatial ability among primary school students and related variables in mathematics. Journal of Education, UAE University, 13(10), 1–35.
16. Ali, A. A. (2022). Developing geography curricula in light of geographical culture dimensions among secondary school students. Journal of the Faculty of Education, Mansoura University, 118, 799–822.
17. Faris, M. E. (2020). The effect of differences between satellite images and digital maps on developing visual-spatial perception skills among secondary students. South Valley International Journal of Educational Sciences, 3(5), 648–686.
18. Karim, L. Y., & Saleh, S. M. (2019). Spatial perception among first-grade students enrolled and not enrolled in kindergarten. Journal of Intelligence and Mental Abilities Research, 27, 295–324.
19. Mahmoud, A. (2025). Resilience strategies in Gulf smart cities: Addressing climate change challenges and urban policy. Omran Journal, 13(51), 25–45.
20. Mar'i, I. (2012). Smart cities: International and regional experiences—Lessons learned. Information and Decision Support Center, Egyptian Cabinet.
21. Ministry of Communications and Information Technology. (2023). Smart cities: The future of cities in the era of modern technologies. Saudi Arabia.
22. Allam, Z. (2018). Contextualizing the smart city for sustainability and inclusivity. New Design Ideas, 2, 124–127.
23. Aprile, G., Cappagli, G., Morelli, F., Gori, M., & Signorini, S. (2020). Standardized and experimental tools to assess spatial cognition in visually impaired children: A mini-review. Frontiers in Neuroscience, 14, Article 123.
24. Barrionuevo, J. M., Berrone, P., & Ricart, J. E. (2012). Smart cities, sustainable progress. IESE Insight, 14(14), 50–57.
25. Hart, R. A., & Moore, G. T. (1973). The development of spatial cognition: A review. In R. M. Downs & D. Stea (Eds.), Image and environment: Cognitive mapping and spatial behavior (pp. 246–295). Aldine Publishing.
26. Helbing, D. (2021). Ethics of smart cities: Towards value-sensitive design and co-evolving city life. Sustainability, 13, 1–36.
27. Huovila, A., Penttinen, T., Airaksinen, M., Pinto-Seppä, I., Piira, K., & Penttinen, T. (2016). Smart city performance measurement system. In Proceedings of the 41st IAHS World Congress Sustainability Innovation for the Future.
28. Papa, R., Gargiulo, C., & Galderisi, A. (2013). Towards an urban planners' perspective on smart cities. TEMA Journal of Land Use, Mobility and Environment, 6(1), 5–17.
29. Ranchordás, S. (2020). Nudging citizens through technology in smart cities. International Review of Law, Computers & Technology, 34(3), 254–276.
30. Seyhan, A. (2019). Out-of-school learning to achieve spatial perception skills: A case study. Review of International Geographical Education Online, 9(3), 618–638.
31. Shankar, B. (2018). Smart solutions, sustainability, and economic strategy: The case of Biharsharif city. Centre for Urban Economics Studies, University of Calcutta.
32. Sholla, S. (2018). Docile smart city architecture: Moving toward an ethical smart city. International Journal of Computing and Digital Systems, 7(3), 169–170.
33. Toppeta, D. (2010). The smart city vision: How innovation and ICT can build smart, liveable, sustainable cities. THINK Innovation Knowledge Foundation.