

Developing an Educational Unit based on the Geography of Innovation and Measuring its Impact on Developing creativity skills

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Abstract

Objective

This study aimed to investigate the effect of a developed educational unit based on the concepts of the geography of innovation in developing creative thinking skills among tenth-grade female students. To achieve the study's objective, a quasi-experimental approach was utilized, employing a pretest/post-test control group design. The study sample consisted of (60) tenth-grade female students, selected purposively and randomly assigned into two groups: an experimental group (30 students) taught using the developed unit, and a control group (30 students) taught using the conventional method. To collect data, a creative thinking skills test was developed, comprising four dimensions (fluency, originality, flexibility, and elaboration), and its validity and reliability were established. The results of the statistical analysis (ANCOVA and MANCOVA) revealed statistically significant differences at the significance level ($\alpha = 0.05$) in the total score of the creative thinking skills test and all its sub-skills attributed to the type of educational unit, in favor of the experimental group. In light of these results, the study recommended incorporating the concepts of the geography of innovation into geography curricula and training teachers to employ them to enhance students' creative thinking skills.

Keywords: Geography of Innovation, Creative Thinking Skills, Developed Educational Unit, Tenth Grade.

Introduction

In the modern era, the world is witnessing radical transformations in all fields of knowledge and technology, which have had a significant impact on the fields of education and learning. Rote-learning-based education has become inadequate for meeting the needs of the 21st century, which is characterized by constant change and intense competition. It has become an urgent necessity for individuals to possess higher-order thinking skills, compelling the educational system to reexamine its philosophy and curricula to move beyond the mere acquisition of knowledge toward its generation, production, and application in innovative ways. Hence, the need has arisen to adopt flexible curricula based on modern approaches that foster creative thinking among learners.

There is no doubt that education plays a vital role in the lives of societies and nations as the cornerstone of development; it is a continuous process aimed at the holistic growth of the learner. Given the accelerating pace of scientific progress, these developments have posed significant challenges to educational institutions in their efforts to improve the educational process (Al-Shasha'a & Al-Ajmi, 2022). Al-Tarhuni (2021) emphasized to educational policymakers the need to adopt strategies that support the development of the educational system—through updating curricula and providing modern technological tools—as well as the importance of stimulating scientific research and educational innovation to discover more effective educational approaches for developing 21st-century skills.

In this context, geography in the modern era has moved beyond merely describing and cataloging locations and topography; rather, it has evolved into a pivotal applied discipline that contributes to understanding the complex relationships between humans and the environment. Hence, there is an urgent need to develop school geography textbooks that move beyond the traditional descriptive approach toward content that supports the geography of innovation. Jo & Bednarz (2009) noted that this development must be achieved through the design of assessment activities that require higher-order cognitive processes. Furthermore, Gomez-Trigueros et al. (2019) emphasized that the effective integration of interactive digital technologies contributes to raising students' spatial awareness and developing their creative skills, thereby enabling them to propose sustainable solutions to their problems.

In the context of establishing this trend, the World Intellectual Property Organization (2019) affirmed that geography has played a pivotal role in organizing economic activity throughout history. Within the framework of what is known as "the geography of innovation," the report noted that the global innovation landscape has undergone structural

shifts; with an increasing concentration of innovative activity observed in specific urban areas that constitute “vital innovation ecosystems” driving scientific development, such as “Silicon Valley” in the United States and the “Shenzhen-Hong Kong” hub in China.

Based on the foregoing, learners’ skills can be developed to keep pace with these innovative transformations by systematically incorporating them into educational institutions (Al-Mashal, 2020) this is to guide students’ minds toward higher-order thinking that goes beyond the passive reception of information to understanding, analysis, and judgment (Salem & Abdel Fattah, 2020). In this context, creative thinking is defined as a mental process characterized by fluency, flexibility, and originality, aimed at producing original and unprecedented outcomes in the form of innovative solutions to educational and real-life problems. It encompasses sub-skills including fluency, flexibility, originality, and attention to detail (Abu Khalif, 2024).

Creative thinking skills, with their core components, emerge as an essential requirement in modern geography education. Geography, with its spatial and analytical nature, provides a rich context that motivates learners to generate diverse ideas for solving environmental and economic problems and to propose original, unprecedented solutions; integrating these skills into the school environment helps transition students from a level of comprehension and rote learning to innovative knowledge production (Abu Jado & Nofal, 2017).

To achieve this knowledge production, the development of creative thinking skills in geography courses requires the adoption of active strategies. Recent studies indicate that integrating project-based learning supported by digital tools into geography curricula provides students with the space to devise solutions to spatial problems, thereby enhancing their creative fluency and flexibility (Farhatin, Putra, Riwanti, & Mkumbachi, 2024). Studies have also demonstrated the effectiveness of designing geography units based on modern theories in raising levels of creative thinking (Sabatin & Al-Ghazawat, 2024). Since the nature of geography is linked to the environment, the inclusion of geographic issues in textbooks motivates students to apply higher-order thinking skills—known as “geographic creative thinking ability”—which is characterized by originality and attention to detail (Triana, Utaya, & Soekamto, 2024). Furthermore, involving learners in the design and production of geographic educational media serves as a strong motivator for developing cognitive flexibility and elaboration (Chumsukon, 2021).

The researcher believes that instilling such perspectives is doubly important when targeting upper elementary students, specifically 10th-grade students, as this stage represents a pivotal turning point in the formation of their spatial awareness. This perspective is consistent with the specific framework for social studies issued by the National Center for Curriculum Development (2024), which emphasizes the need to link curricula to issues of sustainable development, thereby enhancing students’ ability to develop pioneering initiatives based on a deep understanding of the elements of their geographical environment and to apply this understanding in innovative ways.

Research Problem and Questions:

In light of rapid global changes, the development of creative skills has become an urgent necessity for preparing learners for the 21st century. Despite this importance, the educational literature points to a lack of integration between geography curricula and the concepts of “geography of innovation” and their practical applications. Furthermore, recent trends emphasize that integrating creative thinking skills into curricula requires well-planned and innovative instructional strategies to transform traditional content into interactive learning environments.

Although some Arab studies have highlighted the importance of developing geography education programs, the actual implementation of such programs that incorporate “geography of innovation” as a pedagogical approach remains limited. Therefore, there is an urgent need to develop a teaching unit based on the principles of the geography of innovation and to measure its impact on the development of creative thinking skills (fluency, flexibility, originality, and elaboration) among 10th-grade female students, thereby bridging the gap between theory and teaching practice.

Accordingly, this study seeks to answer the following main question:

What is the impact of a newly developed instructional unit based on the geography of innovation on the development of creative thinking skills among 10th-grade female students?

The following sub-questions stem from this main question:

- What is the proposed framework for developing the “Development” unit in the 10th-grade geography textbook in light of the geography of innovation?
- Are there statistically significant differences ($\alpha=0.05$) between the mean scores of students in the experimental and control groups on the creative thinking skills test as a whole, and in its sub-dimensions, attributable to the type of instructional unit?

Significance of the Study

The significance of this study stems from its dual contribution to enriching the educational literature and guiding field practices in the area of geography curricula; it introduces a new approach known as “the geography of innovation,” which helps establish the relationship between contemporary geographical concepts and the development of higher-order thinking skills. The study establishes the conceptual framework for creative thinking skills (fluency, flexibility, originality, and elaboration) within a geography learning environment, thereby serving as a theoretical reference for researchers, while simultaneously providing scientifically grounded feedback to the Ministry of Education and the National Center for Curriculum Development regarding the effectiveness of integrating innovation concepts into textbooks, thereby supporting development efforts to better align with the requirements of the 21st century.

On a procedural level, the study’s significance lies in its presentation of a practical model for a developed instructional unit that teachers and educational supervisors can utilize in designing learning activities that foster creative thinking and move beyond traditional rote-learning methods. Furthermore, the study enriches the Arab educational literature with a validated measurement tool (the Creative Thinking Skills Test), whose psychometric properties—specifically validity and reliability—have been verified. This constitutes a qualitative addition and an effective tool that researchers can utilize in conducting similar future research and studies that seek to link educational theories to geographical reality.

Terminological and Procedural Definitions

Learning Unit

Terminological Definition: An integrated organization of educational experiences and activities centered around a specific topic or problem, aimed at achieving behavioral and cognitive objectives within a specified time frame (Al-Hila, 2014).

Procedural Definition: The fifth learning unit from the 10th-grade geography textbook (the “Development” unit), which the researcher developed to be based on the concepts of “geography of innovation,” including a teacher’s guide and assessment activities designed to measure its impact on female students.

Geography of Innovation

Terminological Definition: A branch of economic geography that studies the spatial distribution of innovative activities and how the geographical and spatial environment, clusters, and knowledge networks influence the generation and diffusion of technology (Asheim, Boschma, & Cooke, 2011).

Procedural Definition: The knowledge and skills content included in the developed instructional unit, which focuses on studying the spatial distribution of innovative activities and the role of smart cities and business incubators in generating ideas and disseminating knowledge; this is measured by the overall score female students achieve on the performance test related to these concepts.

Creativity Skills

Terminological Definition: An integrated system of developable cognitive abilities centered on fluency, flexibility, originality, and elaboration, which are considered key indicators of creative processes that can be applied in the educational environment (Al-Salmi & Al-Sahri, 2024).

Procedural Definition: The set of cognitive abilities demonstrated by 10th-grade female students during their study of the unit, measured by the student’s total score on the creative thinking skills test developed by the researcher based on the following dimensions:

Fluency: The ability to generate as many ideas as possible about innovative geographical phenomena.

Flexibility: The ability to diversify perspectives and shift the course of ideas when addressing geographical content.

Originality: The ability to produce unique and rare ideas inspired by concepts of innovative geography.

Scope of the Study

Subject Matter: The study was limited to developing a teaching unit based on the geography of innovation and measuring its impact on the development of creativity skills among 10th-grade female students. Unit 5, “Development,” from the second semester was selected.

Population Scope: The study was limited to a purposive sample of 10th-grade female students at Na'ima Comprehensive Secondary School for Girls, located in the Bani Obaid District of Irbid Governorate.

Time Scope: This study was conducted during the second semester of the 2025–2026 academic year.

Previous Studies

This section presents an overview of the most important Arab and foreign studies relevant to the subject of this study, arranged chronologically from the most recent to the oldest. A study by Jaffe et al. (1993) sought to investigate the geographical relationship between original patents and those cited by them, with the aim of tracing the mechanisms and spaces of technological knowledge transfer. To achieve this, the researchers adopted a comparative quantitative approach using a control group that matched the target patents in terms of technological characteristics and timing. The results showed that patents tend, to a high and statistically significant degree, to cite other patents issued within the geographical scope of the same city; the probability of local citations was five to ten times higher than that of citations from other geographically distant regions, demonstrating that the flow of knowledge remains confined and concentrated within its original spatial environment.

(Audretsch & Feldman, 1996) conducted a study based on the hypothesis that the geographic location of innovation is a direct result of the tendency of production processes to concentrate within a specific spatial area. Accordingly, the researchers treated the location of production as a key variable in their analytical model and concluded that the tendency of innovative activities to cluster geographically is particularly pronounced in sectors and industries where new economic knowledge plays a central role in generating innovation. Furthermore, the empirical data confirmed an increasing tendency toward the spatial concentration of innovative activity within sectors where the outputs of industrial research and development, university-based academic research, and skilled labor are vital inputs to the innovation process.

Breschi (2000) conducted a comprehensive empirical analysis of innovative sectors to trace the geographic distribution of innovative activities, drawing on the European Patent Office database. The study was based on the hypothesis that the spatial patterns of innovation activity vary significantly across different sectors depending on the qualitative characteristics of the technology, as represented by the concept of the “technological system.” The results of the empirical analysis demonstrated the existence of fundamental differences among various technology categories regarding their spatial patterns of innovation clustering, while at the same time revealing striking similarities among countries in the spatial behavior of innovation when each technology category was analyzed individually.

Breschi & Lissoni (2009) reviewed the scientific literature on the geography of innovation, focusing on two central questions: the extent to which knowledge flows more easily between spatially proximate entities compared to distant ones, and the extent to which local knowledge flows can be considered geographically specific spillover effects (Spillovers). The results of the empirical analysis showed that research and development and knowledge transfer activities not only generate positive externalities but that these effects remain geographically confined and concentrated within the same region or area where the new economic knowledge originated.

A study by Khader (2015) investigated the impact of incorporating enrichment activities on the development of creative thinking skills (fluency, flexibility, and originality) among eighth-grade students in a geography course, and examined the role of student gender as a mediating variable. The researcher adopted a quasi-experimental approach using a sample of 125 students (59 males, 66 females) distributed across four classes in the suburbs of Amman. The study's instruments included a set of developed enrichment activities and the Torrance Test of Creative Thinking (Verbal Figure A). The results indicated a statistically significant positive effect of the use of enrichment activities on the development of overall and sub-skills of creative thinking in favor of the experimental group compared to the control group, while no statistically significant effect was found for the gender variable or the interaction between gender and teaching method on the development of creative thinking.

Abu Sa'ada et al. (2020) conducted a research the aimed of the studies was to develop a teaching unit from the 8th-grade geography textbook in light of thinking styles and to measure its impact on creative thinking among female students in Jordan. The researchers used a quasi-experimental design with a sample of 83 eighth-grade female students, who were randomly assigned to an experimental group (42 students) that studied the developed unit and a control group (41 students) that studied using the conventional method. The study instrument was a creative thinking test, after verifying its validity and reliability. The results revealed statistically significant differences at the significance level ($\alpha = 0.05$) between the mean scores of the two groups on the overall Creative Thinking Test and its subscales (fluency, flexibility, and originality), in favor of the students in the experimental group who studied the unit developed in accordance with the habits of the mind.

Meanwhile, a study by Al-Batayneh & Al-Talafah (2022) sought to identify the effectiveness of using the “cube”

strategy in developing creative thinking skills in geography among 10th-grade students in Jordan. The study followed a quasi-experimental design with a sample of 60 students, who were randomly assigned to two groups: an experimental group of 31 students who were taught the “Contemporary Environmental Problems” unit using the cube strategy, and a control group of 29 students who were taught using the conventional method. The Torrance Test of Creative Thinking (Verbal Figure A) was used as a pre- and post-test measurement tool. The results revealed a statistically significant ($\alpha=0.05$) advantage for students in the experimental group over their counterparts in the control group in the overall score of the creativity test and in all sub-skills (fluency, flexibility, originality) individually, confirming the effectiveness of the cube strategy in teaching geography.

Abu Khalif (2024) conducted a study to determine the extent to which creative thinking skills (fluency, flexibility, originality, and elaboration) are present in the fifth-grade science textbook prescribed by the Ministry of Education of the Syrian Arab Republic. To achieve this objective, the researcher adopted a descriptive-analytical approach by preparing a list of creative thinking skills and their sub-indicators (which included 4 main skills and 74 sub-indicators) and a content analysis questionnaire. The results of the analysis revealed a general weakness in the degree to which creative thinking skills were present in the analyzed textbook; all skills were found to have a low degree of presence (less than 40%). The skill of flexibility ranked first, followed by originality in second place, then elaboration in third, while fluency ranked fourth and last. The study recommended that those responsible for developing educational curricula utilize the list of skills and sub-indicators to update textbook content and incorporate creative activities. Similarly, a study by Al-Sabatin and Al-Ghazawi (2024) aimed to develop a geography curriculum for sixth-grade students based on the theory of multiple intelligences and to investigate its impact on the development of critical and creative thinking skills and student achievement in private schools in the capital, Amman. The study adopted a quasi-experimental design and was applied to a purposive sample of 50 students, who were randomly assigned to two groups: an experimental group (25 students) that was taught using the developed program, and a control group (25 students) that was taught using the conventional method. The study instruments consisted of a critical thinking test, a creative thinking test in geography, and an academic achievement test. The results showed statistically significant superiority of the students in the experimental group—who were taught using the multiple intelligences-based program—over those in the control group across all dependent variables (critical thinking, creative thinking, and academic achievement).

What Sets the Current Study Apart from Previous Studies?

This study differs from previous studies in several respects, most notably:

- This study is unique in that it bridges the gap between foreign theoretical literature on “geography of innovation” and the spatial clustering of knowledge, and applied educational literature focused on developing geography curricula and teaching strategies. The study goes beyond the traditional view of geography instruction based on rote learning or rigid geographical narration to formulate an educational model that links contemporary geographical content with creative thinking skills.
- While previous Arabic studies have focused on measuring the impact of general teaching strategies (such as the Cube Strategy, multiple intelligences, or habits of mind) on traditional geography content, this study presents a teaching unit developed and designed specifically in accordance with the latest methodological approaches, targeting the direct and measurable development of creative thinking skills in their key dimensions (fluency, flexibility, originality, and elaboration), thereby lending the instructional material and newly developed tools a unique scientific originality.
- The study is distinguished by its application of modern spatial theories to the educational and school environment; it fills a gap in the field literature by empirically measuring the impact of developed curricula on the development of students’ creative skills through a quasi-experimental curriculum design (an experimental group and a control group), thereby providing reliable statistical indicators and field evidence that reflect the immediate educational reality.
- This study was not limited to the analytical and evaluative aspects of the content, as in some analytical studies, nor was it limited to the application of a separate measurement tool; rather, its structure combined the design and methodological development of the geography teaching unit on the one hand, and the precise field measurement of its impact on creative thinking on the other, to provide teachers and curriculum developers with an applicable model that can be generalized and put to direct use.

Methodology and Procedures

Research Approach

The study adopted a quasi-experimental approach with a two-group design (experimental and control groups) and two measurements (pre-test and post-test), as it was appropriate for the nature of the study, which aimed to investigate the impact of a developed instructional unit based on the geography of innovation on the development of creative thinking skills among 10th-grade female students, according to the following design:

- Experimental group: The students were taught the developed “Development” unit based on concepts of the geography of innovation, and the study instruments were administered to them (pre-test and post-test).
- Control Group: The same unit was taught using the conventional method, and the study instruments were administered (pre- and post-tests).

Study Population and Sample

The study population consisted of 10th-grade female students. The study sample was selected using a purposive sampling method and randomly divided into two groups: an experimental group consisting of 30 students and a control group consisting of 30 students, for a total sample size of 60 students.

Research Instrument

To achieve the study’s objective, a creative thinking skills test was developed. The test consists of four main dimensions: fluency, originality, flexibility, and elaboration.

Test Validity

The validity of the test was verified by presenting it to a group of expert reviewers to gather their opinions and observations. Additionally, the difficulty and discrimination coefficients for the test items were calculated using a pilot sample consisting of 20 female students from outside the study sample. Table (1) shows the difficulty and discrimination coefficients for the test items:

Table (1) Difficulty and Discrimination Coefficients for the Items.

Item Number	Difficulty Index	Discrimination Index
1	0.45	0.70**
2	0.55	0.59**
3	0.45	0.58**
4	0.45	0.61**
5	0.50	0.63**
6	0.45	0.67**
7	0.45	0.53*
8	0.25	0.57**
9	0.30	0.55*
10	0.65	0.78**
11	0.55	0.59**
12	0.60	0.75**
13	0.65	0.77**
14	0.60	0.74**
15	0.60	0.70**
16	0.40	0.57**
17	0.45	0.66**
18	0.60	0.75**
19	0.65	0.80**
20	0.60	0.74**

* Statistically significant at the 0.05 significance level.

** Statistically significant at the 0.01 significance level.

Table (1) shows that the item difficulty coefficients ranged from 0.25 to 0.65, and the discrimination coefficients ranged from 0.53 to 0.80. These are statistically acceptable values and indicate that all test items are appropriate.

Test Reliability

Test reliability was verified using the test-retest method by administering the test and then re-administering it two weeks later to a pilot sample of 20 students, and by calculating the internal consistency coefficient (Cronbach’s

alpha). Table 2 illustrates this:

Table (2): Internal Consistency Coefficient (Cronbach-Richardson-20) and Test-Retest Reliability for the Dimensions and Overall Score of the Creativity Skills Test

Dimensions	Test-Retest Reliability	Internal Consistency
Fluency	0.90	0.75
Originality	0.88	0.72
Flexibility	0.87	0.72
Elaboration / Enrichment	0.89	0.81
Creativity Skills	0.90	0.93

Group Equivalence in the Pre-Test

To verify the equivalence of the two groups (experimental and control) in the pre-test for the creative thinking skills test, the arithmetic means, standard deviations, and t-test (Independent Samples T-Test) were calculated. Table (3) illustrates this:

Table (3): Arithmetic Means, Standard Deviations, and t-Tests by Group Variable for the Dimensions and Total Score of the Pre-Test for Creative Thinking Skills

Variable	Group	N	Mean	Std. Deviation	t-value	df	Sig. (p-value)
Fluency (Pre)	Experimental	30	2.23	1.165	0.111	58	0.912
	Control	30	2.20	1.157			
Originality (Pre)	Experimental	30	1.77	1.073	-0.239	58	0.812
	Control	30	1.83	1.085			
Flexibility (Pre)	Experimental	30	1.90	1.029	-0.250	58	0.803
	Control	30	1.97	1.033			
Elaboration / Enrichment (Pre)	Experimental	30	1.97	1.299	-0.632	58	0.530
	Control	30	2.17	1.147			
Creativity Skills (Pre)	Experimental	30	7.87	2.776	-0.444	58	0.659
	Control	30	8.17	2.451			

Table (3) shows that there were no statistically significant differences ($\alpha = 0.05$) attributable to group across all dimensions and the overall score of the pre-test, confirming the equivalence of the two groups prior to treatment.

Study Procedures

The study proceeded according to the following procedural steps:

1. Review of the theoretical literature related to the concepts of the geography of innovation and creative thinking skills.

2. Development of the instructional unit and the creative thinking skills test, and verification of their validity and reliability.
3. Selection of the study sample and its random assignment to two groups (experimental and control).
4. Administering the pre-test of creative thinking skills to both groups to verify equivalence.
5. Implementing the experimental treatment by teaching the experimental group using the developed unit and the control group using the conventional method.
6. Administering the post-test of creative thinking skills to both groups.
7. Collect the data and enter it into SPSS for analysis and to extract the results.

Statistical Analyses

The following statistical analyses were performed using SPSS:

- Arithmetic means and standard deviations.
- Discrimination and difficulty coefficients, Pearson's correlation coefficient, and the Coder-Richardson-20 equation.
- Independent Samples t-Test to examine the equivalence of the two groups.
- Analysis of Covariance (ANCOVA) for the total test score.
- Multivariate Analysis of Covariance (MANCOVA) for the subscales.
- Eta-squared (η^2) to calculate the effect size

Presentation of Results

This section presents the results of the statistical analysis of the data collected to answer the study's research question, which is: "Are there statistically significant differences at the significance level ($\alpha=0.05$) between the mean scores of female students in the experimental and control groups on the Creative Thinking Skills Test as a whole, and in its sub-dimensions (fluency, flexibility, originality, and elaboration), attributable to the type of instructional unit (enhanced/standard)?"

To answer this question, the arithmetic means and standard deviations of the 10th-grade female students' scores on the Creative Thinking Skills Test were calculated for the pre-test and post-test measures according to the type of instructional unit (enhanced, standard), as shown in Table (4):

Table (4): Arithmetic Means and Standard Deviations of Students' Scores on the Overall Creative Thinking Skills Test for the Pre- and Post-Tests According to the Type of Instructional Unit

Type of Instructional Unit	N	Pre-test (Mean)	Pre-test (Std. Deviation)	Post-test (Mean)	Post-test (Std. Deviation)
Developed (Experimental)	30	7.87	2.776	15.83	5.140
Conventional (Control)	30	8.17	2.451	11.60	2.207

Table (4) shows apparent differences between the mean scores of female students on the creativity skills test as a whole in the pre- and post-tests, according to the type of instructional unit. To determine whether these differences are statistically significant, a one-way analysis of covariance (ANCOVA) was conducted on the posttest scores for the overall test after controlling for the effect of the pretest. These results are presented in Table (5):

Table (5): Results of the one-way ANCOVA for the posttest scores of female students on the overall creativity skills test after controlling for the effect of the pretest

Source of Variance	Sum of Squares	df	Mean Square	F-value	Sig.	Eta Squared (η^2)
Pre-test	6.627	1	6.627	0.419	0.520	0.007

Type of Instructional Unit	272.831	1	272.831	17.265	0.000	0.232
Error	900.740	57	15.802			
Total	1176.183	59				

Table (5) shows that there are statistically significant differences at the significance level ($\alpha = 0.05$) in female students' scores on the creativity skills test according to the type of instructional unit; the F-value (17.265) with a p-value of (0.000), indicating a positive effect of the developed instructional unit. It is also evident that the effect size was large; the eta-squared (η^2) value explained (23.2%) of the variance in creative thinking skills.

To determine in whose favor the differences were attributed, the adjusted arithmetic means and their standard errors were calculated, as shown in Table (6):

Table (6): Adjusted Arithmetic Means and Standard Errors for the Total Score on the Creativity Skills Test by Type of Instructional Unit

Type of Instructional Unit	Adjusted Post-test Mean	Standard Error
Developed (Experimental)	15.853	0.726
Conventional (Control)	11.581	0.726

The results in Table (6) indicate that the differences were in favor of the experimental group that was taught using the developed instructional unit.

To determine the effect of the developed instructional unit on the sub-skills of creative thinking, the means and standard deviations for the pre- and post-tests of the test dimensions were calculated, as shown in Table (7):

Table (7): Means and Standard Deviations of the Pre- and Post-Tests for the Dimensions of the Creativity Skills Test According to the Type of Instructional Unit

Dimensions	Unit Type	Pre-test (Mean)	Pre-test (Std. Deviation)	Post-test (Mean)	Post-test (Std. Deviation)
Fluency	Developed	2.23	1.165	4.17	1.117
	Conventional	2.20	1.157	3.03	1.129
Originality	Developed	1.77	1.073	3.87	1.655
	Conventional	1.83	1.085	2.90	1.155
Flexibility	Developed	1.90	1.029	3.87	1.548
	Conventional	1.97	1.033	2.77	1.040
Elaboration / Enrichment	Developed	1.97	1.299	3.93	1.437
	Conventional	2.17	1.147	2.90	0.995

To verify the significance of the apparent differences across all dimensions, a multivariate analysis of covariance (MANCOVA) was conducted, as shown in Table (8):

Table (8): Results of the multivariate analysis of covariance for the effect of instructional unit type on the dimensions of the creativity skills test

Effect	Multivariate Test	Value	F	Hypothesis df	Error df	Sig.	Effect Size (η^2)
Unit Type	Hotelling's Trace	0.369	4.701	4.000	51.000	0.003	0.269

Table (8) shows that there is a statistically significant effect at the 0.05 significance level for the developed instrument on the test dimensions as a whole. To identify the specific dimensions on which this effect was observed, an analysis of covariance (ANCOVA) was conducted for each dimension separately, as shown in Table (9):

Table (9): One-Way Analysis of Covariance (ANCOVA) for the dimensional scores of each dimension of the Creativity Skills Test

Source of Variance	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.	Effect Size (η^2)
Type of Instructional Unit	Fluency (Post)	18.126	1	18.126	15.565	0.000	0.224
	Originality (Post)	14.169	1	14.169	6.668	0.013	0.110
	Flexibility (Post)	18.427	1	18.427	10.325	0.002	0.161
	Elaboration / Enrichment (Post)	16.710	1	16.710	11.162	0.002	0.171

Table (9) shows that there are statistically significant differences across all dimensions of creative thinking attributable to the developed instrument. To determine in whose favor these differences were, adjusted means were calculated, as shown in Table (10):

Table (10): Adjusted Arithmetic Means and Standard Error of Measurement for the Dimensions of the Creativity Skills Test

Dependent Variable	Type of Instructional Unit	Adjusted Mean	Standard Error
Fluency	Developed	4.152	0.197
	Conventional	3.048	0.197
Originality	Developed	3.871	0.267
	Conventional	2.896	0.267
Flexibility	Developed	3.878	0.245
	Conventional	2.756	0.245
Elaboration / Enrichment	Developed	3.967	0.224
	Conventional	2.866	0.224

The results shown in Table (10) indicate that the adjusted mean scores for the experimental group were higher than those of the control group across all creative thinking skills, confirming the superiority and effectiveness of the developed unit based on the concepts of the geography of innovation.

Discussion of the Results

Recommendations

The results of the statistical analysis showed a substantial and statistically significant advantage for the participants in the experimental group who studied the developed “Development” unit based on the concepts of the geography of innovation, both in the overall score of the creative thinking skills test and in all of its sub-skills (fluency, flexibility, originality, and elaboration/enrichment), compared to their peers in the control group who studied the same unit using the conventional method. This superior performance can generally be explained by the fact that restructuring the “Development” unit and incorporating concepts of “geography of innovation” brought about a qualitative shift in the learning environment; students transitioned from the role of passive recipients of abstract geographic information to that of active researchers and explorers. By its very nature, the geography of innovation focuses on analyzing spatial relationships, understanding how environments that foster creativity (such as smart cities, technology hubs, and business incubators) emerge, and how to leverage geographic resources to achieve sustainable development. This modern knowledge framework presented a positive challenge to the students’ intellectual abilities, confronting them with real-world spatial and development problems that require unconventional solutions, thereby providing a fertile environment for practicing and developing creative thinking.

In addition, the use of interactive spatial tools and digital maps—such as Google Earth and virtual tours—as part of the activities in the developed unit directly contributed to stimulating the students’ spatial imagination. This interactive practice enabled the students to examine geographical and developmental phenomena up close and connect theoretical concepts with visual reality, which positively impacted their ability to imagine and generate creative ideas.

The growth and improvement in the experimental group’s sub-skills of creative thinking can be detailed as follows:

- **Regarding the skill of “fluency”:** The noticeable improvement can be attributed to the nature of the tasks and activities included in the unit, which relied on geographic brainstorming strategies. The students were asked to generate as many alternatives and proposals as possible to address specific development challenges (such as resource scarcity or environmental pollution), which helped them overcome their hesitation and trained them to quickly recall spatial and economic ideas and let them flow smoothly within a specified time frame.
- **Regarding the skill of flexibility:** This skill developed as a result of exposing the students to learning situations that required them to view development issues from multiple angles. Instead of focusing on a single dimension, the students were trained through the concepts of innovation in geography to shift their mindset and consider the problem from economic, environmental, social, and spatial perspectives simultaneously. This diversity in problem-posing and multidimensional analysis freed their thinking from rigidity and stereotyping.
- **Regarding the skill of “originality”:** The experimental group’s superior performance in this skill is a direct result of the continuous encouragement within the developed module to generate rare and unconventional ideas. The very concepts of innovation reject ready-made solutions, and the students were asked to imagine future development projects or design innovative cities that do not exist in the traditional sense, which motivated them to excel and generate unique ideas to solve spatial and development problems, as well as to devise unprecedented methods for utilizing local resources.
- **Regarding the skill of “Details/Enrichment”:** This skill was enhanced through activities that required the students not only to propose an abstract idea but also to expand upon it and add precise logistical and geographical details. For example, when proposing an innovative development project, they were asked to identify the optimal location on a map, sketch the necessary infrastructure, and add illustrative implementation steps; this emphasis on building and developing the idea led to a significant deepening of their enrichment skills.

Based on the results demonstrating the effectiveness of the developed module, the study offers the following recommendations:

1. **For curriculum developers:** Incorporate concepts of the geography of innovation into elementary-level geography curricula and textbooks, and utilize the unit developed in this study to foster creative thinking skills.
2. **To subject teachers:** Use teaching strategies based on innovation and spatial analysis, and avoid relying solely on rote learning and memorization.
3. **To training departments:** Organize training courses for social studies and geography teachers to equip them with the skills to design and manage activities that stimulate creative thinking in its various dimensions.
4. **For researchers:** Conduct further studies to investigate the impact of concepts in the geography of innovation on the development of other educational variables, such as spatial thinking or the solving of geographic problems, across different grade levels.

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