Researcher

Websites:
http://www.sciencepub.net
http://www.sciencepub.net/researcher

Emails:
editor@sciencepub.net
marslandresearcher@gmail.com

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# "Ensuring the Integration of Mathematics and Geography Subjects in Developing Students' Cartographic Knowledge"

Ergashev Tolibdjon

Namangan State University, Namangan, 160119, Uzbekistan
E-mail. tergash_2025@gmail.com

**Abstract:** Ensuring the integration of academic subjects contributes to strengthening students' knowledge and enriching their understanding of the topics being studied. Therefore, attention is given to using interdisciplinary integration in the educational process. However, achieving interdisciplinary integration is a complex process, where the teacher's experience, professional competence, and skills play a crucial role. In the educational process, geography teachers need to focus on specific aspects of utilizing the interconnection and unity of geographical and mathematical knowledge. The article discusses aspects and factors that should be considered in ensuring the integration of mathematical and geographical subjects to develop students' cartographic knowledge.
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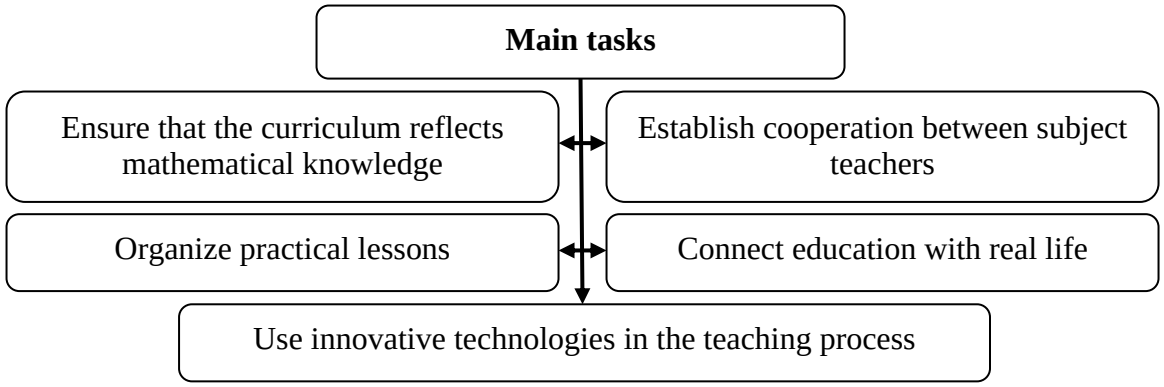
**Key words:** students; cartographic knowledge; development; mathematical knowledge; geographical knowledge; integration; integration of mathematics and geography.

## 1. Introduction:

Geography and mathematics are close to each other in terms of the logical nature of knowledge. Consequently, any arbitrary geographical situation and phenomenon is based on a precise mathematical calculation. Based on this uniqueness, there is an opportunity to strengthen students' cartographic knowledge and enrich them with new concepts by ensuring mutual integration between mathematics and geography in the educational process. The development of students' cartographic knowledge based on the integration of mathematics and geography is ensured by completing the following tasks:




**Tasks to develop students' cartographic knowledge based on the integration of mathematics and geography**

***I. Ensuring that the curriculum reflects mathematical knowledge.*** It is advisable to ensure interdisciplinary integration by achieving the reflection of mathematical knowledge in the curriculum of the subject "Applied Geography" intended for students of academic lyceums. The main attention in this regard is paid to determining the relationship between mathematical and geographical knowledge in the curriculum of the subject "Applied Geography",

for example, mastering the concepts of scale and coordinate system, calculating area, distance and angles. This increases the effectiveness of the integration process and deepens the cartographic knowledge of students.

***II. Establishing collaboration among subject teachers.*** Achieving ongoing collaboration between mathematics and geography teachers in ensuring interdisciplinary integration will yield positive results. Collaboration between them is evident in the development of jointly integrated approaches to lesson planning and delivery.

***III. Practical lessons organization to grow.*** This kind of in classes students
Involving students in working with maps, for example, calculating the scale on thematic (natural or natural geographic maps; socio-economic maps) and digital maps (digital (electronic) models of geographic maps), and analyzing topographic data increases their learning and cognitive activity. In addition, in the "Practical Geography" lessons, introducing the technologies of the Global Positioning System (GPS) and geographic information systems (GIS) into the teaching process and forming the competencies of students to work with these systems will help them acquire practical significance in the geographical knowledge they are acquiring.

***IV. Connecting education with real life.*** The fact that the tasks given to students in the teaching of "Practical Geography" relate to issues that they often encounter in everyday life and are directly linked to mathematics, firstly, ensures that the knowledge being mastered has practical significance; secondly, the knowledge mastered in this analysis is solid and well stored in memory.

**2. Materials and Methods:**

For example, tasks based on the integration of geography and mathematics knowledge could be as follows:

1. A task to determine scales by different sizes (1 mm, 1 cm, 10 cm).

Based on the given scale dimensions, express the actual distance on the Earth's surface in units of 1 mm, 1 cm, and 10 cm.

**Setting scales for different sizes**

| No. | Scales | Dimensions on the map | | |
|---|---|---|---|---|
| | | 1mm | 1 cm | 10 cm |
| 1. | 1:100,000 | | | |
| 2. | 1:500,000 | | | |
| 3. | 1:10000 | | | |
| 4. | 1:5000 | | | |
| 5. | 1:2000 | | | |
| 6. | 1:1000 | | | |
| 7. | 1:500 | | | |
| 8. | 1:200 | | | |
| 9. | 1:100 | | | |

2. Tasks related to calculating scale and distances.

2.1. Find the distance between the cities of Namangan and Jizzakh (Turakurgan, Chust, Pop, Andijan, Fergana, Osh, Angren, Almalyk, Akhangaron, Tashkent, Gulistan, Samarkand, Juma, Nurota, Navoi, Bukhara, Urgench, Nukus, Karshi, Termez) based on the scale given on the map .

2.2. “If the distance between points A and B on the map given to us is 5 cm, what is the distance between these cities in real life?”

The map scale is 1:10000000” [1] .

2.3. In your hands 1:50000 scaled map there is. This map using
Measure the distance between any two points in centimeters and calculate the calculated distance in kilometers.

3. Task on identifying objects in a coordinate system.

3.1. Determine the location of specific points in the geographic coordinate system (latitude and longitude):

A. From the world map, determine the location of the cities of Istanbul, Kyoto, Medina, Mecca, Moscow, Nagoya, Osaka, Beijing, Rotterdam, and Sydney.

**The world's major cities have Geographic coordinates of**

| No. | Major cities of the world | Geographic coordinates | |
|---|---|---|---|
| | | Width | Length |
| 1. | Istanbul | | |
| 2. | Kyoto | | |
| 3. | Medina | | |
| 4. | Mecca | | |
| 5. | Moscow | | |
| 6. | Nagoya | | |
| 7. | Osaka | | |
| 8. | Beijing | | |
| 9. | Rotterdam | | |
| 10. | Sydney | | |

B. From the map of Uzbekistan, determine the location of the cities of Asaka, Bakht, Boysun, Vobkent, Denov, Karmana, Kattakurgan, Pop, Rishton, Tashkent, Urgut, Khiva, Shahrisabz, Kungirat, and Gallaorol.

**Geographic coordinates of cities in Uzbekistan**

| No. | Cities of Uzbekistan | Geographic coordinates | |
|---|---|---|---|
| | | Width | Length |
| 1. | Asaka | | |
| 2. | Happiness | | |
| 3. | Boysun | | |
| 4. | Vobkent | | |
| 5. | Denov | | |
| 6. | Karmana | | |
| 7. | Kattakurgan | | |
| 8. | Pop | | |
| 9. | Rishton | | |
| 10. | Tashkent | | |
| 11. | Urgut | | |
| 12. | Khiva | | |
| 13. | Shahrisabz | | |
| 14. | Call | | |
| 15. | Grain Island | | |

3.2. Mark arbitrary objects on the map using a Cartesian coordinate system (the location of each point in a chosen spatial reference system is represented by three coordinates x, u, z).

3.3. World maps using the central points of different continents
Determine the geographical coordinates.

**Central on different continents of points geographical coordinates**

| No. | Name of continents | Geographic coordinates of central points | |
|---|---|---|---|
| | | Width | Length |
| 1. | Europe | | |
| 2. | Europe and Asia | | |
| 3. | North America | | |
| 4. | South America | | |
| 5. | Africa | | |
| 6. | Australia | | |
| 7. | Australia and Oceania | | |
| 8. | Antarctica | | |

3.4. Determine the coordinates of settlements in the local coordinate system:

A. Namangan region, Yangikurgan district settlements: Nanay, Mamay, Kyzylyozi, Ko'kyor, Zarkent and Paramon rural municipalities.

| Settlements | Coordinates | Settlements | Coordinates |
|---|---|---|---|
| Nanay MFY | | Kokyor MFY | |
| Mamay MFY | | Zarkent MFI | |
| Kyzylyozy MFY | | Paramon MFY | |

B. Large population centers of the Jalalabad region of the Kyrgyz Republic: Jalalabad, Karakul, Maylisay, Tashkumir, Kokyongak, Kerben, Toktogul, Shamoldisay, Kuchkor-Ata, Bazarkurgan.

| Settlements | Coordinates | Settlements | Coordinates |
|---|---|---|---|
| Jalalabad | | Kerben | |
| Karakul | | Toktogul | |
| Maylisoy | | Windy | |
| Coal | | Aries-Father | |
| Blueberry | | Bazaarkurgan | |

C. Find what city is located at 56° (north latitude) 38° (east longitude).

3.4. Find the distance between two objects located on the same meridian.

“The cities of Vladikavkaz and Baghdad are located almost on the same meridian, but at different latitudes. The difference in latitude is 10°. Find the length of the air route that can be carried out along the common meridian between these cities” [3, – p. 34] .

4. An assignment to analyze demographic data (studying local or national population, population growth rates, population density).

4.1. Based on the table below, indicate which country has the highest percentage of the population under the age of 15 and which countries have the same percentage of the population over the age of 65.

**Population size and composition (2019)**

| No. | Countries | Population, million people | Birth and death rates 1000 people | |
|---|---|---|---|---|
| | | | Birth rate | Death toll |
| 1. | China | 1387 | 12 | 7 |
| 2. | France | 65 | 12 | 9 |
| 3. | Kenya | 45 | 23 | 7 |
| 4. | Egypt | 95 | 29 | 5 |

4.2. Calculate the population growth rate of Uzbekistan based on 5-year data and present the results of the calculation in a diagram.

**Population growth rate of Uzbekistan (2019-2023)**

| No. | Years | Birth rate ( thousand people ) | Death toll ( thousand people ) | Overall growth ( million people) |
|---|---|---|---|---|
| 1. | 2019 | | | |
| 2. | 2020 | | | |
| 3. | 2021 | | | |
| 4. | 2022 | | | |
| 5. | 2023 | | | |

4.3. Present the 5-year population growth rate data for Uzbekistan in a diagram.

5. Assignment on natural resource analysis and mapping.

5.1. Calculate the total area of mineral-rich areas based on the map of Uzbekistan.

5.2. Express the ratio of the total area of mineral resources to the total area of the republic, calculated based on the map of Uzbekistan, in percentage.

5.3. Compare the total area of mineral-rich areas in Uzbekistan with the total area of mineral-rich areas in the Russian Federation.

5.4. Express the ratio of the total area of mineral-rich regions in Uzbekistan to the total area of mineral-rich regions in the Russian Federation in percentage.

6. Assignment on analyzing climate data.

5.1. Show on a map data on the amount of annual precipitation by region of Uzbekistan for a specific year.

**Annual precipitation by region of Uzbekistan (2023)**

| No. | Provinces | Annual precipitation | No. | Provinces | Annual precipitation |
|---|---|---|---|---|---|
| 1. | Andijan | | 8. | Surkhandarya | |
| 2. | Bukhara | | 9. | Tashkent | |
| 3. | Jizzakh | | 10. | Fergana | |
| 4. | Navoi | | 11 | Khorezm | |
| 5. | Namangan | | 12. | Kashkadarya | |
| 6. | Samarkand | | 13. | Karakalpakstan | |
| 7. | Syrdarya | | - | | |

5.2. Specific year in the example of Uzbekistan Annual precipitation by region
Calculate the average, minimum, and maximum values based on the data.

**Annual precipitation by region of Uzbekistan (2023)**

| Provinces | Annual precipitation | | | Provinces | Annual precipitation | | |
|---|---|---|---|---|---|---|---|
| | Four . | Min . | Max . | | Four . | Min . | Max . |
| Andijan | | | | Surkhandarya | | | |
| Bukhara | | | | Tashkent | | | |
| Jizzakh | | | | Fergana | | | |
| Navoi | | | | Khorezm | | | |
| Namangan | | | | Kashkadarya | | | |
| Samarkand | | | | Karakalpakstan | | | |
| Syrdarya | | | | | | | |

5.3. For a specific year, plot the average, minimum, and maximum values calculated based on annual precipitation data for the regions of Uzbekistan.

5.4. Using the example of a specific year, display data on annual air temperature by region of Uzbekistan on a map.

**Annual air temperature by region of Uzbekistan (2023)**

| No. | Provinces | Annual air temperature | No. | Provinces | Annual air temperature |
|---|---|---|---|---|---|
| 1. | Andijan | | 8. | Surkhandarya | |
| 2. | Bukhara | | 9. | Tashkent | |
| 3. | Jizzakh | | 10. | Fergana | |
| 4. | Navoi | | 11 | Khorezm | |
| 5. | Namangan | | 12. | Kashkadarya | |
| 6. | Samarkand | | 13. | Karakalpakstan | |
| 7. | Syrdarya | | - | | |

5.5. Calculate the average, minimum, and maximum values based on annual air temperature data for the regions of Uzbekistan for the year 2023.

**Annual air temperature by region of Uzbekistan (2023)**

| No. | Provinces | Annual air temperature | | |
|---|---|---|---|---|
| | | Average | Minimum | Maximum |
| 1. | Andijan | | | |
| 2. | Bukhara | | | |
| 3. | Jizzakh | | | |
| 4. | Navoi | | | |
| 5. | Namangan | | | |
| 6. | Samarkand | | | |
| 7. | Syrdarya | | | |
| 8. | Surkhandarya | | | |
| 9. | Tashkent | | | |
| 10. | Fergana | | | |
| 11 | Khorezm | | | |
| 12. | Kashkadarya | | | |
| 13. | Karakalpakstan | | | |

5.6. Specific year in the example of Uzbekistan provinces according to annual air Represent the average, minimum, and maximum values calculated based on temperature data in a diagram.

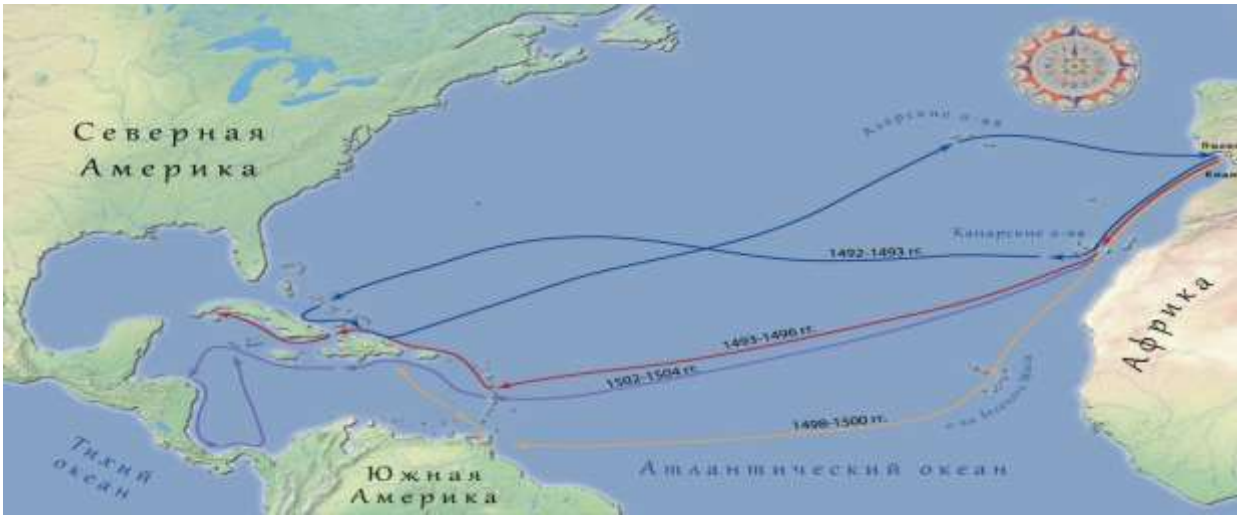
6. Assignment on historical geographical knowledge.

6.1. Abu Rayhan Al-Biruni's information on determining geographical coordinates [2, – Compare the indicators that determine the location of the given places [p. 24] and show the differences.

**To determine geographical coordinates Comparative study of related information**

| No. | Place names | Geographical latitude | | |
|---|---|---|---|---|
| | | According to Abu Rayhan Al-Biruni | According to modern measurement | Intermediate difference |
| 1. | Bukhara | 39 o'clock 20' | | |
| 2. | Samarkand | 40 o'clock 00' | | |
| 3. | Baku | 39 o'clock 00' | | |
| 4. | Darband | 66 º 00' | | |
| 5. | Fergana | 92 o'clock 00' | | |
| 6. | Lost | 92 o'clock 00' | | |

6.2. The 1st, 2nd, 3rd and 4th expeditions of Christopher Columbus according to the coordinate system [5] Measure the distance of the sea route using these maps illustrated.




**Christopher Columbus's 1st, 2nd, 3rd and Sea routes of the 4th expedition**

6.3 . Calculate the diesel fuel consumption of Christopher Columbus for his 1st, 2nd, 3rd, and 4th expeditions at current prices, based on the measured sea route distance.

Ship model: Teplokhod 457

Engine model (power, kW) – K -161-2

Consumption, l/machine-hour – 15.7 D

The average is 30 liters per hour [4] .

The price of diesel fuel is 11,955.6 soums (December 9, 2024) [6] .

**Christopher Columbus spent on his 1st, 2nd, 3rd and 4th expeditions diesel fuel (current price; 09.12.2024)**

| **No.** | Expeditions order | Required diesel fuel (in l/machine-hour) | Amount spent on diesel fuel |
|---|---|---|---|
| 1. | Expedition 1 | | |
| 2. | Expedition 2 | | |
| 3. | Expedition 3 | | |
| 4. | Expedition 4 | | |

***V. Application of innovative technologies in the teaching process .*** In modern conditions, the use of innovative technologies in the process of developing students' cartographic knowledge based on the integration of mathematical and geographical knowledge is of great importance. Therefore, the use of innovative technologies in this process not only reflects the harmonious development of geography with the information society, but also helps students acquire competencies for effective work in a digital environment. Today, the use of Geographic Information Systems (GIS) in geography education based on mutual integration with mathematics is becoming increasingly popular. Performing educational tasks based on this system ensures that students' existing knowledge is transformed into practical skills using innovative technologies.

Involving students in the following tasks based on innovative technologies in teaching the subject of "Practical Geography" creates the opportunity to achieve the expected results:

1. Using GIS software, determine the area of the area (village, city, district) where you live.
2. Create a map based on the identified data.
3. Using GIS software, determine information about the direction of movement of the type of transport you use.
4. Based on the determined data, determine the direction of movement of the transport type on the map.

**3. Discussion:**

Ensuring mutual integration between academic disciplines serves to strengthen students' knowledge and enrich their imagination on the topics being studied. Achieving interdisciplinary integration is a complex process in itself.

Effective implementation of the above tasks increases the effectiveness of the interdisciplinary integration process and deepens students' cartographic knowledge.

Therefore, in achieving mutual integration between academic subjects, the teacher's work experience, professional competence and skills play an important role. In developing students' cartographic knowledge based on the integration of mathematics and geography, it is necessary to ensure that the curriculum reflects mathematical knowledge; establish cooperation between subject teachers; organize practical lessons; connect education with real life; in the teaching process provided by performing tasks such as applying innovative technologies.

**Corresponding author:**
T. Ergashev
Namangan state university, Namangan (Uzbekistan)
Email: tergash_2025@gmail.com
Contact No. +998990699617

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