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Improving The Methodology Of Inquiry-Based Teaching Of Inorganic Chemistry Through Artificial Intelligence

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Abstract. This article analyzes the issue of improving the methodology of inquiry-based teaching using artificial intelligence (AI). Traditional teaching methods are often insufficient for developing students' research and independent inquiry skills. Therefore, integrating AI technologies into the educational process has become an essential task. This paper examines the relationship between artificial intelligence and inquiry-based learning (IBL) methodology and explores its application in teaching inorganic chemistry.
Keywords:

In today's rapidly evolving information technology era, artificial intelligence is increasingly permeating all aspects of life, including education. As a result, not only teachers but also students must acquire proficiency in information technologies and be able to use them effectively, as this has become one of the key demands of the modern world [2].

In the process of improving the methodology of inquiry-based teaching of inorganic chemistry through artificial intelligence, classroom activities focus on research-oriented tasks utilizing AI. For instance, students analyze data related to iron compounds in water, fostering critical thinking and independent analytical skills. The study provides recommendations for integrating AI-based research activities into the learning process [3].

The topic of iron compounds in water is closely related to inorganic chemistry and environmental science, making it an ideal subject for developing students' research abilities. This topic enables the application of inquiry-based learning (IBL) using artificial intelligence (AI) [4]. Students are given the following task: using the element Fe (iron), they investigate water enrichment techniques and methods of introducing iron compounds.

The following steps are undertaken:

1. *Step One* – Students gather scientific information on anemia and iron deficiency from academic sources [8].
2. *Step Two*– They develop an understanding of iron's role in the human body and its connection to drinking water [9].
3. Step Three – With the help of artificial intelligence, they explore global experiences in drinking water treatment, evaluating cost, safety, and technical feasibility [10].

Iron is one of the most essential elements for living organisms. In warm-blooded organisms, including humans, iron is a crucial component of blood [1]. The red color of blood is due to its iron content. A healthy human body can absorb about 2–2.5 mg of iron per day [5]. The iron found in animal-based foods is absorbed more efficiently than that in plant-based foods. A deficiency of iron in the human body can lead to various health issues [6], particularly affecting infants, preschool children, and pregnant women, who are at high risk of iron deficiency and iron-deficiency anemia [7].

Anemia is a disease associated with decreased hemoglobin levels in the blood due to iron deficiency. To understand the impact of iron concentrations in urban and rural water sources on anemia prevalence, students utilize AI-based data analysis tools [8].

To evaluate the drinking water supply experiences in various countries, the following key aspects are considered:

1. Cost. Is the price of water regulated at the national or municipal level? Does the government provide subsidies, or is pricing controlled by the private sector? What factors influence water prices (e.g., water source, purification technology, distribution infrastructure)? [10]

2. Safety. How is water quality monitored? Which countries have successfully prevented drinking water contamination? How strict are safety standards (e.g., WHO, U.S. EPA, EU regulations), and how are they enforced?
3. Technical Capabilities. Is the water supply system managed by the state or private entities? Which countries have effectively implemented modern technologies such as desalination, recycling, and filtration? Where have digital management systems or smart water meters been successfully introduced?
Case Studies of Different Countries:
1. Singapore: High water prices due to the use of water recycling and desalination technologies. The "NEWater" project treats wastewater to meet high-quality drinking water standards. Advanced water-saving technologies and rainwater harvesting systems are well-developed.
2. Germany: Water prices are relatively high, but so is the quality of supply. Strict sanitation regulations and strong environmental monitoring ensure safety. Well-developed water flow monitoring systems help manage distribution efficiently.
3. United States: Water prices vary by region; some areas have low costs but suffer from infrastructure problems. In certain locations, such as Flint, Michigan, incidents of lead contamination have been reported. Major cities use advanced technologies for water analysis and distribution.

4. Israel: High water prices due to reliance on desalination. A global leader in water conservation and efficient management. Technologies allow for stable water supply even in arid regions.

5. India: Relatively low water prices but widespread clean drinking water shortages. Many regions face severe water contamination issues. Some cities have adopted new purification methods, but significant reforms are still needed.

Uzbekistan: Water Supply Issues and Development Opportunities. Uzbekistan is one of the key countries in Central Asia in terms of drinking water supply, with both challenges and opportunities for development. Below is an analysis based on three main factors:

1.Urban areas: Water prices are regulated by the state and remain relatively affordable. Rural areas: Some regions lack centralized water supply, forcing residents to purchase water, leading to additional costs. Government subsidies: The government provides financial support for water supply, but infrastructure challenges persist.

2. Water quality varies by region. Major cities such as Tashkent, Samarkand, and Bukhara have better water quality, while remote areas face a higher risk of contamination. The Sanitary and Epidemiological Service monitors water quality, but aging pipelines in some areas lead to contamination. Factors such as the Aral Sea crisis, groundwater pollution, and industrial waste negatively affect water safety in certain regions.

3. Large cities and regional centers have established water supply systems, but some rural areas still lack access to clean drinking water. The government is modernizing water treatment plants, but the process is slow in many areas. Water meters are being introduced, yet automated management systems are not fully developed.

Global Best Practices in Water Enrichment:

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- Sweden, Finland, and Kazakhstan:

Water enrichment is typically done by adding calcium and magnesium to help prevent heart and bone diseases

- China:

- Long-standing practice of enriching water with iron compounds.
- Iron sulfate ($FeSO_4$) or iron chloride ($FeCl_3$) is added to increase iron intake [9].

- Indonesia: Iron-enriched salts have been widely used, proving to be an effective method for iron supplementation.
- Uzbekistan: 1 kg of table salt is enriched with 40–50 grams of iron sulfate ($FeSO_4$) or iron chloride ($FeCl_3$). This results in approximately 40–50 mg of iron per kg of salt.

Iron sulfate ($FeSO_4$) or iron chloride ($FeCl_3$) is usually added to salt at concentrations ranging from 0.1% to 0.5%

0.1% concentration 1 g of iron per kg of salt.

0.5% concentration: 5 g of iron per kg of salt.

Technological Solutions: Countries such as the U.S., China, India, European nations, African countries, and Latin America use iron cookware in traditional kitchens, which naturally enhances iron intake and improves health.

Iron pans (e.g., cast iron skillets or stainless steel cookware) can be used to increase iron levels in water and food.
This method helps introduce natural iron ions into water, facilitating a chemical reaction with salts for purification.
Particularly beneficial for softening hard water (high mineral content) and addressing iron deficiency. Uzbekistan can benefit from Germany and Singapore's experience in water resource management.

Modern purification technologies, infrastructure upgrades, and water conservation techniques can enhance the country's water supply.

In conclusion: This study scientifically examines the relationship between anemia and drinking water composition. Artificial intelligence (AI) is used to analyze water composition, producing real scientific findings. This research not onlydevelops students' inquiry-based research skills but also fosters an awareness of environmental issues.

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