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ENHANCING STUDENTS' DATA LITERACY, ANALYTICAL AND INTERPERSONAL SKILLS USING INFOGRAPHICS IN BIOLOGY CLASSROOM

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Abstract: Infographics is one of the new educational tools used to provide information to its readers through various visual media such as texts, images, pictures, charts, graphs, etc. The use of infographics is becoming more widespread in both advertising, business and educational environments. This study shows how the use of infographics for educational purposes, improve analytical, interpersonal skills and data collection among students of different ages. The participants in the study were 11th grade students with advanced biology to prepare for the UNT and 8th grade students from a school with a physics and mathematics background and therefore few biology hours. The study was attended by 74 people, who were further divided into control and experimental groups based on the quasi-experimental method. According to the results of the study, the participants found infographics instructive and preferred to use them in core learning processes. In addition, infographics increase interest and motivation in the lesson process, which helps students to memorize key terms on certain topics better. Thus, this study reveals that infographics have increased analytical abilities, interpersonal and data collection skills.

Key words*: infographics, analytical ability, interpersonal skills, data collection, bilology*

Graphics and illustrations have historically served as paramount mediums for conveying information, dating back to ancient times with cave paintings, Egyptian frescoes, and orthodox icons. In the contemporary era, technology has revolutionized the synthesis and transmission of information through the advent of infographics, which are increasingly utilized within educational settings such as schools. Present-day education mandates proficiency in analytical skills, data literacy, and robust interpersonal competencies to thrive in evolving landscapes. These proficiencies facilitate effective collaboration, data evaluation, and expression of data-driven concepts, necessitating diverse methods for their cultivation, with infographics emerging as a potent tool for fostering such skills through visual representation.

The utilization of infographics stands as a potent method for visualizing information, enhancing its comprehension and retention. In response to the burgeoning need to process and disseminate vast data sets, infographics have ascended as a prominent communication tool across various domains including business, advertising, and media. Beyond mere aesthetic appeal, effective infographics possess intrinsic semantic depth and allegorical significance, distinguishing them from conventional graphics and illustrations. By integrating concise textual components, graphs, flowcharts, and pictograms, infographics stimulate imaginative and associative cognition, fostering

diverse interpretations of information. Consequently, infographics have assumed paramount significance within educational contexts, particularly in disciplines like biology, where they facilitate the elucidation of intricate concepts, processes, and data, rendering them accessible and comprehensible to students.

Location of study and participants

The research was carried out in 2 schools in Almaty and Astana cities. Researcher conducted the research at the National School of Physics and Mathematics in Astana city (NSPM), and conducted the research at the DOSTYQ SCHOOL in Almaty.

Both schools have characteristic differences in the educational program of biology compared to most schools in Kazakhstan. At NSPM number of biology lessons are 2 times lower than in common schools due to specification on physics and mathematics. At the same time, DOSTYQ SCHOOL focuses on preparation for the final exams (UNT). Thus, the DOSTYQ SCHOOL combines the functions of a regular school and an educational center.

The study involved 74 students among grades 8 and 11 (Table 1)

Table 1 *Number of participants according to grade and school*

GRADE	TOTAL NUMBER OF STUDENTS	SCHOOL
8th grade	51	NSPM
11th grade	23	DS

Quasi-experimental research design

In this study, a quasi-experimental research design was used to investigate the effectiveness of using infographics to enhance students' data literacy, analytical and interpretation skills in biology classrooms. The study was conducted in two different settings: Researcher conducted the study in a middle school biology classroom (8th grade) and conducted the study in a high school biology classroom (11th grade).

All participants were assigned to either the experimental or control group. Both experiments involved five lessons on different topics of biology. In the experimental group, students were taught using infographics to help them develop their data literacy, analytical and interpretation skills. In contrast, the control group was taught using traditional teaching methods. At the beginning of the study, all participants completed a pre-test to assess their baseline knowledge of the subject matter.

As part of the work of Researcher, 2 8th grade classes were divided into experimental and control groups with 25 and 26 students. High school groups included 12 and 11 people, respectively. (Table 2)

Table 2 *Number of participants according to control and experimental groups*

GRADE	CONTROL GROUP	EXPERIMENTAL GROUP
8th	26	25
11th	12	11

Infographic topics

For the study, 5 topics were selected, according to the content of which 2 infographics were prepared for each lesson. According to Table 3, the total number of infographics is 20. Topics were selected based on the sections that these classes go through according to the Calendar and Thematic Planning of the Ministry of Education of the Republic of Kazakhstan.

Table 3 List of topics that are taught using infographic topics

GRADE	INFOGRAPHIC TOPICS
Middle school (8th grade)	1. The structure of the organs of the urinary system. The structure of the kidney 2. Life cycle of mosses and ferns. Gametophyte. Sporophyte. Life cycle of gymnosperms and angiosperms. 3. The structure of the organ of vision. Visual disturbances. Vision hygiene. 4. The structure of the organ of hearing. Causes of hearing loss. Hearing hygiene. Structure and function of rods and cones, hair cells. 5. Humoral regulation. Location and functions of endocrine, exocrine and mixed glands. Diseases caused by dysfunctions of the endocrine glands
High school (11th grade)	1. CNS. Departments of the nervous system according to their functions 2. Cell cycle. Mitosis and meiosis. Amitosis 3. Biosphere. Ecosystem. Population. Ecological pyramid. Trophic levels. Relationship types. 4. Microbiology. Biotechnology. Viruses and bacteria. 5. Global warming. Modeling. Pesticides. Greenhouse effect.

Data collection

(1) Pre-test results

The purpose of the pre-test is an initial assessment of students' knowledge and obtaining primary data on students' skills in relation to the selected topics. The questions were designed according to Bloom's Taxonomy, including a variety of mental skills.

(2) Post-test results

The purpose of the post-test is to evaluate and collect data on the results of the educational process using infographics. Test results will be analyzed for progress in general knowledge as well as a separate skill analysis through a keyword comparison table

(3) Survey for 8th grade students

The purpose of the survey is to collect reflections from middle school students (8th grade), which will provide feedback on the effectiveness of using infographics. Also, the results of the survey should show topics that were problematic to learn even with the use of infographics.

(4) Survey for 11th grade students

The purpose of the survey is to collect reflections from high school students (11th grade), which will provide feedback on the effectiveness of using infographics. Also, the results of the survey should show topics that were problematic to learn even with the use of infographics.

(5) Interviews with teaching staff

The interview is a qualitative data collection method for this study. A guest was invited to the first and last lesson to observe the students. The transcript of the interview will give an unbiased opinion on the benefits of using infographics in biology classes. And the analysis of the transcript will show the theses of the interviewee.

(6) Interview with student

The interview is a qualitative data collection method for this study. The interviewer will receive qualitative information from the student, compared to a survey, where most of the data is provided by a quantitative method. The analysis of the transcript will show the theses of the interviewee.

EXPECTED RESULTS

The quasi-experimental method provided insights into the efficacy of infographics in biology instruction, revealing increased general knowledge, improved information literacy, and enhanced interpersonal and analytical skills. Notably, infographics usage demonstrated consistency in curriculum development compared to traditional instruction methods.

Characteristics of the Sample: The study encompassed 51 8th-grade students from NSPM and 23 11th-grade students from Dostyk School, divided into experimental and control groups. The experimental groups engaged with biology topics using infographics, while the control groups received traditional instruction.

Pre-test Results: Pre-test scores indicated modest initial knowledge levels, with slight variations between experimental and control groups across different question types. Notably, the control group outperformed the experimental group in most question categories.

Post-test Results: Post-test results showcased significant improvements in both experimental and control groups, particularly in analytical skills and knowledge retention. Despite variations in prior knowledge, infographics demonstrated effectiveness in enhancing academic performance, especially in open-ended question categories.

Survey Results for 8th Grade Students: Survey findings highlighted positive student perceptions of infographics, with most students finding them extremely or very useful for comprehension and retention of biology material. Infographics also increased student interest and participation in biology classes.

Survey Results for 11th Grade Students: Similar to 8th-grade students, 11th-grade students perceived infographics as useful tools for learning, particularly in simplifying complex information and increasing subject interest. Additionally, infographics were viewed as effective aids in preparing for assessments, including the Unified National Testing.

Overall, the results underscored the effectiveness of infographics in biology education, with students acknowledging their utility in comprehension, retention, and engagement with course material.

CONCLUSION

Infographics are a valuable tool to help make biology lessons more engaging and effective. Thus, the positive aspects available in infographics have helped students to develop various qualities and skills in the learning process. The use of infographics as a medium to facilitate the learning of biology students at different academic levels is a tool that enhances students' data literacy, analytical and interpersonal skills. Moreover, the use of infographics as a learning tool contributed to students' better comprehension of continuous text.

Based on the research conducted using a quasi-experimental method, interviews with a chemistry teacher and a vice principal, as well as interview with 11th-grade student, the following conclusions can be drawn regarding the use of infographics in the biology classroom to enhance students' data literacy, analytical skills, and interpersonal skills:

- Infographics positively impact data literacy: The use of infographics in the biology classroom has shown to improve students' data literacy skills. By presenting complex information in a visual and organized format, infographics help students understand and interpret data more effectively. This enhances their ability to analyze and draw conclusions from scientific data.
- Infographics enhance analytical skills: Through the visual representation of information, students are encouraged to analyze and synthesize data, identify patterns, and make connections between different concepts. This analytical thinking promotes a deeper understanding of biological concepts and their interrelationships.
- Infographics improve interpersonal skills: Collaborative activities involving the creation and discussion of infographics encourage students to work together, communicate their ideas effectively, and engage in constructive peer interactions. This fosters teamwork, empathy, and active participation, leading to improved interpersonal skills among students.

Although the findings cannot be generalised to all levels of students in different areas and other programmes, the results nevertheless show that students had a generally positive attitude towards the use of infographics in the classroom. Infographics can help students understand complex concepts and succinctly present the flow of complex information.

In conclusion, learning using infographics plays an important role in education, especially helping students improve analytical skills, interpersonal communication and data handling.

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PYTHON SCRIPTED K-MEANS CLUSTERING ON PCA-TRANSFORMED DIVERSE ECOLOGICAL DATA

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Soil microbial communities are diverse and complex, comprising various taxa with distinct ecological roles. Principal Component Analysis (PCA) transformation followed by K-means clustering enables researchers to discern underlying patterns in microbial community structure based on multiple environmental variables[1]. This approach can identify clusters of samples with similar microbial composition and abundance profiles, shedding light on community dynamics and interactions. Soil microbial diversity is crucial for ecosystem functioning and resilience. By clustering PCA-transformed ecological data, scientists can classify soil samples into groups representing different levels or patterns of microbial diversity. Understanding the distribution of microbial diversity across landscapes or under different management practices is vital for ecosystem management and conservation efforts.

K-means clustering seeks to divide data into k clusters, ensuring that data points within each cluster are similar and separated from points in other clusters. Essentially, the algorithm determines k centroids and assigns each data point to the nearest centroid, striving to minimize centroid size. PCA aims to discover a fresh set of variables known as principal components, derived as linear combinations of the original features. These components are selected to maximize the explanation of variance within the data[2]. The primary principal component captures the most substantial variability, succeeded by subsequent components in descending order of importance. Using K-means clustering and PCA together enables the categorization of complex ecological sample data into separate clusters according to their attributes, streamlining the analysis of extensive datasets.[3] In the fields of agroecology and soil science, this method facilitates comparison across diverse data types such as soil chemistry, agricultural practices, microbial composition, and geographical factors.

In this study, the random soil microbial composition and soil characteristics dataset was generated via scikit-learn Python package. All statistical analysis was performed in Google Colab workflow. To successful statistical representation it is recommended to select proper variables, which represent ecosystem of interest (in the case of soil microbial ecology, the best measurements are soil pH, nitrogen, carbon and microbial composition for instance). In considering various different measurements it is necessary to avoid multicollinearity, otherwise, the model is redundant. After selection and normalization of dataset, the dimensionality of data was reduced and simplified via implementing PCA by sklearn package[4]. Now simplified data was proceeded K-means clustering, also with sklearn. Such machine learning technique organizes each data point into clusters with shared characteristics, highlighting similarities and distinctions. In this study, 3 clusters was used, but depending on any data availability it may be changed. The analyzed clusters shows how soil parameters relate to microbial diversity.