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The Effect of Using Word Cloud in Primary School Science Teaching on the Cognitive Structure of Students[1]

Ebru Deniz *, *Minister of National Education, Turkey*
Güntay Taşçi, *Erzincan Binali Yıldırım University, Faculty of Education, Turkey*

*Corresponding Author: ebrudeniz246@gmail.com

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Abstract

This study investigated the effects of creating word cloud activities on students' cognitive structures in a fourth-grade science course in primary school. The study was semi-experimental research, included 38 primary school students, and used the word association test for data collection. In data analysis, Mann Whitney-U Test and Wilcoxon Signed-Rank Test as the non-parametric tests, and their parametric equivalents were used together. Within the scope of the study, whereas the word cloud activity was performed in the experimental group, the teacher-centered teaching activity was conducted in the control group. The study's findings showed no difference between the groups in concept remembering but in meaningful propositions in favor of the experimental group.

INTRODUCTION

Technology innovation has affected many education areas and resulted in changes in curriculum, learning environment, learners' and teachers' roles, and teaching approaches (Alpar, Batdal & Avcı, 2007). Individuals who embrace change can develop into capable learners who can access information, acquire effective learning strategies, and apply their knowledge to real-world situations (Orkun & Bayırlı, 2019). Thus, learners must first be able to cope with technology. Therefore, students should also be provided with opportunities for active participation in the teaching process (Somuncuoğlu & Yıldırım, 1998). For teachers to meet these expectations, they must assign learning responsibilities to students and incorporate appropriate technologies into the instructional process while considering the technological advancements of the time (Gülcü, Aydın, Koçak & Solak, 2013). Technological developments have led to the occurrence of various Web 2.0 applications. O'Reilly (2005) reported that Web 2.0 encompasses all tools and activities that enable the creation of an interactive instructional environment. Horzum (2010) defines that Web 2.0 involves various devices and applications that allow people to experience multiple applications. By another definition, Alexander (2006) describes Web 2.0 as an interactive social software that lets users share ideas and participate in online activities. With today's technology, Web 2.0 offers conveniences and support for people of all ages, such as quick and easy access to data, interactive designs, sharing, and saving (Altun,

2008). Thus, beneficiaries can generate, edit, save, share, and evaluate products on the internet using Web 2.0 tools comfortably (Altıok, Yükseltürk & Üçgül, 2017; Elmas & Geban, 2015). Therefore, many passive users have become individuals who actively create, share, evaluate, interpret, and contribute to various types of content on the internet (Chen et al., 2012; Horzum, 2010).

The literature reported that the usage of Web 2.0 applications for teaching is increased, wide various new tools are being developed (Korkmaz et al., 2019; Özipek, 2019; Ramazanoğlu, 2019; Talang & Mahmoodi, 2013). Kahoot (Batıbay & Mete, 2019; Ramazanoğlu, 2019), Plickers (Akbaba, 2019; Akkaya, 2020; Korkmaz et al., 2019), Edmodo (Özkan, 2017), Padlet (Özipek, 2019), Storybird (Karadağ, 2018), Word Cloud (Afurobi et al., 2015; Dağ Gülcan, 2013; Le & Lauw, 2016; Viegas et al., 2009; Viegas & Wattenberg, 2008; Yıldız, 2015) are among the applications discussed in the literature. In these studies, variables such as attitude, motivation, and self-efficacy are noticed to be investigated, as well as variables such as educational benefit, integration into the learning environment, level of use, and academic success. These studies have indicated that Web 2.0 tools can positively affect affective areas such as attitude, motivation, and self-efficacy (Acar & Gülnar, 2018; Akbaba, 2019; Batıbay & Mete, 2019; Orhan & Men Durak, 2018). Additionally, conducted studies reported results on participants creating positive awareness about these tools and these applications using effectively by adopting these tools (Horzum, 2010; Ramazanoğlu, 2019). On the other hand, these applications have been expressed to possibly impact academic achievement (Akkaya, 2020; 2019; Korkmaz et al., 2019).

The word cloud is one of these WEB 2.0 activities. Word clouds are effective and practical tools to facilitate teaching (Perveen, 2021). According to McNaught & Lam (2010), word clouds are expressed as specific visualizations of textual information. Visualization of the text is based on the conversion of word frequencies into a visual representation. Hence, words frequently appearing in the word cloud are emphasized by being more prominent. Since word clouds have become increasingly popular, many different word cloud activities have emerged (Halvey & Keane, 2007). To visualize, users can either load a ready-made text or determine the words themselves through these activities. As Baralt et al. (2011) have mentioned, the activity offers the features of creating a word cloud according to the total word frequency by customizing the font, different themes, colors, and direction and excluding unwanted words.

According to Shavelson (1974), the cognitive structure reflects the concepts and the relationships of concepts in a student's long-term memory. The cognitive structure has also been mentioned to be important in facilitating our learning and retaining what we have learned. At this point, the changes in students' cognitive structure are stated to be necessary for learning (Kurt & Ekici, 2013). Very few studies have been determined to be carried out regarding science courses in the literature on Web 2.0. Moreover, these studies are noticed to be carried out only on science courses' various topics in middle school grades (Akbaba, 2019; Akkaya, 2020; Gürleroğlu, 2019). The word cloud is considered a popular technique for creating an aesthetic and expressive visual representation of textual expressions (Li, Dong & Yuan, 2018). Despite the emphasis placed on the positive potential of word clouds in education, there are only a limited number of studies investigating their impact on teaching when reviewing national and international research (Afurobi et al., 2015; Dağ Gülcan, 2013; DeNoyelles & Foster, 2015; Mansouri, 2015; Miley & Read, 2011; Perry, 2012; Perveen, 2021; Talang & Mahmoodi, 2013; Yıldız, 2015). The present study investigates the effects of word cloud activities on primary school students' cognitive structures in biology subjects in the science course. Through word cloud activities, students were tested on their ability to remember terms and concepts and their

ability to create meaningful propositions. Accordingly, the research problem of the study was as follows:

Does instructing the subject "Our Foods and Their Properties" in the science course using the word cloud reveal significant differences in students' cognitive structures?

Sub-problems related to the study were presented accordingly.

Problems of the Study

1. Is there any significant difference between the groups' pre-test scores?
2. Is there any significant difference between the groups' post-test scores?
3. Is there any significant difference between the pre- and post-test scores of the experimental group?
4. Is there any significant difference between the pre- and post-test scores of the control group?

METHOD

The study groups were determined randomly, but the participants in these groups could not be assigned randomly. Therefore, the study was realized with the pre-and post-test control group design, which was quasi-experimental.

Study Group

The study groups included students in a primary school's 4th class in the 2021-2022 year. Since some students only participated in part of the process, they were excluded from the data analysis. Totally 38 students were contained in the analysis. Table 1 presents the groups' gender frequencies. Accordingly, it is seen that the groups are similar regarding gender rates.

Table 1. The gender distribution of the study groups

Group	Gender	Frequency	Percentage (%)
Control	Female	10	52,63
	Male	9	47,37
	Total	19	100,00
Experiment	Female	9	47,37
	Male	10	52,63
	Total	19	100,00
Total	Female	19	50,00
	Male	19	50,00
	Total	38	100,00

This study's approval was primarily obtained from the Educational Sciences Human Research Ethics Committee at Erzincan Binali Yıldırım University. Additionally, permission to apply was obtained from the Provincial Directorate of National Education, where the study was conducted. The school administration and teachers were informed about the activity. The parents were informed about the participation of the students with the parent consent form, and their consent was obtained. Personal and institutional information was not collected and used in the study.

Development of WAT and Data Collection

In this study, the concept of "Food" was selected to create the Word Association Test. The concept was chosen because it provided a basic structure and general framework for the

subject. This key concept was written 24 times on a page with spaces to write the words the student thought relevant. Each of the four words was followed by a blank to be filled in with an association sentence. In the introduction part of the test, students were instructed on how to take it. A field expert and a classroom teacher analyzed the Word Association Test (WAT) in its present form, and their opinions were asked on suitability. In previous studies using the WAT, 30 seconds was regarded to be the most appropriate time (Bahar & Özatlı, 2003). Due to the study group being primary school fourth graders, the total duration of the study was determined to be ten minutes, including one minute for each section. For equal periods of time, the developed data collection tool was administered to both groups, without interruption, at the beginning and end of the activity.

The Study Process

Process of Preparation

From the "Living Beings and Life" subject area the "Our Food" unit was selected for the activity based on an analysis of the science curriculum and coursebook. In this unit, the subject of "Foods and Their Properties" was chosen, and the activities were planned on two acquisitions in this subject. An emphasis was placed on making the info text concise and simple and including the topic's main topics and key concepts. The info text was finalized by obtaining expert opinions regarding the necessary arrangements. The info text included 475 words. Students in both groups were given the same info-text.

Prior to the activity, "I am Learning with Word Cloud Task Cards" were developed for creating the word clouds in the experimental group. These cards included three questions for the experimental group students to answer using the information texts and coursebook. The researchers created these questions to include the essential concepts of the acquisition areas. In this context, "Basic Food Sources," "Benefits of Foods" and "Food Contents" were structured as different tasks.

Four instructions were given on each task card for creating a word cloud. These instructions included choosing words, writing them in the program, determining their frequency, and customizing the design. For one-course hour before data collection, the Word Association Test was introduced to control and experimental group students, and sample activities were conducted using a different topic's key concepts. The "WordArt" tool was introduced to the experimental group to create the word cloud. Moreover, the students had the opportunity to experiment with the interface related to entering words, the frequency, and customizing the design. Three-course hours were allocated for this process.

Activity Process

The study process was carried out by planning according to the pre-test and post-test control group design. Table 2 summarizes this study process.

The information texts were given to both groups to read as homework on the same day. Upon returning to school the next day, both groups performed the activities with their teachers in their classrooms for three-course hours. The control groups' students studied subjects and activities in the science coursebook with their classroom teachers. This teaching process was carried out as teacher-centered. Classroom teachers used the oral expression method, and open-ended questions from the coursebook related to the topic were included in the course. There were no experiments or technological activities performed aside from this. The teacher conducted a question-and-answer activity in the course's final part.

Table 2. Study process

Group	Pre-test	Activity	Post-test
Control	WAT	1. Giving the Info Text (Home Activity) 2. Teacher-Centered Instruction Appropriate to the Current Curriculum (In-class Activity) (3-Course Hours)	WAT
Experiment	WAT	1. Giving the Info Text (Home Activity) 2. Creating and presenting the word cloud (In-class Activity) (3-Course Hours)	WAT

There was no instruction provided to the experimental group by the teacher. This group's students were given task cards "I am Learning with Word Cloud" in the classroom and asked to complete the tasks using the information text and coursebook. Then, each student got a computer or mobile device and created a word cloud with the words they determined. Using WordArt, they wrote the words in word boxes, weighted the words according to their importance, and customized them (font, size, color, horizontal, vertical, or random customization of words). The prepared word clouds were presented to the class by the students. Creating the word clouds (WordArt activity) during the activity took longer than a one-course hour, whereas the other stages took less than a one-course hour.

Data analysis

Among the words written for the key concept in the WAT, the concepts and terms related to the key concept (protein, carbohydrate, vitamin, fat, water, mineral, plant food, etc.) were classified as conceptual knowledge (CK). The ones that had an indirect relationship with the key concept or sample food in terms of its content (fruit, milk, meat, olive oil, etc.) were classified as indirectly related knowledge (IRK). Likewise, the sentences related to the subject and informative were coded as meaningful propositions (MP) ("They are protein-making and regulatory foods," "Hazelnuts, walnuts are foods containing fat," etc.). On the other hand, the sentences that were independent of the subject and did not contain information ("I drank ice-cold water", "We ran out of butter in our house") were coded as unrelated propositions (UP). In the concepts written after this coding, the concepts coded as conceptual knowledge (CK) and indirectly related knowledge (IRK) were scored 1 point, and unrelated ones were scored 0 points. Similarly, Word Association Test proposition scores were obtained by scoring 1 point to the sentences coded as meaningful proposition (MP).

The distribution characteristics of the scores obtained from the tests were analyzed using descriptive statistics and the Shapiro-Wilk test before the statistical analysis was performed. Thus, it was discovered that the data set had no normal distribution. Non-parametric tests were performed since the data set did not meet the normality assumption. In this study, we utilized the Mann-Whitney U Test for independent groups' comparisons. Additionally, we used the Wilcoxon Signed Ranks test to compare two measurements obtained from the same data source. (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2017). Parametric equivalents of these tests were also used in the study. Since the results were similar, the average values were used to interpret the results.

Validity and Reliability

The Word Association Test prepared by a field expert and a classroom teacher was used in the study. The researcher used a predetermined rule to code the answers given in the concept and proposition analysis of the WAT. Since the coding was based on simple theoretical knowledge on the basis of words and propositions, the coding was shown to another field expert to take the opinion. The classroom teacher and field expert reached a consensus on this. The coding was rearranged and finalized based on the opinions. During the experimental process, identical conditions and materials were provided to both groups, except for the word cloud activity. Since the experimental and control group activities were carried out simultaneously, an interaction between the groups was not possible. The WAT was performed before the procedure to allow both groups to gain experience with the data collection tool.

FINDINGS

For Independent Groups Concept Analysis Results

The statistical results to analyze the difference between the groups regarding the pre-test and post-test scores were presented.

Table 3. Mann-Whitney and Independent Groups t-Test Results

Variable		Group	n	Mean	Std. Dev.	Mann-Whitney	p	t-test	df	p
CK	Pre-test	Control	19	1.36	1.60	193.00	0.70	0.00	36	1.00
		Experiment	19	1.36	2.03					
	Post-test	Control	19	2.15	2.69	141.50	0.25	-1.16	36	0.25
		Experiment	19	3.42	3.89					
IRK	Pre-test	Control	19	12.57	7.14	261.00	0.01	2.73	36	0.01
		Experiment	19	7.26	4.56					
	Post-test	Control	19	16.26	6.99	230.50	0.14	1.17	36	0.25
		Experiment	19	14.00	4.71					

*CK: Conceptual Knowledge IRK: Indirectly Related Knowledge

Table 3 shows that there was no statistically significant difference between groups regarding the pre-test conceptual knowledge ($t_{(36)}$=0.0; p>0.05). This result indicated that the two groups had similar conceptual characteristics at the beginning of the activity. In terms of indirectly related concepts, the difference in pre-test mean was found to be significant (X=12.57) in favor of the control group ($t_{(36)}$=2.73; p<0.05). In terms of the post-test findings, there was no difference between the groups in conceptual knowledge ($t_{(36)}$=1.16; p>0.05) and the indirectly related knowledge ($t_{(36)}$=1.17; p>0.05).

Concept Analysis Findings Related to Dependent Groups

The statistical findings for each group's initial and final results are presented in Table 4. As a result, the difference between the tests' means of the control group was not significant for the conceptual knowledge dimension ($t_{(18)}$=1.68; p>0.05), but significant for the indirectly related knowledge dimension ($t_{(18)}$=3.15; p<0.05). There was a statistical significant difference between the tests' mean of the experimental group in both conceptual knowledge and indirectly related knowledge dimensions ($t_{(18)}$=3.26, t(18)=4.14; p<0.05). Accordingly, it was noticed that whereas the pre-test conceptual knowledge mean was 1.36, it was 3.42 in the post-test. This indicated an increase in conceptual knowledge. It was also revealed that while the pre-test mean was 7.26 in terms of indirectly related knowledge, it was 14.00 in the post-test, and there was a rising end of the process.

Table 4. Wilcoxon and Paired Samples t-Test Results

Group	Variable	n	Mean	Std. Dev.	Wilcoxon	p	t-test	df	p
Control	Pre-test CK	19	1.36	1.60	19.00	0.12	-1.68	18	0.10
	Post-test CK	19	2.15	2.69					
	Pre-test IRK	19	12.57	7.14	17.50	0.01	-3.15	18	0.00
	Post-test IRK	19	16.26	6.99					
Experiment	Pre-test CK	19	1.36	2.03	9.00	0.00	-3.26	18	0.00
	Post-test CK	19	3.42	3.89					
	Pre-test IRK	19	7.26	4.56	14.50	0.00	-4.14	18	0 .00
	Post-test IRK	19	14.00	4.71					

*CK: Conceptual Knowledge IRK: Indirectly Related Knowledge

Propositional Analysis Findings Regarding the Independent Groups

The descriptive statistics and test results regarding the pre-test and post-test scores of the experimental and control groups in the dimension of creating propositions were presented in Table 5.

Table 5. Results for Mann-Whitney and Independent Groups t-Test

	Variable	Group	n	Mean	Std. Dev.	Mann-Whitney	p	t-test	df	p
Pretest	MP	Control	19	0.89	1.19	156.50	0.64	-0.87	35	0.38
		Experiment	18	1.33	1.81					
	UP	Control	19	4.78	1.96	225.50	0.09	1.67	35	0.10
		Experiment	18	3.61	2.30					
Posttest	MP	Control	19	1.36	1.70	23.00	0 .00	-7.44	35	0 .00
		Experiment	18	5.05	1.25					
	UP	Control	19	4.26	1.91	305.00	0 .00	5.80	35	0 .00
		Experiment	18	1.11	1.32					

*MP: Meaningful Proposition UP: Unrelated Proposition

When the table was analyzed, it was noticed that the difference between the pre-test scores of the groups was not statistically significant before the experimental activity (MP: $t_{(35)}$=0.87; UP: $t_{(35)}$=1.67; p>0.05). These findings indicated that the cognitive structures of the groups before the experimental activity were similar in terms of propositional, that is, conceptual relations. After comparing the post-test results of the groups, it was found that there was a statistically significant difference in favor of the experimental group in terms of meaningful propositions and in favor of the control group in terms of unrelated propositions (MP: $t_{(35)}$=7.44; UP: $t_{(35)}$=5.80; p>0.05). Considering that the increase in meaningful propositions and the decrease in unrelated propositions indicated an improvement in cognitive structure, the fact that the mean of unrelated propositions was statistically significantly lower in the experimental group than in the control group was a positive indication of improved cognitive structure. Therefore, at the end of the application, the number of unrelated propositions decreased, and the number of meaningful propositions increased in the experimental group compared to the control group. Accordingly, it was concluded that the experimental group was more successful at creating

meaningful relationships between concepts, and the number of unrelated propositions decreased as a result. Hence, word cloud activity performed in the experimental group was found to be associated with meaningful relationships in the cognitive structure of the participants.

Propositional Analysis Findings Regarding the Dependent Groups

Table 6 presents the statistical analysis results of paired t-test. Accordingly, the difference between the mean scores of MP and UP is not significant in the control group ($t_{(18)}$=1.34, t(18)=1.48; p>0.05). Contrarily, there was a significant difference between the experimental group's meaningful proposition ($t_{(18)}$=9.06; p<0.05) and unrelated proposition ($t_{(18)}$=4.12; p<0.05) pre-test and post-test scores.

Table 6. Wilcoxon and Paired Samples t-Test Results

Group	Variable	n	Mean	Std. Dev.	Wilcoxon	p	t-test	df	p
Control	Pretest MP	19	0.89	1.19	19.00	0.22	-1.34	18	0.19
	Posttest MP	19	1.36	1.70					
	Pretest UP	19	4.78	1.96	29.00	0.13	1.48	18	0.15
	Posttest UP	19	4.26	1.91					
Experiment	Pretest MP	18	1.33	1.81	0.00	0.00	-9.06	17	0.00
	Posttest MP	18	5.05	1.25					
	Pretest UP	17	3.82	2.18	125.50	0.00	4.12	16	0.00
	Posttest UP	18	1.11	1.32					

*MP: Meaningful Proposition UP: Unrelated Proposition

Whereas the pre-test meaningful proposition mean of the experimental group was 1.33, it increased to 5.05 in the post-test. The unrelated proposition, the mean was 3.82 in the pre-test, but it decreased to 1.11 in the post-test. This finding indicated that meaningful propositions increased and unrelated propositions in the cognitive structure of the experimental group decreased. In the control group, there was no significant difference in terms of establishing a relationship between the concepts during the activity.

CONCLUSION, DISCUSSION AND SUGGESTIONS

This study investigated the effect of word cloud activity in biology subjects on the cognitive structure of primary school fourth-grade students at conceptual and propositional levels. The content of this activity was based on the subject of "Foods and Their Properties" and two learning outcomes in this subject. Beginning of the study, the groups had no significant difference in the cognitive structure to related subjects in terms of conceptual knowledge and propositions. Nevertheless, at the end of the instructional process, there was no significant difference in conceptual remembering between the groups, but a significant difference was observed in creating meaningful propositions between concepts.

It was observed that the experimental group improved in writing meaningful propositions, whereas they had a decrease in terms of unrelated propositions in their cognitive structure. However, the control group did not improve statistically significantly. Accordingly, word cloud activities were beneficial for students in terms of acquiring essential concepts of the subject and associating them. Similarly, in the literature, word clouds were reported to improve students' skills contributing to their cognitive structures, such as remembering words and keeping them in memory (Afurobi et al., 2015; DeNoyelles & Foster, 2015; Miley & Read, 2011; Talang &

Mahmoodi, 2013; Yıldız, 2015). According to the literature, the use of Web 2.0 tools in educational environments contributes in various ways to the instructional process (Batıbay & Mete, 2019; Horzum, 2010; Mansouri, 2015; Talang & Mahmoodi, 2013). Moreover, studies on word clouds as a Web 2.0 tool have shown that this activity makes the course more enjoyable and motivates students to learn while also being an easy tool to support learning, as highlighted by Miley and Read (2011). The present study revealed that the Web 2.0 tool provides ease of use and positively influences their learning process allowing primary school students to create word clouds independently. Additionally, it has been found that students have improved their ability to establish meaningful connections between biology concepts and terms during the science course.

Suggestions

The study included the process of students' creating a word cloud in the WordArt application using important words or concepts. The results related to this activity revealed that primary school students were able to easily use the appropriate Web 2.0 tool after becoming familiar with it. Students could be introduced to these tools at different stages of the instructional process, and these could be used for teaching purposes. In this sense, teachers can use appropriate word cloud applications, implement these activities in other subjects and courses, and contribute to the education process in terms of different criteria. In addition, researchers could contribute to the literature by investigating these processes in terms of different variables. As part of this context, their effects on different variables such as creative thinking, critical thinking, and design skills should also be analyzed besides the students' cognitive structures. Another usage area of word clouds was the opportunity to develop different teaching materials by teachers or for teachers. Relatedly, investigating the effects of these ready materials on students would contribute to the literature.

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ChatGPT - Science Education and Instruction Reshapes Management

M. Said Doğru *, *Kastamonu University, Araç Rafet Vergili Vocational School, Turkey*

*Corresponding Author: msaid.dogru@yahoo.com

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Abstract

Artificial intelligence has transitioned from being a mere fictional concept depicted in novels and movies to a practical reality. However, its integration into science education and instructional management has been a gradual process. The emergence of chatbots like ChatGPT, powered by extensive training on internet-derived textual data, has revolutionized the way we approach science education. While this technology brings numerous advantages, it is crucial to exercise caution and thoughtful consideration regarding its application.

INTRODUCTION

Over time, Artificial Intelligence (AI) has undergone significant advancements and has transformed into a tangible aspect of our lives. Initially, it was envisioned as a way to replicate and automate human thought processes and logical reasoning. This concept, once considered futuristic and reminiscent of science fiction movies such as 'The Matrix' and 'The Terminator,' has now become a part of our everyday reality. We are currently living in the era of "big data," where the application of AI can be observed in various industries, including technology, banking, marketing, entertainment, and many others. From navigation tools like Google Maps to facial recognition technology and virtual assistants like Siri and Alexa, AI's impact and presence continue to expand and shape our world (Adamopoulou & Moussiades, 2020).

Language processing capabilities, in particular, are advancing rapidly in the realm of AI (Deng & Lin, 2022). Chatbots, such as ChatGPT, Jasperchat, DialoGPT and Replica, along with transcription technologies like Otter.ai, are at the forefront of this progress. Among them, ChatGPT stands out for its remarkable ability to generate high-quality content. Developed by OpenAI, ChatGPT is a large-scale language model that has gained significant recognition (Deng & Lin, 2022).

In essence, AI, particularly in the form of language models like ChatGPT, has emerged as a transformative force. Its potential applications are vast and varied, with implications across

numerous fields. As technology continues to advance, the impact of AI is likely to expand even further (Khan et al., 2023).

Use of Artificial Intelligence in Education

Education is undergoing more and more transformations under the influence of technological advances. An important component of this transformation is the use of artificial intelligence (AI) technologies in educational processes. AI can be defined as a field that allows computer systems to imitate human-like intelligence and learning abilities (Sucu & Ataman, 2020). The use of AI in education offers the potential to increase student achievement, improve teacher performance, and provide more personalized learning experiences (Tapalova & Zhiyenbayeva, 2022). However, it should be noted that this use brings some opportunities and challenges.

Opportunities:

Individualized Learning: AI can offer personalized learning materials tailored to student's needs and learning styles. It can make learning experiences more effective by providing students with tailored feedback and learning roadmaps (Arslan, 2020).

Teacher Support: AI can lighten teachers' workload and provide them with more time and resources. Automatic rating systems and data analytics tools that teachers can use in assessment processes can speed up assessment processes, and provide a more objective assessment.

Student Tracking and Early Intervention: IA can be used to monitor students' progress and intervene early. With data analytics and machine learning algorithms, it may be possible to identify students' learning difficulties or needs and appropriate interventions can be planned accordingly.

Challenges:

Ethical Issues: Significant ethical issues may arise with the use of AI. For example, issues such as student privacy and data security must be properly addressed and protected. Also, concerns that AI systems may lead to prejudice or discrimination should be taken into account (Masters, 2023; Kim & Kwon, 2023).

Teacher-AI Interaction: Rather than literally replacing the teacher, teacher-OR collaboration is an important issue. Proper use of AI systems by teachers still plays a critical role in understanding students' needs and responding appropriately.

Technology Access and Inequality: AI technologies need to provide equal access and reduce the digital divide. All students should have access to AI technologies, and fair policies should be adopted so that technology use does not become a source of inequality (Metin & Bahat, 2020).

The use of artificial intelligence in education brings many opportunities and challenges. When managed properly, AI can improve students' learning experiences, support teachers and help reduce inequalities in education. However, it is important to address challenges such as ethical issues, teacher-artificial intelligence interaction and technology inequality (Çelik, 2023). Therefore, the use of artificial intelligence in education is a process that requires careful planning, cooperation between education stakeholders and compliance with ethical standards.

Discovering the basic principles of science in the minds of students and being able to understand the natural world has made science education a discipline that makes it important. New opportunities in science education have a significant potential to increase learning experiences with the rapid advancement of technology, especially with the development of artificial intelligence (Goralski & Tan, 2020). Artificial intelligence has become an important function in providing a science education at the point of individualizing students, strengthening their interactions and solving problems (Moreno-Guerrero et al., 2020). In this study, the potential and possibilities of using artificial intelligence in science education were examined.

Potentials:
1. Virtual Laboratories and Simulations: Students can find the opportunity to try experiments and activities that they cannot do in real life through virtual laboratories and simulations with artificial intelligence. Thus, scientific concepts can be understood more clearly by students, and progress can be made in scientific thinking skills with the application of experiments.

2. Data Analysis and Prediction: In science education, AI can provide feedback to students and predict science events by analyzing large amounts of data. Based on real-time data, it allows students to analyze their results and conduct data-driven studies in science.

3. Student Monitoring and Personalized Learning: AI can monitor student's progress and provide students with personalized feedback and learning materials. This can increase student success by allowing students to identify their weak areas and work more effectively accordingly (Vorst & Jelicic, 2019).

Facilities:
1. Teacher Support: In science education, artificial intelligence provides important support to educators and teachers, as well as the progress of students on the subject can be monitored carefully with artificial intelligence. Course programs and plans can be arranged according to the subjects that students need. While doing all this, ChatGPT can also give an idea about how teaching materials can be used more efficiently (Chiu et al., 2023).

2. Motivation and Interaction: It is related to the motivation of students towards science subjects in order to learn science subjects and concepts better. Here, artificial intelligence can bring the student's motivation to the highest level by interacting in the context of the subjects. Here, by increasing learning experiences, it can increase interaction in this sense by establishing interactive connections such as rewards and gamification of items (Huang, Lu & Yang, 2023).

3. Teacher Training: Teacher training is very important for the effective delivery of science education. Here, increasing teacher education with artificial intelligence can be used more effectively thanks to these technologies. In order for artificial intelligence applications to be used effectively in the classroom environment, artificial intelligence-based usage skills of such tools can be added. Teacher education can be increased to higher levels by gaining such skills to teachers (Mohammed et al., 2021).

In conclusion, artificial intelligence in science education has the potential to transform learning. Facilities such as virtual labs, data analysis, personalized learning, and teacher support can make science education more interactive, engaging, and student-centered. However, for its successful implementation, educators need to ensure the ethical use and

proper integration of GI (Sijing & Lan, 2018). Artificial intelligence can offer very important opportunities to increase students' interest in science and improve their scientific thinking skills.

Effects of Using ChatGPT in Science Education

The quality of science education is important for the easier understanding of science subjects and concepts and the development of scientific thinking skills. In this sense, it has become an important discipline area. This importance emerges with the rapid development of technology with artificial intelligence. Here, he develops his learning experiences with language models based on artificial intelligence. Thanks to these models, ChatGPT can provide students with information about science topics, answer questions and guide their learning processes by interacting with students. The use of ChatGPT to increase learning and communication in science education reveals new discourses (Alam, 2021).

1. Technology-Student Interaction: As stated above, ChatGPT can communicate with students through a natural language model. Here, students can ask questions to ChatGPT, request information, and request explanations about the subjects. In this way, ChatGPT can interact with users and provide them with positivity at the point of active learning. By doing this, students will be able to learn the subject and concepts better.

2. Question-Answer and Lecture: In this part, answering and explaining questions about science subjects can be done by ChatGPT. Here, students can talk about different topics with ChatGPT and contribute significantly to their learning as they reinforce the concepts and learn more deeply (Ray, 2023).

3. Teacher Support: ChatGPT can also offer support to teachers. Teachers can use ChatGPT in a classroom setting to provide students with additional resources and learning materials. In addition, teachers can provide more interaction and feedback and improve classroom time management with ChatGPT answering students' questions.

4. Customized Learning Experience: ChatGPT has the potential to provide students with a personalized learning experience. Adaptable to students' needs and learning speeds, ChatGPT can provide students with customized guidance and support. Thus, an environment can be created where each student can progress at their own pace and receive additional explanations on the subjects they need (Kasneci, 2023)

The use of language models such as ChatGPT in science education has the potential to support student-teacher interaction and enrich the learning experience. Their ability to answer students' questions, explain topics, and offer customized guidance can make science subjects more understandable and interesting. However, ethical issues regarding the use of ChatGPT and the limitations of the language model must be considered. In order to use ChatGPT successfully in science education, teachers' guidance and correct guidance is important (Cooper, 2023).

The Purpose of Study

The main objective of this article is to explore the transformative effects of artificial intelligence-powered chatbots like ChatGPT on science education and instructional management. It aims to delve into the potential impacts, advantages, and challenges that ChatGPT brings to the realm of science education and teaching administration. Moreover, the article highlights the growing significance of artificial intelligence in education and examines

how the interaction between education experts and artificial intelligence is evolving. Its purpose is to elucidate the advancements of AI-based technologies in science education and instructional approaches, create awareness among teachers and educators in this field, and initiate a discussion on the benefits and challenges associated with these novel technologies.

Using Chatgpt as a Tool in Science Education

The utilization of language-based tools like ChatGPT in science education serves the purpose of facilitating student engagement with scientific topics and enhancing their learning journeys. The incorporation of ChatGPT in science education can be elucidated as follows:

1. Question-Answer Interaction and Information Distribution: ChatGPT plays an important role in answering questions about scientific issues and distributing information about these issues. Here, students can search for ChatGPT's descriptions and definitions using natural language. As a result of these searches, appropriate answers are given by ChatGPT, and students are enlightened on the point of scientific knowledge (Lee, 2023).

2. Detailed Explanation: ChatGPT is of great importance in narration or promotion. In particular, they can explain science subjects and concepts in detail. While making these explanations, it can enable students to learn concepts more deeply with detailed examples. This situation enables students to understand the subjects and concepts better and settle them in their minds. Because of all these, it may be sufficient to express this artificial intelligence application as an important tool in the permanent learning of subjects and concepts in minds (Santos, 2023).

3. Private Guidance: Individual guidance services can be offered to students through ChatGPT. ChatGPT can be used to ask in-depth questions about specific topics and further clarify concepts. Accompanying students throughout their learning journey, necessary additional explanations and support are provided through ChatGPT.

4. Fostering Communication Skills: By engaging with ChatGPT, students are encouraged to enhance their written and verbal communication skills. Through natural language interaction with ChatGPT, students can inquire, express their understanding of concepts, and receive responses. This process aids in strengthening their communication abilities and articulation of science-related topics.

Artificial intelligence tools can also be used as an effective learning tool. The fact that these tools are language-based contributes more to learning. In this context, ChatGPT not only provides information support to students, but also contributes to increasing their communication skills. Teachers can also use it as a resource and support tool. For this reason, ChatGPT can take an important place in a permanent and effective science education.

On the other hand, the artificial intelligence tool ChatGPT can understand and use human language with its unique bilingual feature. Although it does not completely replace the teacher, it is an effective tool in science education. It is a suitable environment for students to present their knowledge subjectively, practice and develop speech-based answers. This potential extends not only to science education but also to the realm of health education (Sallam, 2023; Khan et al., 2023).

ChatGPT provides feedback to students about language use and writing styles, and provides an important gain in terms of improving students' scientific knowledge. This situation can

have a much more beneficial effect, especially on students whose native language is not English, and this situation is expressed in studies (Kohnke, Moorhouse & Zou, 2023). Apart from the field of education, the usability of ChatGPT was discussed in the field of health education, especially within the framework of patient interviews. Here, students can practice concepts such as medical history and symptoms by interacting with the artificial intelligence application (Kung et al., 2023; Seetharaman, 2023).

Better Use of ChatGPT In Science Education

Access to educational information and resources is very easy, especially in the digital age, where online resources are frequently used. Contrary to this ease, misunderstandings and interpretations can be encountered in the learning processes. Students need to make serious efforts to understand science subjects and concepts. In this sense, ChatGPT can be used as an important tool in their own upbringing. Here, ChatGPT can be used as an important teaching strategy for small group assessment (SGA). Students' course materials (books, magazines, etc.) can be increased in terms of source variety through ChatGPT by teachers during the small group assessment process. Thus, it can be ensured that the concepts become more meaningful and permanent in the minds. By emphasizing that students' answers should exceed those provided by ChatGPT, it reinforces the idea that science teachers should always possess superior knowledge compared to an online search engine. Consequently, ChatGPT can serve as a benchmark for students to strive for in their pursuit of science education. By comparing their own responses with those generated by ChatGPT, students can identify any gaps in their understanding and actively work towards bridging them. This scenario is encountered across diverse professional fields and educational contexts (Seetharaman, 2023).

With the feedback feature of ChatGPT, this artificial intelligence application, it can provide significant support in improving students' subjective expressions of scientific knowledge about their writing styles and language use. It is clear that this situation will help students whose mother tongue is not English to define their knowledge and skills and will provide important support in the difficulties encountered (Kohnke, Moorhouse & Zou, 2023). Apart from this, ChatGPT can be used actively to simulate experiments and activities of students. In this way, the interactive practice of knowledge can be realized. ChatGPT plays a valuable role in providing feedback on the comprehensiveness and accuracy of information gathered, assisting students in honing their communication skills and clinical judgment. Beyond its applications in science education, ChatGPT can serve as a tool for evidence-based science education and experimentation. Students can utilize ChatGPT to design experiments and receive suggestions for potential teaching approaches based on existing literature. This nurtures their capacity to interpret and apply scientific research to real-life situations (Cooper, 2023).

Other Areas Where ChatGPT Can Be Used

In science education, ChatGPT offers more than just surpassing the knowledge available through online search engines. Students have the opportunity to utilize ChatGPT to enhance their exam preparation by generating case studies and question papers based on previous year's topics and questions. This approach not only encourages analytical thinking but also facilitates the practical application of acquired knowledge, which are fundamental skills for educators. Moreover, leveraging ChatGPT in this manner enables students to foster critical thinking, problem-solving abilities, and effective communication skills (Kasneci, 2023; Rahman & Watanobe, 2023).

Furthermore, ChatGPT's capabilities can benefit learners in training programs (Rahman & Watanobe, 2023). By leveraging ChatGPT to search for the latest research papers, experiments, and teaching guides, teachers can stay updated and deliver the most effective teaching and learning methods to their students.

While using these effective methods, it also benefits simulation training. Here, it can facilitate the use of virtual laboratories, especially with real-life scenarios. As it is known, virtual laboratories are one of the most important tools that keep students' learning curiosity at the highest level and actively positively affect their learning against the course. ChatGPT provides an important support in transforming simulations into a virtual laboratory for students, revealing participation and realism. Thus, students can learn basic science concepts together with their cognitive skills at the highest level of subjects, concepts and experiments effectively.

Limitations and Disadvantages

While ChatGPT has proven to be a very important tool in science education, it is necessary to consider the limitations and potential disadvantages. One of the major drawbacks here is the risk of student responses being generated via ChatGPT. This situation does not affect students' learning. It leads to a superficial understanding of the subjects. In this sense, it is important for students to understand basic science concepts in order to prevent meaningless learning. Although there is substantial access to current research and development here, the importance of efficient interaction of reasoning in education cannot be fully achieved by ChatGPT. While ChatGPT is thought to help learning significantly, it cannot be expected that this artificial intelligence application should be considered as a tool that replaces human qualities and abilities in education (Lee, 2023).

Moreover, ChatGPT has its limitations in understanding contextual cues and subtle linguistic nuances, which can lead to inaccuracies or misinterpretations in its responses. It is essential to acknowledge that ChatGPT is not a teacher and cannot offer guidance on instructional approaches. Therefore, it is crucial to use ChatGPT as a complementary tool in conjunction with conventional teaching methods rather than a complete replacement. Lastly, the accuracy and dependability of the information provided by ChatGPT can be influenced by the quality of the training data utilized during its development (Seetharaman, 2023).

Measures to Restrict the Use of ChatGPT

With the increase in artificial intelligence applications, their use cases are also considered. Here, in particular, the use of ChatGPT leads to some disadvantages. It may be necessary to take some measures to reduce this use. In particular, to prevent students from using ChatGPT too often, some inputs at the point of using ChatGPT can be limited to subjective expressions of intellectual input. The importance of using ChatGPT as an auxiliary tool by preventing it from replacing books and magazines on the basis of course materials can be explained to students by teachers. It can be perceived as a reference tool. Again, ChatGPT can be transformed into a helpful data set for transforming difficult or obscure concepts into simpler and more understandable expressions. Here, real-life examples can be developed, and ChatGPT can be used for the above purpose. An effective teacher model is important in developing the necessary critical thinking, problem-solving and communication skills. Users or teachers can take advantage of such advantages by making ChatGPT a companion to traditional learning methods by helping the classroom. This situation has also been expressed in different disciplines (health) (Lee, 2023).

Research Ideas for Evaluating the Effectiveness of ChatGPT in Science Education

In addition to the fact that ChatGPT has become a very important tool in science education, there may be some different situations. It is necessary to know that there are limitations and possible disadvantages here. Speaking of these disadvantages, students' high reliance on ChatGPT may lead to deficiencies in learning the subjects, or there may be a lack of in-depth teaching. At this point, it is very important for students to understand basic science concepts. ChatGPT is very important in reasoning and human relations at the point of access to current research and developments. Although mutual empathy and intuitive teaching methods and approaches help ChatGPT at the point of learning, it cannot be expected to function like a human being (Lee, 2023).

Understanding key aspects of ChatGPT language models and responding to some limitations can lead to misunderstandings. Here, it is necessary to accept that this artificial intelligence (ChatGPT) has a guiding role in teaching methods in certain subjects and concepts rather than being a trainer. For all these reasons, it should be seen as a complementary tool that makes an important contribution to the learning of existing teaching methods, not the actual implementer. ChatGPT can be seen as an important tool in order to increase the accuracy and reliability of the information as well as the quality of education data (Seetharaman, 2023). These research ideas can provide a foundation for evaluating the effectiveness of ChatGPT in science education and understanding its advantages. The research can assess various factors such as student achievement, motivation, feedback, teacher perspectives, and deep learning, thereby helping us gain a better understanding of the potential of ChatGPT in science education.

ChatGPT can be used in many different areas. Here, case studies can be used to increase problem-solving, critical thinking and communication skills. Improvements in these skills can take place primarily among students, with various developments taking an active role in ChatGPT. In this way, it is thought that it will make important contributions by playing an active role in the future of science education. The development of these skills may appear as the result of antecedent criteria. As a result, it is thought that ChatGPT, as a product of artificial intelligence, will play an important role in improving the knowledge and skills of users (students) and shaping education.

Insights for Science Education Professionals

Science educators can explore ChatGPT's development of different abilities in students and reveal useful information. While ChatGPT can be useful in enhancing learning and telling, Feners should not ignore its downsides (limitations) and potential risks. Considering these limitations and risks, these subject matter experts and other application researchers can develop artificial intelligence tools that improve subjective learning and narrative abilities without the risks of addiction and science education. Seetharaman (2023) mentioned these in his study with medical students.

These emerging tools may not only provide answers, but may also encourage inquiry, such as revealing the reasoning behind the answer, explaining it, or allowing the user to choose between them. Thus, new artificial intelligence tools can be useful for students to understand the material better and develop their skills effectively and responsibly. This may contribute positively to science education in the future, as well as increase the quality of preparation for teaching and learning. (Cooper, 2023; Lee, 2023; Seetharaman, 2023).

CONCLUSION

The increase in students' objective knowledge as well as other knowledge and skills related to the subject emerges as an important result. Adequate facilities may be required for this. This opportunity is provided with ChatGPT, which is one of the artificial intelligence tools that has reached a certain level in natural language processing and has been developed. Even if ChatGPT is not an expert trainer in a field, it can have a significant impact on increasing basic knowledge and skills in subjects such as questioning thinking and problem-solving. In addition to this, with ChatGPT, it is possible to conduct experiments, learn information and prepare for the exam. In terms of accessing foreign resources, it can help with some features such as speaking and writing, especially in English or other languages. In the development of science education programs, educators or teachers can benefit greatly from the use of ChatGPT. Because of all these, ChatGPT's contribution to the development of science education is great.

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