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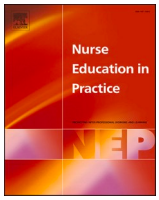

The effect of the use of artificial intelligence in the preparation of patient education materials by nursing students on the understandability, actionability and quality of the material: A randomized controlled trial

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ABSTRACT

Aim: This study was conducted to examine the effect of nursing students' use of artificial intelligence (AI) tools while preparing patient education materials on the understandability, actionability and quality of the material in terms of content.
Background: AI can significantly improve nursing students' learning experiences, helping them to be better prepared for the challenges of a rapidly changing healthcare environment. By ensuring that materials are prepared in accordance with students' individual learning styles, preferences and needs, AI can both improve the effectiveness of educational materials and contribute to better learning outcomes.
Design: This study was conducted as a randomized controlled experimental study.
Methods: The study completed with 180 nursing students (control group = 89; intervention group = 91). The students in the control group used auxiliary tools such as books, journals and websites while preparing patient education materials. The students in the intervention group used AI tools in addition to tools such as books, journals and websites. Patient Education Materials Assessment Tool (PEMAT) and Global Quality Scale were used to evaluate the educational materials.
Results: There are significant differences in students' PEMAT scores between the intervention and control groups in terms of both understandability, actionability and quality ($p<0.001$).
Conclusions: Nursing students' use of AI tools in preparing patient education materials has increased the understandability, actionability and quality of educational materials. The results show that the integration of AI into educational material preparation processes plays an important role in improving the effectiveness of educational contents.

1. Introduction

While nurses assess the health care needs of patients, they also determine their educational needs. The effectiveness of patient education on health outcomes of individuals with different diseases has been proven based on data from many studies (Simonsmeier et al., 2022). What is important in patient education is that the information provided reaches the patient and is understandable by the patient (Bastable, 2017). At the planning stage of the educational process, the nurse selects the educational materials, evaluates their suitability for the patient and uses them (Bastable, 2017; Cutilli, 2020). In addition to verbal education to improve the patient's physical and psychosocial well-being, personalized patient education materials improve patient satisfaction and health literacy, leading to improved patient care (Bhattad and Pacifico, 2022).

It is important to explore how well the principles of patient education are taught and integrated into student nurse practice in undergraduate nursing programs where nurses begin to explore the basic principles of patient education (Richard et al., 2018). While some studies indicate that students have adequate knowledge, skills and abilities to provide

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patient education (Scheckel et al., 2010), others have reported inadequate preparation for health informant roles (Danielson and Berntsson, 2007; Jahromi, 2016). One reason for this inadequacy is that the prepared materials are not understandable and actionable (Zuzelo, 2019). Patient education materials become understandable when individuals from different backgrounds and with different levels of health literacy can process and explain key messages and actionable when individuals can identify what they can do based on the information presented (Shoemaker et al., 2013). Preparing patient education materials in a actionable way is challenging because this process requires taking into account many factors such as patient diversity, different health literacy levels, language and cultural differences (Erbas, 2016). Inadequate understandability and actionability of the materials used in patient education can seriously affect patients' disease perception and health-seeking behaviors (Zuzelo, 2019). In the literature, the main difficulties encountered by students while preparing patient education materials include spending too much time, difficulties in literature review, not knowing how to prepare educational materials, difficulty in applying the acquired knowledge and inability to use time effectively (Demir et al., 2009). Facilitating these difficulties experienced by students will improve the quality of patient education materials and patient education.

Artificial intelligence (AI) offers significant advantages in combining information from different databases. It collects, analyzes and integrates information from different sources to create a meaningful whole. This process reveals relationships between data sets and provides users with comprehensive insights. As a result, AI makes complex data more accessible and supports better decision-making (Duana et al., 2019; Qiu et al., 2016). In this way, AI makes educational materials more understandable by using natural language processing techniques. AI can simplify texts and explain complex concepts in simpler language. This helps patients to better understand information, especially in the health field. AI can create personalized training materials according to the needs of individual patients. This personalization enables patients to receive more relevant and actionable information about their own health status, thus increasing the effectiveness of the educational process (Wang et al., 2023). It is thought that using AI will provide great benefits for nurses and nursing students who provide health education to individuals. AI guides students in the preparation of nursing education materials, providing interactive learning experiences and saving time. AI can significantly improve nursing students' learning experiences, helping them to be better prepared for the challenges of a rapidly changing healthcare environment (De Gagne, 2023; Sun and Hoelscher, 2023). By ensuring that materials are prepared in accordance with students' individual learning styles, preferences and needs, AI can both improve the effectiveness of educational materials and contribute to better learning outcomes. Furthermore, AI can be used to create interactive learning experiences, which provide real-time feedback to learners, making the learning process more adaptive and attractive. Educational materials prepared with AI respond better to the needs of students, making the materials more effective, understandable and actionable (Banerjee et al., 2021). Therefore, the use of AI in preparing patient education materials for students can make significant contributions to the development of educational processes.

There are various types of AI for educating patients, such as chatbots, virtual health assistants, interactive training platforms, natural language processing. But chatbots offer tools to educate patients that patients can access whenever they need them. They are effective tools that can instantly answer patients' questions, provide educational materials and guide patients through their treatment plan. The fact that chatbots activate the patient education process accelerates the process of transforming learning into behavior (Aggarwal et al., 2023). AI-based chatbots also contribute to the production of patient education material at any time (Eid et al., 2024).

AI speeds up the education process, allowing nurses and students to be more in touch with the patient. The lack of these tools may cause nurses to use their time less efficiently (Tóth et al., 2020). The students stated that the most important barriers to patient education were the physical and mental problems of the patients and inadequate knowledge and skills of the nurses about the diseases (Tahery et al., 2011) and time limitation (Jahromi, 2016). Nursing students stated that not having sufficient academic knowledge was a major problem they faced in patient education. AI tools can overcome this problem by providing quick access to the most up-to-date information (Abbasi et al., 2018; De Gagne, 2023).

This study was conducted to examine the effect of students' use of AI tools while preparing patient education materials on the understandability, actionability and quality of the material in terms of content.

Hypotheses of the Research

H_{1-1}. **:** The use of AI tools in preparing patient education materials has an impact on the understandability of the material.

H_{1-2}. : The use of AI tools in preparing patient education materials has an impact on the actionability of the material.

H_{1-3}. : The use of AI tools in preparing patient education materials has an impact on the quality of the material.

2. Method

2.1. Design

This study was conducted as a randomized controlled experimental study.

2.2. Setting and participants

The research population consisted of 230 first-year students enrolled in the Nursing Department of a state university in the spring semester of the 2023–2024 academic year. In the institution where the study was conducted, students start clinical practice in the first year of their nursing program education. Students receive detailed training on basic nursing skills, nursing process, patient education planning and implementation before clinical practice. After the training, students are provided to practice in the clinic. Inclusion criteria were (1) taking the Fundamentals of Nursing II course for the first time; and (2) not working as a nurse in a hospital or any health institution. Exclusion criteria included: (1) having prepared patient education materials before; (2) repeating the Fundamentals of Nursing II course; (3) not having internet access; (4) not having a computer or smartphone; (5) difficulty speaking and understanding Turkish; (6) not attending the course. In addition, those who received AI support in material preparation for the students in the control group were excluded from the study.

Students who had difficulty speaking and understanding Turkish (n = 3), repeated the Fundamentals of Nursing II course (n = 8) and did not attend the course (n = 6) were excluded from the study. In addition, 29 students did not agree to participate in the study and a total of 46 participants were excluded. Then, 184 students were randomly divided into control (n = 92) and intervention (n = 92) groups based on grade point average and gender. Three students in the control group and one student in the intervention group could not complete the patient education materials and the study ended with 180 students (control group = 89; intervention group = 91). The allocation of participants was illustrated using CONSORT 2010 Flow diagram (Fig. 1).

After examining all the materials of 91 students in the intervention group and 89 students in the control group, a post-hoc calculation was made with the G*power 3.1 program over the actionability score averages of 180 students. According to this calculation, the power of the study was found to be 99 % in the analysis made with 5 % type 1 error, effect size 0.7 and it was decided that the sample size was sufficient.

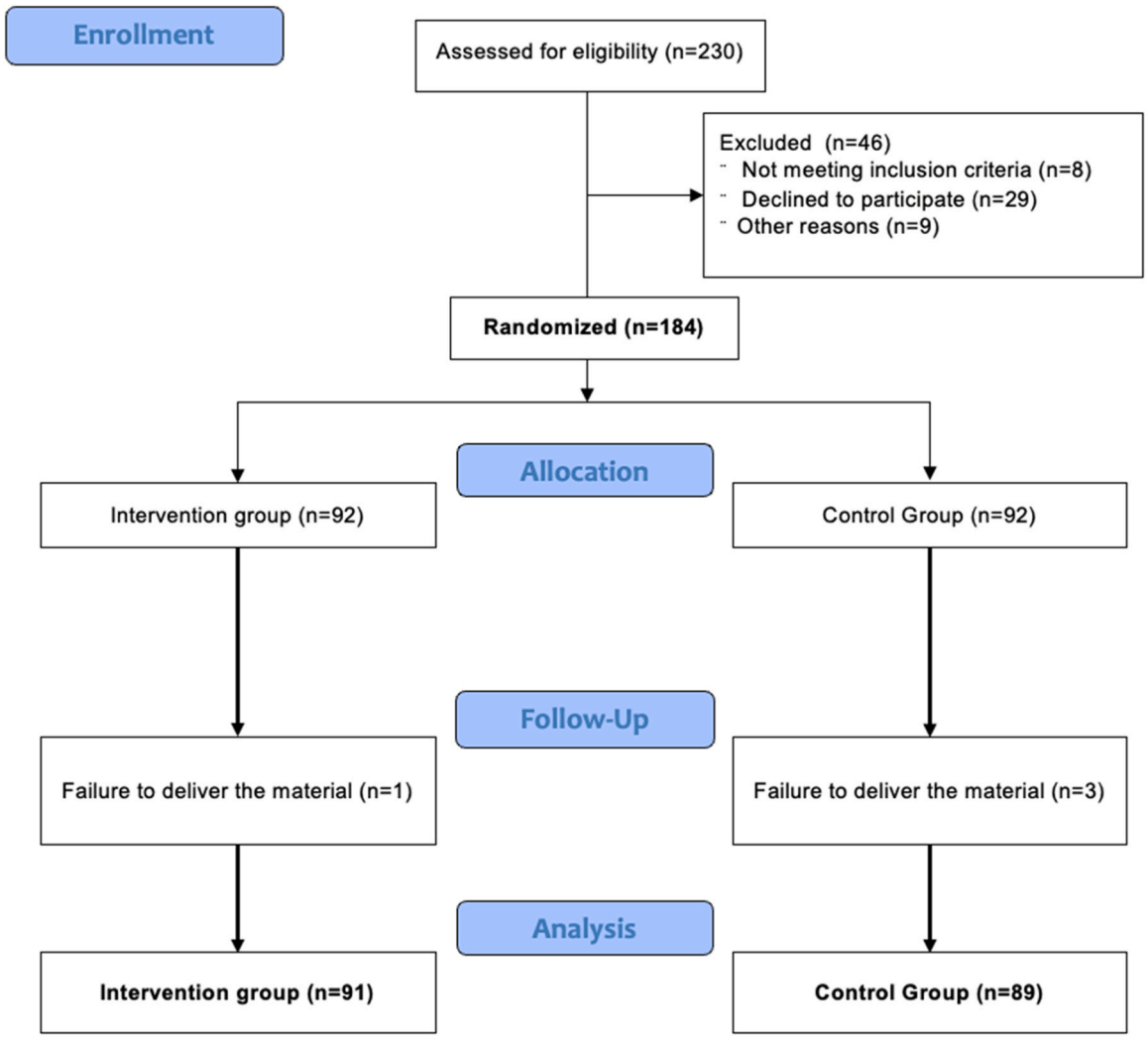

Fig. 1. Flowchart of the study.

2.3. Data collection tools

In the study, the Descriptive Characteristics Form for students, Patient Education Materials Assessment Tool, Patient Education Planning Form and Global Quality Scale were used.

2.3.1. Descriptive characteristics form

The form, which was prepared by the researchers by reviewing the relevant literature, consists of questions about the students' age, gender, grade point average and graduated high school (Darkwah et al., 2011; Forbes et al., 2021; Tasocak et al., 2014).

2.3.2. Patient education materials assessment tool (PEMAT)

The Turkish validity and reliability of the assessment tool developed by Shoemaker et al. (2014) was conducted by Akkoç and Orgun (2023) (Akkoç and Orgun, 2023; Shoemaker et al., 2014). There are two versions of the PEMAT: "Patient Education Materials Assessment Tool for Printable Materials (PEMAT-P)" and "Patient Education Materials Assessment Tool for Audiovisual Materials (PEMAT-A/V)" (Shoemaker et al., 2014). In this study, patient education materials prepared by the students on "rational drug use" were evaluated using PEMAT-P. PEMAT consists of two domains: understandability and actionability. Each item in the assessment tool is evaluated with a score of 0 (disagree) and 1 (agree) and for some items there is a third option, "Not applicable". The tool consists of a total of 26 items, 19 items evaluating the understandability of the materials and 7 items evaluating their actionability. PEMAT scores materials from 0 to 100 points for understandability and actionability. Understandability statements focus on content, particularly clarity, organization, layout and use of visual aids. The material is scored for word choice and the ability to familiarize the reader with medical terminology and the use of quantitative information. The actionability of the materials was rated according to their capacity to provide the reader with clear actions, to provide the reader with a concrete tool (e.g. a checklist) and to address the user directly when describing the action. In the adaptation study, it was determined that the goodness of fit statistics and factor loads of the scale were within acceptable ranges, the Cronbach alpha reliability coefficient for PEMAT-P was 0.901 and for PEMAT-A/V was 0.897 and the Turkish version of PEMAT was a valid and reliable measurement tool in the evaluation of both printed and audiovisual patient education materials (Akkoç and Orgun, 2023). In this study, the Cronbach's alpha coefficient of the tool was 0.702. Permission for the use of the assessment tool was obtained from the author who conducted the adaptation study.

2.3.3. Patient education plan form

This form is a structured form that students fill out as they create an individualized education plan tailored to each patient's needs. In this form, information such as the patient's name, surname, diagnosis, subject of education, purpose, goal, evaluation criteria, the way the education is given, materials prepared and references used are recorded in

detail (Hacıalioğlu, 2011).

2.3.4. Global quality scale (GQS)

The content quality of the training materials was assessed using the Global Quality Scale developed by Bernard et al. (Bernard et al., 2007). According to this scale, the quality of the training materials was evaluated on a 5-point scale (1: poor quality, 2: low quality - limited use, 3: somewhat useful, 4: useful, 5: useful-excellent quality). During the evaluation, the item that best expresses the quality of the material is selected (Table 1).

PEMAT does not assess accuracy or comprehensiveness, nor does it conduct readability tests. For example, a material may be very understandable, but may contain inaccurate information. Therefore, it was stated that PEMAT should be supported by additional assessments (Shoemaker et al., 2013). Based on this information, GQS was used to assess the information quality of the materials.

2.4. Application of the study

First, 230 students were informed about the purpose and content of the study. Then, 184 students who agreed to participate in the study and met the inclusion criteria were asked to fill out the "Informed Consent Form". Then, the Descriptive Characteristics Form was distributed in the classroom and the students who agreed to participate in the study were asked to fill out the form. In line with the information obtained from the Descriptive Characteristics Form, students were stratified according to their grade point averages and gender. Stratified sampling method was adopted to ensure that the groups were balanced in terms of basic demographic and academic characteristics, specifically gender and grade point average. This method was chosen to control for potential confounding variables that could influence the outcomes, such as differences in academic performance or gender-related learning preferences. Students who met the inclusion criteria were first stratified into subgroups based on gender and grade point average. This allowed us to ensure that these variables were evenly distributed across both the intervention and control groups. After stratification, participants from each subgroup were randomly assigned to either the intervention or control group. The randomization process was carried out using the random.org website, which generates true random numbers. This tool was used to create random sequences for participant assignment, ensuring that the allocation was unbiased and that each participant had an equal chance of being placed in either group. The computer-assisted randomization process helped to minimize any selection bias, which is vital for the integrity of a randomized-controlled trial. As a result, the students were divided into two groups, the intervention group and the control group (Fig. 2). The p-value obtained as a result of the t-test conducted to test the difference between the grade averages of the two groups was 0.414 (t-test: 0.818). This indicates that there is no statistically significant difference between the mean grades of the intervention and control groups. That is, the groups were homogeneously distributed in terms of grade point averages. The p-value obtained as a result of the chi-square test to evaluate the homogeneity of the gender distribution of the two groups was 0.742 (chi-square value (χ^2): 0.108). This result indicates that there is no statistically significant difference between the intervention and control groups in terms of gender distribution. In other words, the groups were homogeneously distributed in terms of gender. Thus, the use of stratified sampling and randomization ensured a balanced and unbiased allocation of participants. Other interventions for the groups are as follows.

2.4.1. Control group

Students in the control group were interviewed and asked to prepare a patient education material on "rational drug use" for a patient with a chronic disease. It was explained to the students that they could use supplementary tools such as books, journals and internet sites to prepare educational materials. The students were given five days and were asked to submit the patient education materials and the "Patient Education Plan" at the end of five days. In the Patient Education Plan form, students were asked to write in detail the references they used and to include direct links to the websites of the internet resources. After the research data were collected, the students in the control group were given information about AI tools and the students in the intervention group were allowed to share their experiences with their friends.

2.4.2. Experimental group

One week after the first interview with the control group, the intervention group was interviewed and asked to prepare a patient education material on "rational drug use" for a patient with a chronic disease. They were asked to use an AI tool as a resource while preparing educational materials. Firstly, the intervention group was trained. This training was conducted in a classroom environment with internet access. In this training given to the students, topics such as definition of AI, its scope, tools in this field, usage areas of these tools and the use of tools were included and the training lasted 2 hours. All students in the intervention group were trained at the same time and their questions were answered. No additional counseling was provided to the students after the training. It was explained to the students in the intervention group that they should prepare the educational material primarily using the AI tool and that they could use auxiliary tools such as books, journals and websites while preparing the educational material. The students were given five days and were asked to submit their patient education materials and "Patient Education Plan" at the end of five days. In the Patient Education Plan form, students were asked to write in detail the resources they used and to put direct links to the websites of the internet resources.

The reason for not conducting the procedure for the two groups simultaneously was the risk that the students in the control group would learn the AI tools from the intervention group and use them in material preparation. While all students were initially informed about the study, the AI tools were not introduced. In addition, students were not graded according to the study materials. The materials were used for research purposes only. In both groups, students were asked not to share their prepared materials with their friends. In both groups, students prepared educational materials for real patients. To organize patient education at a similar level as possible for all students, the topic of "Rational Drug Use" was chosen. The students cared for patients with diseases such as diabetes mellitus, hypertension, heart failure and renal failure.

2.4.3. Evaluation of patient education materials

All materials were evaluated for comprehensibility, actionability and quality. This evaluation was carried out by two independent researchers (GS, SK). The materials were scored separately by both researchers.

Table 1
Tools used to evaluate the quality of educational materials (Global quality scale-GQS).

Global quality scale (GQS)
1. Poor quality, most information missing, not helpful
2. Generally poor, some information given but of limited use
3. Moderate quality, some important information is adequately discussed
4. Good quality, most relevant information is covered, useful
5. Excellent quality, very useful

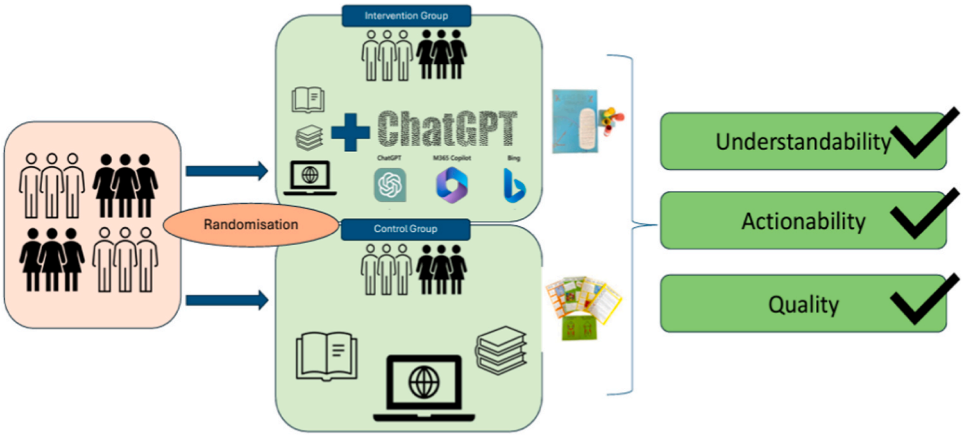

Fig. 2. Graphical abstract (A higher resolution version of the Graphical abstract is available as Supplementary information).

Fig. 3. Examples of education materials.

Inter-rater agreement was evaluated with Kappa value. Two researchers calculated the Kappa agreement for each student's material. Finally, the arithmetic average of the Kappa value calculated for each student was taken. The Kappa compatibility value of two independent researchers was found to be 0.98. As the kappa value approaches 1, it indicates perfect inter-rater agreement (McHugh, 2012). This analysis showed a high agreement between the two researchers. The third researcher assessed the two materials that differed between the two researchers and made the final decision. However, since Kappa agreement was at a good level, the agreement rate was not calculated again as a result of the third researcher's assessment. Two researchers are nurse academicians with a doctorate in the basic field of nursing. One researcher is a nurse academician who is doing her doctorate in the basic field of nursing. Each researcher teaches nursing students about patient education. They also guide the nursing students both in the sampling units and during practice in various clinics. The first researcher was a research assistant at a local university, the second researcher was an associate professor at a local university and the third researcher was a professor at a local university. Examples of educational materials prepared by students in the intervention and control groups are shown in Fig. 3.

2.5. Data analysis

SPSS (Statistical Package for Social Sciences for Windows, Version 25.0) was used to evaluate the data. Frequency (n), percentage (%), mean±standard deviation (Mean±SD) values were used for descriptive statistics. Chi-square analysis was used to compare descriptive/demographic characteristics between groups. The conformity of the data to normal distribution was evaluated by Shapiro-Wilk test, histogram and Q-Q plot. Kappa value was calculated to determine the agreement between two independent raters. Comparison between groups was analyzed with Independent Sample t test. Statistical significance level was accepted as $p<0.05$.

2.6. Ethical considerations

Written approval for the study was obtained from both the university ethics committee (Date: 06.02.2024, Decision No: 2024–04/14) and the relevant institution (dated 26.01.2024 and reference number E-42695516–302.08-00000605909). Prior to their participation, students were thoroughly informed about the aims and methodology of the study and their written informed consent was obtained. In addition, students were informed that they would not receive any grades for their participation in the study.

3. Results

3.1. Descriptive and demographic characteristics of students

The mean age of the students in the intervention group was 20.41 (SD 3.96) years, the mean grade point average was 2.31 (SD 0.71), 80.2 % were female and 73.6 % were graduates of Science-Anatolian High School. The mean age of the students in the control group was 20.49 (SD 2.51), the mean grade point average was 2.30 (SD 0.57), 74.2 % were female and 70.8 % were graduates of Science-Anatolian High School. It was determined that the individuals in the intervention and control groups were homogeneous in terms of grade point average, age, gender and school of graduation (Table 2).

3.2. Understandability of patient education materials

The mean PEMAT understandability score of the 91 materials in the intervention group was 75.36 (SD 12.24) and the understandability scores of the materials ranged between 33.33 and 100. The mean PEMAT understandability score of 89 materials in the control group was 57.57 (SD 16.19) and the understandability scores of the materials ranged between 8.33 and 87.5. According to the results, it was found that the understandability scores of the materials prepared by the students in the intervention group were significantly higher than those in the control group ($p<0.001$) (Table 3).

Table 2
Distribution of students according to descriptive characteristics.

Characteristics	Intervention Group (n=91)		Control Group (n=89)		p
	Mean±SD		Mean±SD		
Grade point average	2.31±0.71		2.30±0.57		0.414*
Age	20.41±3.96		20.49±2.51		0.877*
	n	%	n	%	
Gender					
Female	73	80.2	66	74.2	0.742**
Male	18	18.8	23	25.8	
Graduated high school					
Health Vocational High School	3	3.3	2	2.2	
Other Vocational High School	1	1.1	1	1.1	
Science-Anatolian High School	67	73.6	63	70.8	0.825**
Private High School	5	5.5	4	4.5	
Other	15	16.5	19	21.3	

* Independent samples t-test
** Chi-square

3.3. Actionability of patient education materials

The mean PEMAT actionability score of the 91 materials in the intervention group was 34.71 (SD 23.46) and the actionability scores of the materials ranged between 0 and 100. The mean PEMAT actionability score of 89 materials in the control group was 17.56 (SD 24.92) and the actionability scores of the materials ranged between 0 and 100. According to the results, it was found that the actionability scores of the materials prepared by the students in the intervention group were significantly higher than those in the control group ($p<0.001$) (Table 3).

3.4. Quality of patient education materials

When the materials were evaluated in terms of quality score, the GQS score of those in the intervention group was determined as 3.65 (SD 0.80) and that of those in the control group was 2.23 (SD 0.92). According to the results, it was determined that the quality scores of the materials prepared by the students in the intervention group were significantly higher than those in the control group ($p<0.001$) (Table 3).

3.5. AI tools used by students

When the students were asked which AI tools they used within the scope of the research, it was determined that they used ChatGPT, Gemini, Copilot, Bing and CANVA tools. The most frequently used tool was ChatGPT (62 %). It is also seen that students used Copilot (20 %) and Gemini (13 %) tools intensively (Fig. 4).

Table 3
Analysis of training materials according to understandability, actionability and quality score.

Characteristics	Intervention Group (n=91) Mean±SD (Min-Max)	Control Group (n=89) Mean±SD (Min-Max)	p
Understandability of the education materials (PEMAT)	75.36+12.24 (33.33–100)	57.57+16.19 (8.33–100)	<.001 *
Actionability of the education materials (PEMAT)	34.71+23.46 (0–100)	17.56+24.92 (0–100)	<.001 *
Quality score of the education materials (GQS)	3.65+0.80 (1–5)	2.23+0.92 (1–5)	<.001 *

* Independent samples t-test

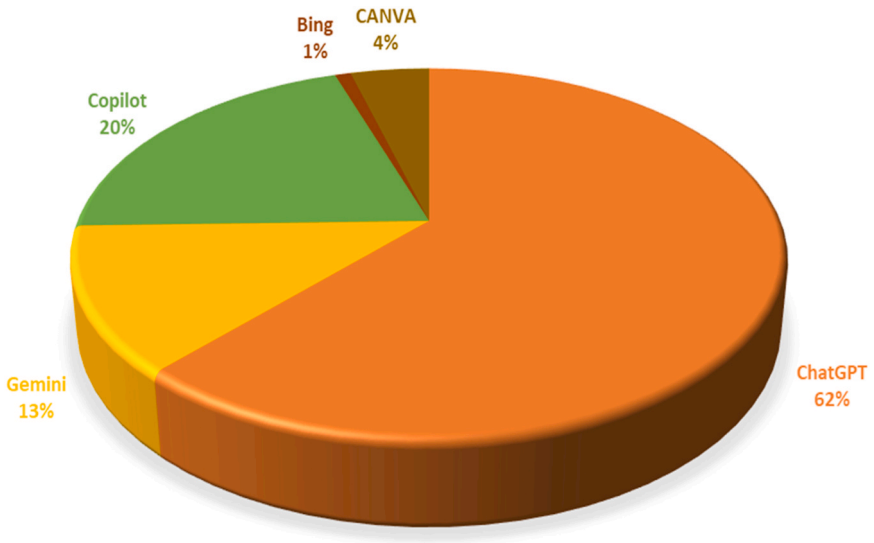

Fig. 4. Artificial intelligence tools used by students.

4. Discussion

In patient education, it is important to provide understandable and effective education by preparing appropriate materials for the patient. This study was conducted to evaluate the patient education materials prepared by two groups of nursing students using and not using AI tools in terms of understandability, actionability and quality. The most used AI tool by the students is ChatGPT, which is a highly reliable tool in line with the literature (Arbel et al., 2024; Gosak et al., 2024; Rossettini et al., 2024). The studies mention the benefits of ChatGPT both in the field of health education and nursing education (De Gagne, 2023; Sallam, 2023; Seney et al., 2023). In the first patient education materials prepared by first-year nursing students, the materials prepared by those who used AI tools were better in terms of understandability, actionability and quality than the materials prepared by the group who did not use AI tools. In terms of actionability, 6 of the materials prepared by the intervention group and 50 of the materials prepared by the control group received zero points. It is seen that approximately 25 % of the patient education materials evaluated in the literature have zero actionability scores (Kang and Lee, 2019). This shows that it is quite difficult to prepare the materials in an actionable (Erbas, 2016).

The number of materials with a high level of both understandability and actionability is quite low. In general, the understandability of the materials in the studies is at a good level, while their actionability is at a lower level (Orgun et al., 2024; Kang and Lee, 2019). In the studies examined in the literature, only one study was found where nursing students' patient education materials were evaluated (Orgun et al., 2024). In a study conducted with senior nursing students, the understandability score of the materials prepared by the students was 80.10 and the actionability score was 65.95 (Orgun et al., 2024). In our study, the scores of the materials prepared by first-year students, who had their first experience in preparing materials, were found to be low in terms of understandability and actionability. This result, which differs from our findings, is thought to be due to the different grade levels of the students. In Orgun et al.'s (2024) study, it is possible to say that senior students who prepared materials with high understandability and actionability rates became competent because they experienced this activity many times. Because it is important to prepare patient education materials in nursing education (Atabek Aşti and Karadağ, 2024). For this reason, students prepare countless patient education materials throughout their education life. In another study evaluating patient education materials in the literature, it was found that the understandability scores were between 49.5 and 62.46, while the actionability scores were between 31.4 and 39 (Lipari et al., 2019). In another study, while the average understandability score was 49.5, the actionability score was 31.4 (Kang and Lee, 2019). In the study, it was found that although the understandability and actionability scores of the control group were low (understandability: 57.57, actionability: 17.56), the scores of the intervention group were quite high (understandability: 75.36, actionability: 34.71). This supports the knowledge that the use of AI tools in preparing patient education materials increases the understandability and actionability of the material (Cheong et al., 2024). It was seen that AI tools can be used as appropriate auxiliary tools for first year nursing students to prepare initial materials. AI tools can translate complex medical terms and concepts into simpler language. AI-based language models automatically make texts more understandable and clear, which enables students to communicate complex information more simply (Sun and Hoelscher, 2023). This feature ensures that training materials are appropriate to the literacy level of the target group and increases understandability. Armstrong et al. reported that the readability levels of patient education materials prepared using an AI tool increased and the texts were made simpler and more understandable, meaning that they were suitable for a wider readership (Armstrong et al., 2024). By organizing health-related instructions step-by-step, AI can help patients communicate more clearly how they can integrate it into their daily lives. Furthermore, AI tools provide suggestions and enable students to present more specific and actionable information (Sun and Hoelscher, 2023), this contributes to making the material more easily actionable by patients.

The high quality of the patient education materials prepared by the students increases the quality of the education (Ghorbani et al., 2014). In the literature, the quality of health information produced by AI tools is reported to be good (Hershenhouse and Cacciamani, 2024; Pan et al., 2023). When the education materials were evaluated in terms of quality, the quality score was below average in the control group, while it was above average in the intervention group. It was observed that the quality of the materials prepared by the students using the AI tool was better. AI collects information from a wide variety of sources, making training materials more comprehensive and accurate. AI increases the scientific accuracy and coverage of the materials by providing students with a larger knowledge base. Moreover, AI's editing and reviewing capabilities minimize inconsistencies and errors in the materials, thus improving the overall quality of the material (Kalla et al., 2023). Therefore, the use of AI tools both enables students to access information more easily and contributes to making the material more appropriate to the needs and characteristics of the target population.

4.1. Strengths and limitations

One of the strengths of this study was the first study to evaluate the effect of the use of AI tools in the preparation of patient education materials by nursing students. Other strengths are the presence of an experimental design with a randomized and control group and the evaluation of the understandability, actionability and quality of the prepared educational materials using a valid and reliable assessment tool. While this study contributes to the literature, it also has some limitations that future research should take into account. The fact that patient education materials were prepared on only one subject limits the generalizability of the results. In addition, other limitations are that this study was conducted on students studying at a single university and the study was not blinded. Due to the shortage of studies in this area, future researchers should consider examining the impact of AI tools on different topics and on different nursing skills. Other limitation of the study is that the understandability, actionability and quality of the training materials could not be evaluated by the patients. In further studies, it is recommended to examine the effect of training prepared with AI tools on patient outcomes. Another limitation is that the difficulties experienced by students while preparing the materials are unknown. In the study, the difficulties experienced by students while using this tool were not questioned. In future studies to be supported by qualitative research, it may be recommended to take measures according to students' experiences. Although the current study showed positive results, the fact that the students prepared a single patient education material limits the study. Therefore, future studies that evaluate multiple materials and involve longer research periods will be of significant value, potentially enriching the field with more comprehensive and generalizable findings.

5. Conclusions

Nursing students' use of AI tools in preparing patient education materials has increased the understandability, actionability and quality of educational materials. Our results show that the integration of AI into educational material preparation processes plays an important role in improving the effectiveness of educational contents. These results provide a valuable basis for nursing students, educators and clinical practicing nurses to develop new strategies to facilitate and encourage the preparation of patient education materials. As educational environments continue to evolve with technological innovations, this research provides guidance on the opportunities offered by the integration of advanced technologies such as AI into nursing education practices.

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Ethical statement

Written approval for the study was obtained from both the Kırşehir Ahi Evran University Health Sciences Scientific Research and Publication Ethics Committee (Date: 06.02.2024, Decision No: 2024–04/14) and the relevant institution (dated 26.01.2024 and reference number E-42695516–302.08-00000605909).

CRediT authorship contribution statement

Ayla Ünsal: Writing – review & editing, Supervision, Methodology. **Sevda Korkut:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Data curation, Conceptualization. **Gamze Saatçi:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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