Redesigning Health Education Through Artificial Intelligence: Innovative and Sustainable Learning for Student-teachers at the Lebanese University Faculty of Education

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Abstract

Today's globally engaged learners face greater health-related challenges that require decision-making skills, ethical sensitivities, and healthy lifestyles. Thus, student-teachers must develop not only knowledge in health education but also ethical awareness and sustainable decision-making skills. This research aimed to assess the impact of using different generative Artificial Intelligence tools on the knowledge, attitudes, and ethical inclination of the student-teachers. To address the research question: Does integrating AI in health education improve student-teachers' knowledge, attitude, and commitment to sustainability? Action research was conducted on 39 first-year student-teachers majoring in Early Childhood at the Lebanese University Faculty of Education. Data was collected through a structured pre/post-test and an interview to evaluate students' knowledge, attitudes, and ethical awareness against the dimensions of health sustainability, namely, social, behavioral, environmental, and economic. The findings showed significant improvement compared to their pre-values after applying AI-augmented educational training. The results showed that the mean score for the "social heath education " increased from (M=1.28) in the pre-test to (M=3.23) in the post-test. In addition, the mean score of "Environmental Health Education" increased from (M=1.74) to (M=5.72), similarly the Economical Health Education from (M=2.28) to (M=10.15). The rate of utilization of AI resources increased from 38% to 90%, and the level of satisfaction was reported at 95%. In addition, students gave positive feedback regarding the experience. It is suggested that AI-enabled and ethics-integrated health education be formally integrated as part of the Faculty of Education curriculum at the Lebanese University to promote responsible, sustainable, and future-proof teaching methodologies.

Keywords

Artificial intelligence, sustainable Health education, knowledge, attitude, ethics.

مستخص

يواجه المتعلمون المنخرطون عالميًا اليوم تحديات صحية متزايدة تتطلب مهارات في اتخاذ القرار، وحسًّا أخلاقيًّا، وأنماط حياة صحية. وبالتالي، يجب على الطلبة-الأساتذة تطوير معارفهم في مجال التثقيف الصحي إلى جانب الوعي الأخلاقي ومهارات اتخاذ القرار المستدام. هدفت هذه الدراسة إلى تقييم أثر استخدام أدوات الذكاء الاصطناعي التوليدي المختلفة على معرفة واتجاهات وميل الطلبة-الأساتذة نحو الأخلاقيات. وللإجابة عن سؤال البحث: "هل يسهم دمج الذكاء الاصطناعي في التثقيف الصحي في تحسين معرفة واتجاهات الطلبة-الأساتذة والتزامهم بالاستدامة؟"، تم إجراء بحث إجرائي شمل 39 طالبًا-أستاذًا في السنة الأولى في اختصاص الطفولة المبكرة في كلية التربية – الجامعة اللبنانية. تم جمع البيانات من خلال استبيان منظّم قبل/بعد التجربة، بالإضافة إلى مقابلات لتقييم المعرفة والاتجاهات والوعي الأخلاقي لديهم، وذلك وفقًا لأبعاد الاستدامة الصحية: الاجتماعية، السلوكية، البيئية، والاقتصادية. أظهرت النتائج تحسّنًا ملحوظًا مقارنة بالقيم السابقة بعد تطبيق التدريب التربوي المعزز بالذكاء الاصطناعي. فقد ارتفع متوسط درجة "التثقيف الصحي الاجتماعي" من (M=1.28) في الاختبار القبلي إلى (M=3.23) في الاختبار البعدي. كما ارتفع متوسط "التثقيف الصحي البيئي" من (M=1.74) إلى (M=5.72)، وارتفع متوسط "التثقيف الصحي الاقتصادي" من (M=2.28) إلى (M=10.15). كما زاد معدل استخدام موارد الذكاء الاصطناعي من 38٪ إلى 90٪، وبلغ مستوى الرضا 95٪. بالإضافة إلى ذلك، أعرب الطلاب عن آرائهم الإيجابية تجاه هذه التجربة. يوصى بدمج التثقيف الصحي المدعوم بالذكاء الاصطناعي والمندمج بالقيم الأخلاقية ضمن منهاج كلية التربية في الجامعة اللبنانية، لتعزيز ممارسات تدريس مسؤولة ومستدامة ومواكِبة للمستقبل.

كلمات مفتاحية

الذكاء الاصطناعي، التثقيف الصحي المستدام، المعرفة، الاتجاه، الأخلاقيات.

Résumé

Face aux enjeux sanitaires mondiaux, les étudiants-enseignants doivent développer des savoirs en éducation à la santé, une conscience éthique et des compétences pour des choix durables. Cette recherche vise à évaluer l'impact de l'utilisation de différents outils d'intelligence artificielle générative sur les connaissances, les attitudes et les inclinations éthiques des étudiants-enseignants. Une recherche-action a été menée auprès de 39 étudiants-enseignants de première année spécialisés en éducation de la petite enfance, à la Faculté de pédagogie -Université libanaise. Les données ont été collectées au moyen d'un questionnaire structuré pré/post et d'un entretien. Les résultats ont montré une amélioration significative par rapport à leurs valeurs initiales après l'application de la formation pédagogique enrichie par l'IA. Les résultats du pré-test ont montré une amélioration du score de la santé sociale de (M = 1,28) à (M = 3,23) au post-test. De même, pour l'éducation à la santé environnementale a augmenté de (M = 1,74) à (M = 5,72), ainsi que pour l'éducation à la santé économique de (M = 2,28) à (M = 10,15). Par ailleurs, Le taux d'utilisation des ressources d'IA est passé de 38 % à 90 %. De plus, les étudiants ont exprimé des opinions positives vis-à-vis de cette expérience. Il est recommandé d'intégrer formellement l'éducation à la santé

soutenue par l'IA, et fondée sur des valeurs éthiques, dans le programme de la Faculté d'éducation de l'Université libanaise, afin de promouvoir des méthodes d'enseignement responsables, durables et pérnes.

Mots clés

Intelligence artificielle, éducation à la santé durable, connaissances, attitude, éthique

1.Introduction:

World health sustainability starts with strong health education. When people have the right information, they can make better choices for themselves and their communities, which helps support and maintain global health systems over time. The World Health Organization (WHO) (2022) defines health education as a combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes. Because knowledge alone may not be powerful enough to motivate change, health education works to enhance knowledge, attitudes, and skills to influence health behaviors of individuals and communities positively. Nevertheless, education is essential for moving toward a more sustainable future. We cannot imagine how the people of all nations could move toward a more sustainable world without the contribution of educators from around the globe. Educating for a more sustainable future in its broadest sense includes improving the quality of basic education, reorienting education to address sustainability, improving public awareness, and providing training to many sectors of society (UNESCO, 2012). Health education plays a big role in helping us reach sustainable development that is directly linked to the three dimensions of sustainability: social, economic, and environmental. Socially, a healthy culture enhances collective awareness and supports the building of more cohesive and resilient societies.

Economically, it reduces health costs through prevention and reduces the burden on healthcare systems. Environmentally, it helps individuals understand the relationship between the environment and their health, encouraging sustainable behaviors that conserve resources and reduce pollution (UNESCO, 2023).

Lately, we've seen a trend of new technology in education, and AI is at the center of it all. AI is already making a huge impact in a lot of different industries, and now it's starting to show real promise in schools too (Sunmboye et al., 2025). Bringing AI into the classroom is already starting to make a difference by allowing learning to be more personalized and flexible. It moves away from the one-size-fits-all approach and focuses more on what works best for each student. Even though the changes might not be obvious right away, over time AI is going to seriously change

how education looks and feels (Strielkowski, Grebennikova, Lisovskiy, Rakhimova, & Vasileva, 2025). It's important to use generative AI tools in education because they can reshape the content, make things easier to understand, enhance interaction, and save time for both teachers and students (Luckin, 2018; Zawacki-Richter et al., 2019).

Piaget (1970), believed that students should be the center of the learning process and construct their knowledge through exploration and interaction with their environment. When learners encounter situations that challenge their current viewpoints, it is essential to implement learning strategies that foster personal growth and cognitive change. This reflects Mezirow's theory of transformative learning, which highlights the capacity of individuals to revise their thinking, core beliefs, and expectations in response to new, meaningful experiences (Taylor & Cranton, 2012). According to this viewpoint, student-teachers discover AI tools and use them to build their own knowledge in health education, promoting self-directed and critical learning and fostering educational practices based on deep understanding and exploration (Papert, 1980; Mishra & Koehler, 2006). Learning with AI can really make learners think differently and start to change how they see things, what they believe, and how they act.

With this in mind, the student-teacher becomes the center of the learning process, using AI tools not just as tech platforms but as "cognitive tools" that help them create new content, explore health topics, and organize what they learn in a more creative and meaningful way based on their understanding and experience also, modifying their thinking and remodeling their attitude and opinions (Mezirow, 1997). For example, when a student uses tools such as Chat GPT, Adobe Express, or Suno AI to create a story, song, or awareness video on a health topic (such as nutrition or hygiene), they not only understand the concept, but reconstruct it to suit their level of thinking, skills, and target audience. By using AI tools to design educational resources related to health education, the student-teacher can practice self-learning, develop their skills in critical thinking and creativity, and take into account ethical dimensions associated with the use of these tools, such as protecting children's privacy and checking the accuracy of content. This is in line with modern educational trends that raise the status of the thinking and creative teacher, who is able to employ technology in the service of the goals of humanitarian and preventive education.

However, health education is essential for helping students understand how to make healthy choices. Therefore, it is necessary for future teachers to learn how to use AI tools to create content that is both engaging and ethically responsible and tailored to students' developmental needs. Doing this helps students make better decisions for themselves and follows what the Centers for Disease Control and Prevention (CDC, 2023) recommends for strong health education at every grade level. But even with all its potential, a lot of schools and health systems still aren't fully equipped to bring sustainable practices into what they do, or to really take advantage of new technologies (WHO, 2022).

The motivation for this research is the need to prepare student-teachers in the field of early childhood to be able to innovate and design educational and health activities that are appropriate for children's developmental characteristics. When this teacher excels in using artificial intelligence tools such as Chat GPT, Suno AI, in-video AI, and Adobe Express, they can generate diverse content (educational stories, health songs, illustrations, and interactive videos) that enhance children's understanding of topics such as nutrition, hygiene, dental care, and a healthy diet. These tools also allow teachers to design educational resources tailored to their students' level, with lower costs and time, and enhance efficiency and creativity in the classroom (Cope & Kalantzis, 2017; Bower & Sturman, 2015).

1.1Research problem

In Lebanon, the education system continues to face a lot of challenges, like outdated curricula, limited access to technology, and significant gaps in quality. To address these issues, there needs to be a push to adopt advanced tools like artificial intelligence (AI), especially in the Faculty of Education at the Lebanese University, where the Health Education course is taught across all majors, but without the integration of AI tools. This presents a clear gap in practice that this study aims to address. Hence, artificial intelligence tools are integrated into the teaching of this course

to examine their impact on early childhood students. This integration aligns with global movements advocating for sustainable and future-ready education systems (UNESCO, 2021).

Despite global advancements in using AI in education, there remains a lack of research on integrating generative AI tools in health education, particularly in preparing student-teachers to create developmentally appropriate, ethically responsible content. In Lebanon, this gap is even more pronounced, as most education programs have not yet incorporated AI in teacher training courses, especially in health education. This study addresses this gap by exploring how AI tools can support knowledge acquisition, attitude development, and ethical thinking in future educators.

1.2 Research Questions

1. To what extent does integrating generative AI tools in health education improve student-teachers' knowledge across social, environmental, and economic sustainability
2. How does the use of AI tools enhance student-teachers' attitudes toward sustainable health education?
3. How does AI-improved health education affect student-teachers' ethical inclinations and decision-making related to health sustainability?

1.3 Aim of the Study

This study aims to assess the impact of generative Artificial Intelligence tools on the knowledge, attitudes, and ethical inclinations of student-teachers in the field of health education. Specifically, it seeks to:

1. Measure the impact of AI tools in enhancing student-teachers' knowledge in health education, across the social, environmental, and economic dimensions of sustainability.
2. Understand student-teachers' attitudes toward integrating AI in the creation of health-related educational content.
3. Analyze student-teachers' moral awareness and ethical decision-making when using AI tools for sustainable health education.

1.4 Significance of the Study

This research lies in its potential to improve health education by equipping student-teachers with the skills to use AI tools responsibly and creatively. It explores how AI supports the development of knowledge, fosters positive attitudes, and encourages ethical awareness—key components in shaping future educators who are capable of advancing sustainable development goals. By focusing on Lebanon's educational context, the study also provides practical solutions to overcome systemic challenges and contributes to global efforts toward integrating AI into teacher training for a sustainable future.

2.Methodology:

This study adopted an action research approach to investigate the impact of incorporating artificial intelligence into a health education course on student-teachers' comprehension, sense of responsibility, and commitment to sustainability. Lewin (1946) first introduced action research that focuses on studying different kinds of social actions and using what's learned to create real change. This view shows how action research is meant to be collaborative and focused on making a difference, which is why it made sense for our study as we looked at how AI could help bring sustainability into education in a meaningful way

2.1 Sample:

The study involved 39 first-year student-teachers majoring in Early Childhood Education at the Lebanese University, Faculty of Education. Participants were enrolled in a health education course that was improved with AI tools as a part of the experimental process.

2.2 Instruments:

To measure the student- teachers' knowledge, attitude and ethical awareness among the three axes of sustainability: social, environmental and economical sustainability, two research instruments are used:

a) Pre-/Post-Test: This test (appendix 1), was distributed to Student-teachers before and after the intervention in order to measure any changes. The test consisted of 36 questions**,** divided into five sections**:**

1. **Personal Information :** Q1, Q2, Q3
2. **Health Education and Society:**
    - Q4 to Q11 explore participants' understanding of the social aspects involved in sustaining health education.
    - Q12 to Q19: examined participants' awareness of ethical considerations and their decision-making processes related to promoting sustainable health education.
3. **Health Education and environment**
    - Q20 to Q24 explored how well participants understood the environmental side of health education sustainability.
4. **Health Education and economy**
    - Q25 to Q29 were designed to find out how much participants understood the economic side of health education sustainability. Also, Questions 28 and 29 gave insight into how student-teachers think and make decisions ethically when it comes to keeping health education sustainable.

5. **AI in Health Education**
    - Q30, Q31, Q33, Q35, Q36 looked at how participants felt about sustainability in health education.
    - Q32 and Q34 focused more on how participants approach ethical decision-making when AI is involved in health education.

a) **Interview**:

We interviewed thirty-nine student-teachers at the end of the intervention to help answer the three research questions and make sure the results were accurate. We asked them seven structured questions:

1- *Can you describe your experience using AI tools in health education?*
2- *What do you think are the main advantages of using AI in learning health-related topics?*
3- *Have you noticed any improvements in your understanding, engagement, or motivation when using AI-based tools? Can you give an example?*
4- *Do you have any concerns about privacy, data collection, or how your interactions with AI tools are being used?*
5- *How much do you trust the information or feedback provided by AI tools? Have you encountered any misleading or inaccurate content?*
6- *How important is the teacher's presence and guidance when using AI tools in health education? Can AI ever replace that role?*
7- *What improvements or changes would you suggest for using AI more effectively and ethically in health education programs?*

Questions 1 and 2, are related to the research question 1, and are studying improvements in understanding across social, environmental, and economic sustainability dimensions.

Question 3 and question 6 connect to Research Question 2 by looking at how student's attitudes are changing toward sustainable health education and how open they are to using AI as a learning tool.

Q4, Q5, and Q7 all tie into Research Question 3 because these questions reveal how students approach the responsible use of AI and the ethical decisions they consider when engaging with this technology.

2.3 Data collection/ procedure:

Before AI training:

A pre-test was conducted to the student-teachers to target the three domains of sustainable health education: Social, Environmental, and Economic sustainability in addition to their attitude and ethical inclination.

During AI training:

Students were first trained to use AI tools generative AI tools which include Chat GPT, Copilot, Leonardo AI, Adobe Express, Suno AI, Once Upon a Bot and In Video AI and many others over 8 weeks (3 hours per a week). After training, they applied the tools independently to create PowerPoint, posters, videos, stories, songs of different topics of health education course. These topics, concerning healthy food and the food pyramid, malnutrition and diseases, hygiene in schools, the role of the health advisor in public schools, and healthy lifestyle habits and preparing an outdoor activity.

After training and at end of the implementation:

The post-test was distributed to assess the impact of the intervention. A paired-samples t-test was directed to compare pre- and post-intervention scores, with statistical significance set at $p < .05$. In addition, Questions 30 till 35 were designed as descriptive questions to gather further insights on students' usage of AI, attitudes toward ethical issues such as privacy and fairness, and their trust in AI tools. These responses provided qualitative support to the quantitative data and contributed to understanding the ethical dimension of AI in health education.

Additionally, after the intervention an interview was conducted on 39 students using a set of seven questions exploring their ethical inclinations and the level of trusting AI tools. A descriptive analysis was performed to interpret the students' responses.

2.4- Validity and reliability:

The validity of the instrument was reviewed and approved by presenting it to two professors from the Faculty of Education at the Lebanese University.

A pilot test was conducted to check the reliability of the instrument. Cronbach's alpha coefficient was calculated for the items in Section 5 of the questionnaire (questions 30–36) after numerically coding them. The reliability coefficient reached a value of ($\alpha = 0.82$), indicating very good internal consistency. Reliability was not calculated for the remaining sections due to the different nature of the questions and the variety of response patterns, as they were not designed within a standardized scale that could be subjected to direct statistical analysis.

2.5- Data analysis

Concerning the test, the Data was analyzed using SPSS software. Quantitative variables were expressed using range, mean, and standard deviation, while qualitative variables were expressed as frequency and percent. Paired Student's t-test was used to compare pre-test and post-test grades. P-value was assumed to be significant at 0.05.

On the other hand, descriptive analysis was performed on 39 interviews conducted on 39 students after they were trained on how to use artificial tools effectively.

2.6- Ethical consideration

The consent of the Lebanese university administration to participate in the study was obtained. Also, the consent of the student-teachers requires participating in the artificial intelligence training session, and performing the anonymous pre- and post-training exam.

3-Results:

3.1- Results of the pre- and post-tests:

The results of the pre- and post-tests on health education components of 39 student-teachers showed statistically significant differences between the participants' mean difference scores.

Paired-samples t-test results in table 1, showed significant improvements in most domains. Nutrition and Health (M = -1.872, SD = 1.239), Physical Activity (M = -2.103, SD = 1.774), and Health Guidance (M = -2.077, SD = 1.494) all showed significant gains, $p < .001$. The Healthy Lifestyle domain did not show a significant change (M = -0.436, SD = 2.100), $p = .203$. Substantial improvements were found in Health and Environment (M = -4.154, SD = 2.007) and Health and Economy (M = -8.949, SD = 4.078), both $p < .001$.

Table 1. Paired Samples t-Test Results for Health Education Components

Variables Compared	Mean Difference	Std. Deviation	t-value	df	p-value (2-tailed)
Social sustainability	-2.017	0.94	-13.407	38	.000
a. Nutrition	-1.872	1.239	-9.433	38	.000
b. Physical activity	-2.103	1.774	-7.402	38	.000
c. Health awareness and guidance	-2.077	1.494	-8.684	38	.000
d. Personal health	-0.436	2.1	-1.296	38	.203
Environmental sustainability	-4.154	2.007	-12.925	38	.000
Economic sustainability	-8.949	4.078	-13.704	38	.000

These results show that the intervention had a strong impact across most categories, except for healthy lifestyle.

These findings indicate a significant improvement in health knowledge across the dimensions of social, behavioral, environmental, and economic sustainability after integrating AI tools into teaching.

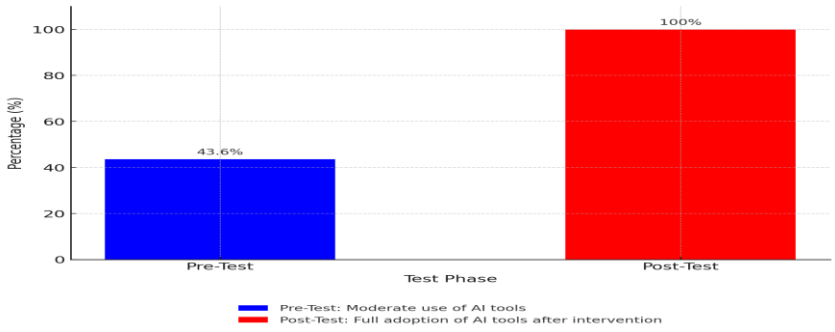
Despite these marked improvements in knowledge, changes in healthy lifestyle behaviors were minimal. The only notable behavioral change was an increased intake of healthy foods, particularly vegetables and fruits, while other aspects of their lifestyle remained unchanged.

3.2-Results of Section five/ Evaluating AI in Health Education:

Q.30- Have you ever used artificial intelligence tools in your studies?

Fig.2 showed that 43.6% of students in pre-test (before the intervention), reported that they utilized AI tools during their learning in the pre -test. While in post-test 100 % of students reported that they utilized AI tools during their learning.

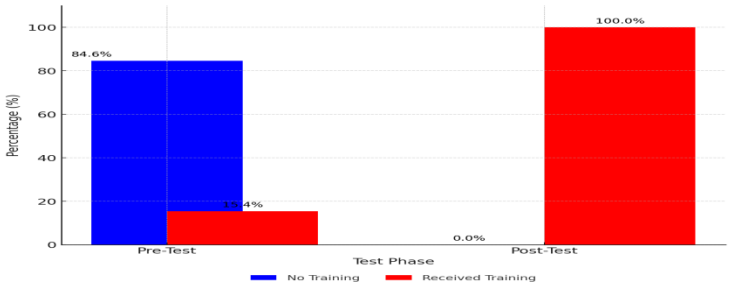
Figure 2: Percentage of Student-Teachers Utilizing AI Tools in Learning Activities During Pre- and post-test.



Q.31- Have you received AI training?

Fig.3 showed that before the intervention 84.6% of students reported that they did not receive any training in the use of artificial intelligence. After the intervention 100% of students reported that they received formal training in this field .

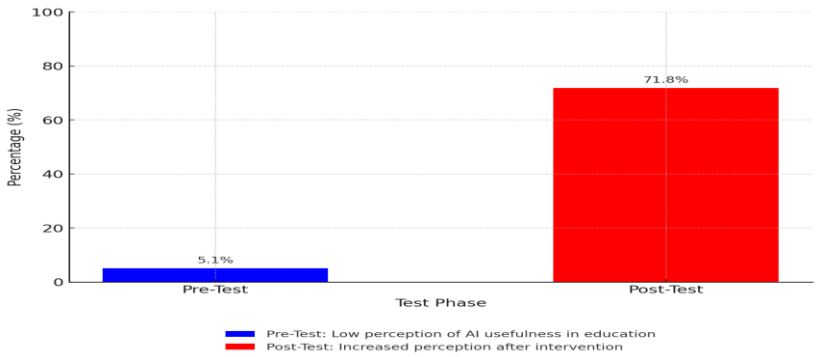
Figure 3. AI training among participants.



Q.33- Do you believe AI improves your learning/teaching?

Fig.4 showed that in the pre-test 5.1% of students said that AI can be used to enhance education and training, while in post- test 71.8% of students said that AI can be used to enhance education and training after training on AI tools.

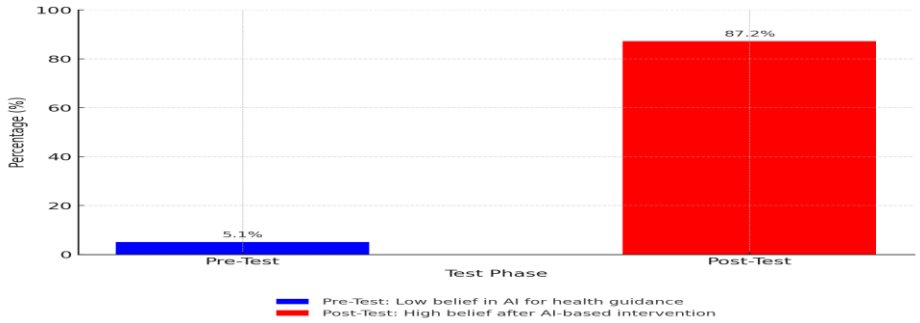
Figure 4. Perception of AI usefulness in enhancing education.



Q.34-Can AI improve health guidance in schools?

Figure 5 showed that 5.1% believed that artificial intelligence can improve health guidance in schools in the pre-test, While 87.2% believe that artificial intelligence can improve health guidance in the post test.

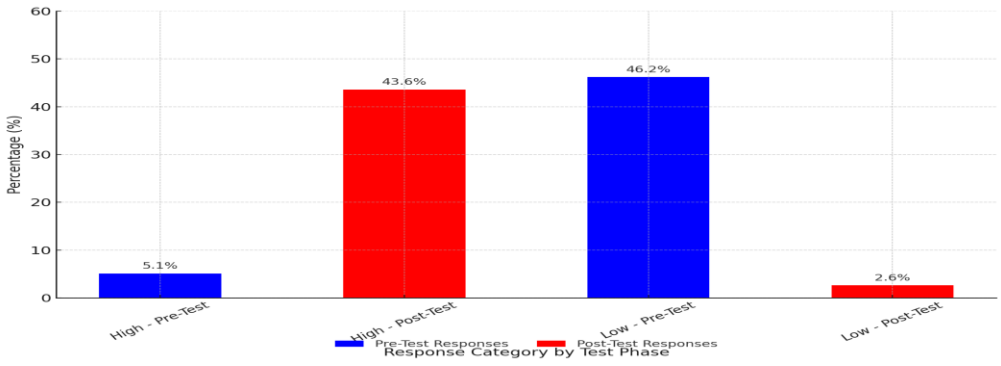
Figure 5 : the percentage of those who believe that artificial intelligence can improve health education in schools in pre- and post- test



Q.35- Overall rating of AI in supporting school health education:

In fig.6, 5.1% of students in the pre-test have high" estimate of artificial intelligence importance in facilitating health education, and 46.2% have "low" estimate. While 43.6% have "high" estimate of artificial intelligence importance in facilitating health and 2.6% have “low" estimate in the post test.

Figure 6: percentage of the changed perceived importance of AI in health education in pre- and post-test.



3.3-Results of interview:

The **interview** conducted with 39 student-teachers showed that the majority (over 85%) expressed positive satisfaction with the experience of using AI tools in health education lessons. This experience was described with terms such as "useful," "interactive," and "facilitating the understanding of complex health concepts," reflecting a positive engagement with modern technological applications. A significant percentage of participants (90%), indicated that they used tools such as Chat GPT, Copilot, Adobe express, and Ideogram to design advanced educational activities, awareness posters, educational stories, and providing visual presentations related to nutrition and mental health concepts. Nearly 70% of participants reported that the use of AI stimulated interaction and facilitated the understanding of concepts through visual content or educational simulations. On the other hand, approximately 60% of participants expressed concerns about digital privacy and data collection, emphasizing the need for oversight over the use of AI tools. Regarding the role of the teacher, nearly 90% of participants agreed that artificial intelligence cannot replace teachers, but rather should serve as a supportive tool that serves educational goals. More than 75% of participants also offered development suggestions to improve the use of artificial intelligence in health education, especially: training teachers on the ethical use of technology, ensuring content accuracy, and protecting learners' privacy.

4- Discussion:

Concerning research question1*: To what extent does integrating generative AI tools in health education improve student-teachers' knowledge across social, environmental, and economic sustainability dimensions?*

The results of the interviews and the analysis of the pre- and post-tests of 39 student-teachers, we concluded that the integration of AI tools into health education lessons contributed effectively to improving students' knowledge, attitudes, and ethical tendencies. First, the results of the t-test showed statistically significant differences between the students' scores before and after the intervention, in favor of the post-test, at a significance level of 0.05. For example, the mean score in the nutrition axis increased from 2.89 to 4.21, in physical activity from 2.76 to 4.08, and in health guidance from 3.10 to 4.34. Similarly, the mean score of Environmental Health Education

increased from 1.74 to 5.72, and the Economical Health Education from 2.28 to 10.15. These findings confirm that the use of AI can promote health literacy within the three dimensions of sustainability which support the response to the first research question on the improvement of knowledge. These results are similar with those reported by Xu (2024), who suggested that AI achieved significant positive outcomes in academic performance, motivation, engagement, and overall learning progress. Furthermore, the interview data also demonstrate a better understanding of the significance of technology in health education among student-teachers. This aligns with the findings of Gillespie et al. (2025), who, in their global investigation, noted that while people recognize the potential benefits of AI, they also express concerns around safety, privacy, and its long-term societal impact.

The majority of participants **(**over 85%**)** demonstrated a clear understanding of the role artificial intelligence can play in enhancing interactive learning, particularly in areas such as nutrition, disease awareness, and preventive practices. Also, about 70 % of participants said that they used AI tools like Chat GPT, Copilot, Adobe Express, and Ideogram to create nutrition posters, mental health awareness materials, and other visual content. This shows that they were able to use AI to support health education in both social and environmental sustainability topics. These qualitative findings are consistent with the results of the pre/post-test, which revealed statistically significant differences, according to a t-test analysis, between the pre- and post-test averages, enhancing the reliability of these data. The students' repeated assertion that artificial intelligence helps accelerate understanding and personalize content reflects an improvement in the "knowledge" component related to social, environmental, and economical sustainability, which is the focus of the first research question.

We found that students actually learned a lot more about health, environmental, and economic sustainability after using AI tools. They said they understood health topics better, felt like the learning was more tailored to them, could get accurate information faster, and had an easier time planning out their health-related goals.

Concerning research question2: ***How does the use of AI tools enhance student-teachers' attitudes toward sustainable health education?***

The increased interaction and desire to implement classroom activities, noted repeatedly among participants, reflects a shift in attitudes and tendencies relevant to the second research question. About 77% of students reported feeling more motivated to learn, and that lessons were fun and interactive. 62% specifically mentioned enjoying activities like creating health songs and stories or designing posters, all of which made them feel more connected to the content**.** Many reported feelings more engaged in discussions and engaged with health topics in new ways. This demonstrates that AI is not only a tool for understanding, but also plays a significant role in improving students' attitudes and engaging them more with health education. These outcomes are consistent with Chan and Hu (2023), who found that university students using generative AI for learning expressed greater engagement and motivation, although they continued to emphasize the importance of instructor guidance.

Concerning research question3: ***How does AI-improved health education affect student-teachers' ethical inclinations and decision-making related to health sustainability?***

The ethical concerns expressed by participants regarding privacy or the reliability of information are an indication of the development of critical and ethical awareness among learners, aligning with the systematic review's findings on responsible AI literacy and effective pedagogies that foster ethical learning in K-12 education (Ma, Ng, Liu, & Wong, 2025). which supports the answer to the third question related to decision-making and ethical tendencies.

In the end, students started making healthier and more sustainable choices and were more thoughtful when it came to making decisions about their health. They also brought up some (60%) concerns around privacy and how their data was being used. A lot of them (90%) said it was important to double-check the information they were getting, and they really stressed the need for human oversight and clear rules on how AI should be used responsibly and 54% don't fully trust AI generated.

The interviews also demonstrate a mature understanding of the pedagogical role of the student-teacher, with the majority (90%) expressing the need for a "guiding student-teacher" alongside AI, demonstrating a balanced understanding between technological empowerment and educational leadership, and more than 75% gave helpful suggestions on how to make sure AI is used ethically and effectively. These qualitative findings, when compared to the improved quantitative results after the intervention, confirm that the integration of AI into health education is not limited to enhancing knowledge alone, but extends to shaping sustainable educational attitudes based on awareness, criticism, and ethics.

Conclusion:

The findings of this study confirm that the use of artificial intelligence tools in the health education course led to a significant improvement in sustainable students' knowledge, attitudes, and ethical awareness. These results reflect a growing student awareness of how to use such tools responsibly while safeguarding their privacy. This trend is supported by current educational models like self-directed learning, Piaget's theory of constructivism, and transformative learning models ((Mezirow, 1990), shifting from teacher-centered instruction towards student-centered learning. These models have been found to facilitate students to own their learning and become increasingly active participants within the learning process.

Based on what we found, we recommend adding this AI-supported program to the curriculum across different subjects and majors, especially in health education courses. Doing this would help build a more creative and engaging learning environment. At the same time, the Lebanese University should focus on providing students with strong and reliable internet access so they can fully benefit from AI tools. With better access, students would be able to use AI to create educational content like videos and posters, which are an important part of how these tools enhance learning. this would help students be better prepared for future careers in science and education using tools that reflect global trends.

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Appendix1: pre-post-test

The Role of Artificial Intelligence in the Sustainability of Health Education

This study aims to examine the impact of artificial intelligence tools in teaching health education on the knowledge, habits, and attitudes of student-teachers. Please take a few minutes to answer the questions honestly. Everything you share will stay private and only be used for research.

Section One: Personal Information

1. Full Name: _____
2. Age: _____
3. Gender:
    - Female
    - Male

Section Two: Health Education and Society

Instructions: write the best answer for each question.

4. What does the word "health" mean to you?

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5. What are the main types of health?

Instructions: choose the best answer for each question.

6. What happens when someone doesn't get enough iron in their diet??
    - They feel tired and low on energy
    - Their physical and mental activity improves
    - Their body digests food faster and absorbs more nutrients
    - Has no effect on general health
7. What is the importance of organizing food in the food pyramid?
    - Helps maintain a healthy weight
    - Ensures balanced meals from different food groups
    - Reduces carbohydrates in the diet
    - Encourages excessive olive oil consumption
8. How does being physically active help manage blood sugar?
    - It helps the body make more insulin
    - It helps muscles use sugar as energy
    - It blocks carbs from being absorbed in the stomach
    - It moves sugar straight into the muscles
9. What is the key role of sports in sustainable development?
    - Economic development.
    - Promoting social values like tolerance and inclusion.
    - Supporting elite athletics only.
    - Enhancing industry and agriculture.
10. What is the role of the school health counselor?
    - Solve psychological issues.
    - Organize sports activities.
    - Implement preventive measures and ensure safety.
    - Only teach science-based health subjects.

11. What is the main factor contributing to student smoking despite guidance?
    - Peer influence
    - Allowing smoking in school
    - Teachers promoting smoking
    - Cigarette sales at school store
12. How many servings of fruits and vegetables do you eat per day?
    - None
    - 1–2
    - 3–4
    - 5 or more
13. How often do you eat fast food or snacks weekly?
    - Daily
    - Once or less
    - 2–3 times
    - 4–5 times
14. How many days per week do you engage in at least 30 minutes of moderate activity?
    - 0
    - 1–2
    - 3–4
    - 5–7
15. Do you currently use any apps or devices to track your fitness or health?
    - Yes
    - No
16. How much water do you drink daily?
    - Less than 1 liter
    - 1–1.5 liters
    - 1.5–2 liters
    - More than 2 liters
17. How often do you use cigarettes or hookah in a day?

- Never
- Rarely
- Sometimes
- Regularly

18. How often do you get health checkups or consultations?
    - Never
    - Once a year
    - 2–3 times a year
    - Every three month
19. How many hours do you sleep daily?
    - Less than 4
    - 4–6
    - 6–8
    - More than 8

Section Three: Health Education and Environment

20. What's the best way to prevent infectious diseases?
    - Wash hands and ventilate rooms
    - Take supplements without other precautions
    - Regular low-dose exposure to germs
    - Use antibiotics frequently
21. What should schools do to prevent disease outbreaks?
    - Close school completely
    - Promote hygiene awareness
    - Prevent sharing without promoting hygiene
    - Allow sick students to attend

22. What hygiene measures are followed in public schools?

- Clean water and soap
- Ask students to clean school
- Dump waste without sorting
- One cleaner for entire school

23. How can schools improve environmental awareness?
    - Awareness campaigns and waste separation bins
    - No tech and only paper
    - Reduce trash bins
    - Financial rewards for paper-saving students
24. What is the teacher's role in promoting environmental awareness in health education?
    - Teach apps related to environment
    - Let students research alone
    - Keep lessons separate from real life
    - Encourage use of non-recyclables

Section Four: Health Education and Economy

25. How can school health services improve with limited costs?
    - Digital health platforms for students
    - Remove school counselors
    - Stop routine checkups
    - Handle emergencies only
26. How can schools cut disease prevention costs without harming students?
    - Reduce school days
    - Cancel annual exams
    - Free vaccinations
    - Charge parents for checkups

27. How can hygiene be improved with a small budget?

- Train students to save water and cleaning tools
- Clean bathrooms weekly
- Fewer cleaners
- Fewer sanitizers

28. What is the best way to reduce utility expenses in health facilities?
    - Smart faucets and energy-saving lights
    - Reduce bathrooms
    - Regular maintenance
    - Turn off utilities during school hours
29. What innovative economic strategies can improve school health programs?
    - AI to analyze student health data
    - Remove health programs
    - Stop maintenance
    - Rely on hospitals

Section Five: AI in Health Education

30. Have you ever used AI tools in your studies?
    - Yes, regularly
    - Yes, but rarely
    - No
    - Not sure
31. Have you received any training in using AI for education?
    - Yes, formal training
    - Yes, self-taught
    - No
    - Never heard of these tools

32. If yes, what tools did you use?

33. Do you think AI helps in your learning and teaching?
    - Yes, it helps with learning and creativity
    - Yes, but it still needs improvement
    - No impact
    - Negative impact
34. Do you think AI can improve school health counseling?
    - Yes
    - Maybe
    - Not really
    - I don't know
35. Overall, how do you rate the importance of AI in improving health education in schools?
    - High (9–10)
    - Medium (5–8)
    - Low (1–4)
    - I don't know
36. Do you have any suggestions for improving health education using AI?