Effective Methodologies for Teaching AI and its Tools for Students at the Faculty of Pedagogy

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Abstract

The focus of this study is on the employment of efficient teaching methods for Artificial Intelligence (AI) concepts, their integration in the educational curricula and their practical application. Thus, it aims to identify various teaching methods that can help explain AI concepts and their practical applications, through a pilot-three-chapters modular curriculum for the students enrolled in the Faculty of Education. The curriculum, delivered over four interactive sessions for Math junior students in one of the Lebanese universities, provided a comprehensive introduction to AI, exploring its origins, core principles, and the underlying technologies empowering it. A particular emphasis was put on the hands-on exploration of AI tools which have the potential to transform classroom instruction, empowering teachers and enriching student learning experiences. To thoroughly evaluate the efficacy of the curriculum, a mixed-method research design was employed. The findings demonstrated a significant increase in the students' knowledge and understanding of AI, and also revealed a high level of student engagement and enthusiasm for the curriculum, with a clear preference for the practical tool-focused aspects over purely theoretical content.

Key words

Artificial Intelligence (AI), Pedagogical approaches, Curriculum development, Ethical AI use

Résumé

Cette étude se concentre sur l'emploi de méthodes d'enseignement efficaces pour les concepts d'IA, leur intégration dans les programmes d'études et leur application pratique. Elle vise à identifier diverses méthodes pédagogiques permettant d'expliquer les concepts de l'IA et leurs applications pratiques, à travers un programme pilote modulaire de quatre-chapitres destiné aux étudiants de la Faculté de Pédagogie. Ce programme, dispensé en quatre sessions interactives à des étudiants en mathématiques d'une université libanaise, a fourni une introduction complète à l'IA, en explorant ses origines, ses principes fondamentaux et les technologies sous-jacentes qui la rendent possible. L'accent a été mis sur l'exploration pratique d'outils d'IA ayant le potentiel de transformer l'enseignement en classe, d'habiliter les enseignants et d'enrichir les expériences d'apprentissage des élèves. Pour évaluer rigoureusement l'efficacité du programme, une approche de recherche mixte a été utilisée. Les résultats ont démontré une augmentation significative de la connaissance et de la compréhension de l'IA chez les étudiants, ainsi qu'un niveau élevé d'engagement et d'enthousiasme pour le programme, avec une nette préférence pour les aspects pratiques axés sur les outils plutôt que pour le contenu purement théorique.

Mots-clés

Intelligence Artificielle (IA), Approches pédagogiques, Développement de programmes d'études, Utilisation éthique de l'IA

المستخلص

يركز هذا البحث على استخدام أساليب تدريس فعّالة لمفاهيم الذكاء الاصطناعي ودمجها في المناهج التعليمية وتطبيقها عمليًا. كما يهدف إلى تحديد أساليب تدريس متنوعة تسهم في شرح مفاهيم الذكاء الاصطناعي وتطبيقاته العملية من خلال منهج تجريبي مكوّن من ثلاثة فصول لطلاب كلية التربية. تمّ تقديم المنهج على مدى أربع حصص تفاعلية لطلاب السنة الثانية في قسم الرياضيات بإحدى الجامعات اللبنانية. وقد شمل مقدّمة عامة عن الذكاء الاصطناعي، واستكشاف أصوله ومبادئه الأساسية والتقنيات التي يعتمد عليها. وتمّ التركيز بشكل خاص على الاستكشاف العملي لأدوات الذكاء الاصطناعي التي يمكنها تحويل عملية التدريس في الفصول الدراسية، وتمكين المعلمين وإثراء تجارب التعلّم للطلاب. استّخدم تصميم بحثي يجمع بين الأساليب الكمية والنوعية لتقويم فعالية المنهج. أظهرت النتائج زيادة كبيرة في معرفة الطلاب وفهمهم للذكاء الاصطناعي، كما كشفت أيضًا عن مستوى عالٍ من مشاركة الطلاب وحماسهم تجاه المنهج، مع تفضيل واضح للجوانب العملية التي تركّز على الأدوات بدلًا من المحتوى النظري.

كلمات مفتاحية

الذكاء الاصطناعي(AI) ، المناهج التربوية، تطوير المناهج الدراسية، الاستخدام الأخلاقي للذكاء الاصطناعي

1. Introduction

The increasing integration of Artificial Intelligence (AI) in various sectors, including education (Wang & Johnson, 2019), necessitates a critical evaluation of how higher-education students are prepared to engage with this transformative technology. Many countries have already tried integrating AI in their curriculum like Korea, Indonesia, USA, Finland, … (J. Kim et al., 2022; Fitria, 2021, Mohamed et al., 2022, Pörn et al., 2024). As for Lebanon, one can witness a move towards AI in education through webinars, workshops, and conferences; but, to the knowledge of the researchers, there is no written curriculum to implement as an integrated part of the educational system. Even the preservice teachers during their higher education studies are not offered any course on how to integrate AI in their future careers of teaching and learning.

Recognizing the relation between Mathematics algebra, statistics/probability, logic, … and how AI operates, in addition to the rich literature of implementing and integrating AI in the Math curriculum (Wang & Johnson, 2019; Mohamed et al., 2022; Wardat et al., 2023; Pörn et al., 2024) encouraged the researchers to take a first step in filling the gap of integrating AI in the Lebanese Math curriculum. Moving bottom up from preparing and reinforcing preservice Math teachers with the AI features and the AI tools in general and for Mathematics teaching in particular, a modular was designed to fulfill this perspective to be tried as a pilot study. It is imperative for preservice teachers to acquire practical skills and ethical awareness in precedence of utilizing AI tools and consequently, an acknowledged Math teacher can facilitate an AI-integrated Math Curriculum.

The research aims to identify diverse pedagogical approaches that can facilitate a comprehensive understanding of AI, investigated through the development of a modular curriculum designed for junior Math students enrolled in the Faculty of Education.

By employing a mixed-method research design, the efficacy of the proposed curriculum was assessed. The tools implemented were pre- and post-tests, module evaluations and focus group discussions. The insights collected from this study will contribute to the ongoing discourse on AI education, offering valuable guidance for educators seeking to equip the preservice teachers with the skills necessary to navigate the evolving landscape of AI technologies.

2. Research Questions

The literature highlights the increasing importance of AI literacy across educational levels, emphasizing the need for pedagogical approaches and curricula that not only target theoretical knowledge but also foster practical application. Additionally, studies revealed that teachers should understand the importance of using AI in their classrooms and explain its concepts to the learners with focus on ethical and responsible use. In K-12 mathematics education, AI tools have shown promising results in personalizing instruction and assessment, yet they also raise concerns about overreliance and ethical issues (Pörn et al., 2024). Research also suggests that thoughtfully designed AI curricula, incorporating ethical considerations, can significantly enhance student engagement and understanding (Luckin et al., 2016).

To address these gaps and explore the most effective strategies for empowering future Math educators with the potential of AI in the classroom, within a theoretical framework, this research seeks to answer the following questions:

RQ1: What pedagogical approaches are most effective in teaching Artificial Intelligence (AI) concepts to higher education students enrolled in the Faculty of Pedagogy programs?

RQ2: To what extent does tailoring an AI education curriculum specifically for teacher training programs impact the development of future educators' skills?

RQ3: How can higher education and K-12 students be effectively trained on the responsible use of AI tools and technologies?

RQ4: What feedback do students in the Faculty of Education have on the proposed AI curriculum, and how can this feedback be used to improve the curriculum for future iterations?

3. Literature Review

3.1. Definition of AI

Many definitions of Artificial intelligence exist and the adopted definition in this study is "artificial intelligence refers to applications of software algorithms and techniques that allow computers and machines to simulate human perception and decision-making processes to successfully complete tasks" (Murphy, 2019, p. 2).

There are 4 types of AI, Reactive Machine, Limited Memory, Theory of Mind, and Self-Awareness. The first and second fall under the phase "Artificial Narrow Intelligence", the third under the phase "Artificial General Intelligence", and the fourth under the "Artificial Super Intelligence" (Dorr, 2022). The AI has different subsets and the most known are Machine Learning, Deep Learning, Natural Language Processing, and Robotics.

AI is nowadays applied in different fields like medicine (medical imaging, diagnosis, drug development, disease treatment, …), arts (create art, produce images and music, …), Financial market (fraud detection and security, …), transportation logistics (autonomous vehicles, route optimization, …), and education (student personalized and interactive learning, teacher assistant, …). In education, Magic School AI has been used by teachers to develop lesson plans, work sheets, MCQs, etc.

3.2. AI and education

UNESCO publication highlights the global movement towards integrating AI into K-12 education. By focusing on core competencies, interdisciplinary learning, ethical considerations, and teacher support, these curricula aim to prepare students for a future where AI plays a significant role. The importance of this initiative lies in fostering a well-prepared, innovative, and ethically aware future workforce capable of navigating the complexities of an AI-driven world (K-12 AI Curricula: A Mapping of Government-Endorsed AI Curricula - UNESCO Digital Library, 2022).

Moreover, the review of AI applications in K–12 education offers valuable insights into the evolving role of teachers in the digital age. By embracing AI technologies, educators have the

opportunity to enhance their pedagogical practices and better support student learning. It is imperative to address the associated challenges and ethical considerations to ensure that AI integration is done thoughtfully and responsibly. This underscores the importance of recognizing teachers as key stakeholders in the implementation of AI tools, emphasizing their role as facilitators of meaningful educational experiences (Murphy, 2019). Additionally, the irreplaceable human element of teaching underscores the need for a balanced integration of AI in education (Fitria, 2021).

Kim et al. (2022) investigated Student-AI Collaboration (SAC) through interviews with ten leading Korean AI-Teachers in Education. The study revealed a three-stage progression for students developing SAC: “learning about AI, learning from AI, and learning together” (J. Kim et al., 2022, p. 1). According to “Intelligent Unleashed” (2016), Artificial Intelligence in Education (AIED) refers to computer systems designed to interact with the world using capabilities like visual perception, speech recognition, and intelligent behaviors such as decision-making. AIED aims to enhance education by making learning more personalized, flexible, inclusive, and engaging. It supports teachers and learners by providing tools to respond to both what is being learned and how it is being learned. By integrating human and artificial intelligence, AIED can help students in closing the gaps towards achievement, improve teachers’ retention and development, and equip parents to support their children’s learning (Luckin et al., 2016).

3.3. AI and Math Education

Recognizing the growing importance of AI, Wang & Johnson (2019) conducted a pilot study to explore integrating AI concepts into the high school Math curriculum. Their work aimed to leverage game-based learning to introduce students to AI basics, while emphasizing the new skills and ethical considerations surrounding this technology. The study's foundation lies in the understanding that AI relies heavily on logic, computation, and probability, making mathematics a fundamental building block. The researchers piloted a curriculum in USA schools to identify AI concepts compatible with the Common Core Math Standards. This analysis revealed common ground across topics like algebra, geometry, calculus, and statistics/probability. (Wang & Johnson, 2019).

In addition, a study conducted in Finland explored teachers' attitudes and expectations towards AI in K-12 Math classrooms. The teachers were open to using AI tools, but also cautious about potential risks. They saw AI as helpful for personalization and assessment, but worried about overreliance and ethical issues. The findings showed three teacher attitudes: general openness, concern, and overestimation of AI capabilities. Teachers also expressed a desire to maintain focus on core skills like problem-solving alongside using AI tools. The study highlights the need for AI literacy education and proper teacher preparation, including developing new competencies specific to K-12 AI education (Pörn et al., 2024).

Another study aimed to explore the perspectives of students and educators on using artificial intelligence, particularly ChatGPT, in teaching Mathematics post its launch. The results revealed that ChatGPT is acknowledged for its enhanced Math capabilities and potential to boost educational success by providing foundational Math knowledge and comprehensive instruction; some caution against its integration was recorded. The findings also showed ChatGPT limitations in deeply understanding geometry and correcting misconceptions. Its effectiveness varied with equation complexity, input data, and instructions provided (Wardat et al., 2023).

A review of different studies aims to provide a comprehensive overview of the use of AI in Mathematics education across all educational levels, focusing on studies predominantly from the USA and Mexico. The review analyzed 20 articles published between 2017 and 2021. The findings indicated that AI in mathematics education can significantly improve students' attention and motivation, enhancing training programs and teaching practices; and effective integration of AI can promote creative and critical thinking skills among students and educators. However, AI should complement traditional teaching methods rather than replace them, and educators need a solid conceptual understanding of AI to effectively deliver knowledge to students (Mohamed et al., 2022).

3.4. AI and Curriculum Design

A scientific article outlines an intervention pilot curriculum aimed at fostering AI literacy among Grade 5 and Grade 6 students in Korea. This curriculum focuses on developing three key competencies: AI Knowledge, AI Skills, and AI Attitude. The analysis showed a statistically significant improvement in students' AI Skills, particularly in using AI-based applications,

approaching real-world problems with AI, and creating AI programs using block coding. Additionally, there was a significant positive shift in students' perceptions of AI's societal impact. The study suggests that AI literacy should be achieved through project-based learning and problem-solving activities, rather than focusing solely on AI concepts or tools. The teaching strategies should include: Unplugged Learning, Appropriate Tools and Platforms, and Engaging Topics.

The assessment methods should be objective, focusing on students' interactions, presentations, and discussions. Peer and self-assessment and small group discussions are recommended. The article emphasizes the necessity of preparing students for a rapidly changing society influenced by AI; elementary AI education should aim to develop AI literacy, enabling students to critically evaluate, communicate, collaborate with, and use AI tools effectively (S. Kim et al., 2021).

Another article describes the development and piloting of a curriculum designed to teach middle school students about AI in the context of science. The researchers aimed to create a program that: Engages students with fundamental AI concepts, integrates AI with real-world science problem-solving, and uses an interdisciplinary approach. Findings included: block-based programming appears to be an effective way for students to learn and implement algorithms, the curriculum successfully engaged students and motivated them to learn about AI, and students developed a solid understanding of the presented AI concepts and were able to apply them to solve science problems (Akram et al., 2022).

The design of the modular curriculum considered and benefited from the discussed gaps and findings of the literature review to come up with the intervention pilot curriculum.

4. Theoretical framework

The framework chosen to be adapted in this study aiming to suggest a modular curriculum to teach AI concepts and tools for higher education students specifically in teaching Math are the Intelligent TPACK model and the theory of Connectivism.

4.1 The Intelligent TPACK Model

Mishra and Koehler's Technological Pedagogical Conter Knowledge (TPACK) framework proved to be essential t understand how technology is integrated into teaching and learnin (Koehler & Mishra, 2009). Effective technology integration require a balance of technological knowledge (TK), pedagogical knowledg (PK), and content knowledge (CK) (Mishra & Koehler, 2006) Nowadays, TPACK framework has expanded to include the growin field of AI, leading to the concept of Intelligent TPACK (Xu, 2020) This expanded framework recognizes the challenges an opportunities of integrating AI into education, requiring educators to understand AI technologies and to use them effectively in their teaching while considering the specific subject matter (Holmes et al., 2019).

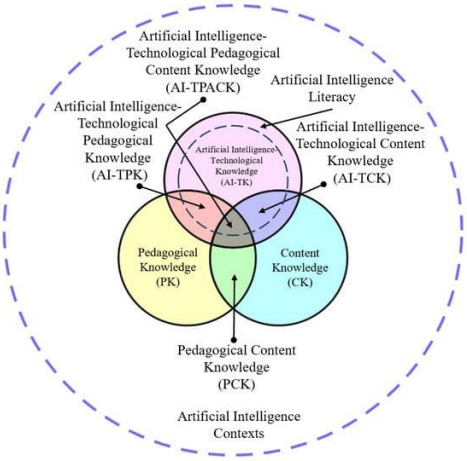

Figure 1 Intelligent TPACK Model summary

4.2 The Connectivism Theory of Siemens

George Siemens mentioned that this theory is more suitable for the revolutionary social networking technologies affecting searching, research, teaching, and learning (Corbett & Spinello, 2020).

Figure 2 Connectivism theory summary

Connectivism learning environment is defined as an environment that supports and inspires learning through a process of establishing a network linking node or resources, sharing and finding out new information facilitated by technology (Techakosit & Wannapiroon, 2015). Learners can use digital platforms to make connections with content, learning communities and other learners to create and construct knowledge, independently (Goldie, 2016).

5. Methods

This study investigates RQ_1- the effective pedagogical approaches of AI concepts for preservice teachers and their practical applications within higher education context; RQ_2- the impact of an AI educational curriculum on the development of future educators' skills; RQ_3- the effective methods to train future educators on the responsible use of AI tools; and RQ_4- the feedback of the participants.

The participants are twelve junior-higher-education students from the Faculty of Pedagogy at one of the Universities in Lebanon specifically for teaching Math in elementary classes. The curricular module designed by the researchers was conducted as part of the participants' course "ICT in education" during their fourth semester to study the efficacy of this module.

The module consists of three engaging chapters delivered over three sessions, and the fourth session was reserved for participants' projects presentation. Briefly, the sessions were distributed as follows:

1. Introduction to Artificial Intelligence embedded the topics: definition of AI, AI's history, the different types of AI, the relation between AI and math, an introduction to machine learning, and the exploration of "Machine Learning for Kids" (ML4Kids).
2. AI subsets and applications: The topics discussed are the AI subsets (Machine Learning, Deep Learning, Natural Language Processing, and Robotics), AI applications in medicine, AI in customer services, AI in education, AI in arts, in addition to AI ethics and responsible use.
3. AI use in education and its tools: The topics discussed were: how AI will affect the teaching methods, what skills should the future educators possess, how to implement AI in lesson planning (Magic Schools AI), and AI tools to generate presentations, photos, videos, voices, …
4. Projects' presentations: The last session was reserved to showcase participants' projects reflecting the practical skills they have acquired from this module.

Knowing that there is no one definite agreement on AI concepts, this curriculum was crafted following the recommendations of UNESCO retrieved in the booklet "K-12 AI Curricula:

A Mapping of Government-Endorsed AI Curricula", 2016; in addition to other articles retrieved particularly in Coursera.

To assess the effectiveness of the AI module, a pre- and post-test was employed. The tests consisted of two parts:

1. AI Knowledge Assessment (Included multiple-choice, short answer, and true/false questions).

2. Self-Esteem and Perceived Competences (Used a Likert scale to gauge participants' self-esteem regarding the participants' familiarity with AI concepts, confidence in their abilities to teach AI, conceptual understanding of the Magic School AI platform, and participants' perceived adaptability of teaching methods to incorporate AI).

The same test was administered before and after the module to measure changes in knowledge and self-esteem. The quantitative data collected from these tests were then analyzed using SPSS to determine the statistical significance of any observed change.

In addition, an evaluation form was prepared with some open-ended questions to learn about the participants' perspectives and recommendations.

A focus group discussion also was conducted with eight of the participants to consider their feedback and suggestions, and obtain more data about the impact of the module.

6. Results

6.1 Quantitative data

As stated before, the pre and post tests were used to study the effectiveness of the module prepared. 12 students of 12 have filled them, knowing that the test is the same. The collected results can be retrieved in the table below:

Table 1 Results of the pre-test

Student ID	AI concepts	AI applications	AI tools	Total	Self Esteem about AI				
Total	4	4	2	10	familiarity	ability to teach AI	Magic school	adaptability of teaching methods to AI	Total
1	2	0	0	2	1	0	0	0	1
2	3	4	1	8	0	1	0	1	2
3	0	0	0.5	0.5	0	0	0	0	0
4	0	4	1	5	0	1	0	1	2
5	0	4	0	4	0	0	0	0	0
6	2	2	0	4	0	0	0	1	1
7	1	2	1	4	1	0	0	1	2
8	2	2	0	4	0	0	0	0	0
9	4	0	0	4	1	0	0	0	1
10	3	4	1	8	1	0	1	1	3
11	2	4	0.5	6.5	1	0	1	1	3
12	3	4	0.5	7.5	1	1	0	1	3

Table 2 Results of the post-test

Student ID	AI concepts	AI applications	AI tools	Total	Self Esteem about AI				
Total	4	4	2	10	familiarity	ability to teach AI	Magic school	adaptability of teaching methods to AI	Total
1	3	4	2	9	1	1	1	1	4
2	4	2	2	8	0	1	1	1	3
3	4	4	2	10	1	1	1	1	4
4	3	2	2	7	1	1	1	1	4
5	3	4	1.5	8.5	1	1	1	1	4
6	4	2	2	8	1	1	1	1	4
7	4	4	1.5	9.5	1	1	1	1	4
8	4	4	2	10	1	1	1	1	4
9	4	4	2	10	1	1	1	1	4
10	4	4	2	10	1	1	1	1	4
11	4	4	2	10	1	1	1	1	4
12	4	4	1.5	9.5	1	1	1	1	4

These collected data were analyzed and compared using SPSS. Note that the grade is divided in a way to be able to measure and compare the impact of each component of the AI module on the participants: AI concepts, AI application, AI tools, their total and AI self-esteem asking about learners' familiarity of AI, Magic School AI, their adaptability of teaching methods, and ability of teaching AI. The charts have shown that the grades of the learners were higher in the post-test.

Table 3 Statistics of the pre-test

Statistics						
		Pre-AI Concepts	Pre-AI Applications	Pre-AI tools	Pre-AI Test Total	Pre-AI Self Esteem
N	Valid	12	12	12	12	12
	Missing	0	0	0	0	0
Mean		1.83	2.50	.46	4.79	1.50
Std. Error of Mean		.386	.500	.130	.675	.337
Median		2.00	3.00	.50	4.00	1.50
Std. Deviation		1.337	1.732	.450	2.340	1.168
Minimum		0	0	0	1	0
Maximum		4	4	1	8	3

Table 4 Statistics of the post-test

Statistics						
		Post-AI Concepts	Post-AI Applications	Post-AI Tools	Post-AI Test Total	Post-AI Self Esteem
N	Valid	12	12	12	12	12
	Missing	0	0	0	0	0
Mean		3.75	3.50	1.88	9.13	3.92
Std. Error of Mean		.131	.261	.065	.296	.083

Median	4.00	4.00	2.00	9.50	4.00
Std. Deviation	.452	.905	.226	1.025	.289
Minimum	3	2	2	7	3
Maximum	4	4	2	10	4

The statistics of the grades obtained from the pre and post tests showed a significant improvement in the mean of the grades of the 4 aspects of the tests and its total. The mean of the grade of AI concepts increased from 1.83/4 to 3.75/4, the mean of AI applications increased from 2.50/4 to 3.50/4, the mean of AI tools increased from 0.46/4 to 1.88/4, and the mean of the total test increased from 4.79/10 to 9.13/10. In addition, the mean of the self-esteem score increased from 1.50/4 to 3.92/4.

In order to measure the impact of the designed modular curriculum on the knowledge of the participants, a paired sample T-Test was conducted.

Table 5 Paired sample T-Test between the results of pre and post tests

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre-AI Concepts – Post-AI Concepts	-1.917	1.165	.336	-2.657	-1.177	-5.702	11	.000

Pair 2	Pre-AI Applications – Post-AI Applications	-1.000	2.174	.628	-2.381	.381	-1.593	11	.139
Pair 3	Pre-AI tools – Post-AI Tools	-1.417	.515	.149	-1.744	-1.089	-9.530	11	.000
Pair 4	Pre-AI Test Total – Post-AI Test Total	-4.333	2.640	.762	-6.011	-2.656	-5.686	11	.000
Pair 5	Pre-AI SelfEsteem – Post-AI SelfEsteem	-2.417	1.240	.358	-3.205	-1.629	-6.751	11	.000

The paired sample T-test is used to analyze pairs, which are essentially a one-sample t-test performed on difference scores (Zimmerman, D. W, 1997). Therefore, the paired sample T-test is used to compare the scores of pre and post-tests and to study the impact of the designed module on participants' knowledge.

The results showed that on a degree of difference of 0.05, the significances of the AI concepts, AI tools, total grade, and self-esteem were 0.00 which means that they are statistically significant. However, the significance of AI applications was 0.139, therefore it is not significant.

6.2 Qualitative data

6.2.1. Focus group discussion

The participants answered the focus group questions as follows: "We discovered a topic that is useful to us and at the same time makes our lives easier and is now often used in daily life."

"No, it is an important topic because if we had not taken the theoretical topic, we would not have had the ability to move to the applied tools, which means that we know how to work with applications related to any.".

"The module we took makes us use any of the tools to prepare a video or a lesson plan to our class according to the need of our students. Instead of searching for videos for example, I can make it.".

"We learned to create appropriate content for all learning styles in our class. We also learned to prepare a lesson, to make a song, and to prepare a video of all of these we learned from this module."

To be able to analyze the data collected from the focus group discussion, the transcription of the discussion was analyzed by decomposing it into several codes which were regrouped into the following themes: Curriculum feedback, Skills for future teachers, Pedagogical approaches, Effective training, Theory VS Practical, Future AI trainer, Daily Life Skills, Role of AI in Education, New role of teacher with AI integration, and Future teachers' perception of AI benefits to students.

The focus group discussion showed that the participants have positive feedback for the module because AI was a new topic to them and they found it interesting. Despite that, they liked the focus on the AI tools more since they were more interested in it and they preferred to do more practical work in the classroom and work together on the AI tools. They assumed also that this lesson will help them in their future work as now they consider themselves able to transform their lessons into videos using the AI tools they have learnt. They have also acquired the skills needed to train their students and other teachers on AI. Nevertheless, they are convinced that AI won't replace teachers in the classroom but it will change the methods of teaching.

6.2.2. Module evaluation form

The feedback of the participants about the designed module has been collected in a form, and the results are summarized in the charts below:

Figure 3 Chart representing the satisfaction of the participants toward the module

This chart shows that the majority of the participants have a very good and excellent as general feedback, they were satisfied and want to suggest the module to other teachers.

Figure 4 Chart showing the contribution of the module to participants learning

This chart shows that the participants have considered this module as a good contributor to their learning as their level of skills has augmented by the end of the module.

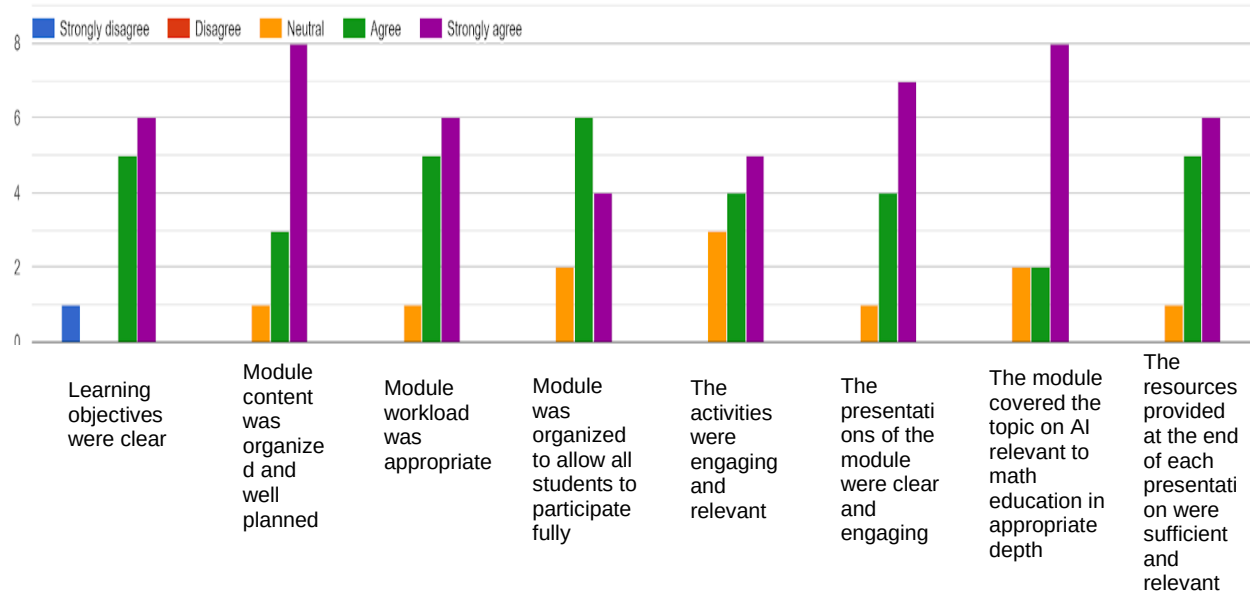

Figure 5 Chart representing the evaluation of the module by participants

The general feedback showed that the participants found the module interesting and they didn't have a major concern about it.

In addition, open ended questions to know in deep the participants' feedback about the module and if they have other suggestions resulted in the following themes: Curriculum feedback, Skills for future teachers, Pedagogical approaches, Theory VS Practical, Role of AI in Education, Future teachers' perception of AI, Benefits to students, and Responsible use of AI. The participants showed positive feedback toward the module, they suggested having more time allocated to the practical work e.g. AI tools, in addition to making it more interactive. They think that AI is reforming education, which will need new approaches and methods of teaching. They also found that this module will help them in making Math more interactive while teaching their future students, in addition to recognizing the importance of teaching their students the responsible use of AI and critical thinking.

6.2.3. Analysis of Participants Projects

The project assigned to the participants was to prepare a completed Magic School AI lesson plan for 50 mins (including objectives, activities, and assessment), with a short video between 40 and 60 seconds utilizing a minimum of four AI tools from the ones we have discussed in the class (Slides GO, Open Art AI, Play HT, Runaway, ChatGPT, or Gemini), explaining a chosen objective from their lesson plan.

The projects prepared by four of the participants showed the excellence of using the AI tools; they showed high critical thinking skills while criticizing the lesson obtained in Magic School AI and then, adapting it into the Lebanese curriculum context. Another seven participants didn't go so far, they used only two of the learned tools: a chat bot and a video creator and presented their lesson plan as they are. In addition to one participant who was unable to prepare a video.

7. Discussion

The quantitative and qualitative data collectively illustrate the effectiveness of the designed AI module to enhance the participants' knowledge and skills related to AI. The significant improvement in test scores, especially in AI concepts, tools, and the overall AI knowledge demonstrates the module's success in enhancing the participants' practical skills and knowledge about AI. The qualitative data further reinforces these findings by highlighting the participants' positive perceptions of the module, their increased confidence in using AI, and their enthusiasm for integrating AI into their future teaching practices. However, the non-significant improvement in AI applications and the feedback of the participants on having a part focused more on practical applications suggests that the curriculum needs to be adjusted and be further adapted. The results of this study provide valuable insights into the research questions posed.

Answer to RQ1: This study revealed that a combination of theoretical instruction and hands-on, practical application of AI tools was highly effective. Participants demonstrated a significant increase in their knowledge of AI concepts and expressed a preference for the practical, tool-focused aspects of the curriculum. This suggests that pedagogical approaches that emphasize active learning and real-world application are crucial for effectively teaching AI to higher-education learners.

Answer to RQ2: A tailored AI curriculum significantly impacts the development of future educators' skills. The curriculum not only enhanced their understanding of AI concepts but also boosted their confidence in using and teaching AI. The focus on practical applications and tools relevant to education empowered learners to know how they could integrate AI into their future classrooms.

Answer to RQ3: Effective training should include theoretical instruction on AI ethics and biases, alongside practical guidance on evaluating AI tools and using them responsibly. This aspect needs to be detailed further including case studies and a well-developed rubric about AI ethics to be used by students.

Answer to RQ4: Participants' feedback was positive inn general. They appreciated the hands-on, practical nature of the curriculum and expressed a desire for even more time dedicated to exploring AI tools. Hence, future modifications of the curriculum could further emphasize practical application and provide more opportunities for learners to experiment with different AI tools in educational contexts. Additionally, while participants valued the theoretical instruction, they expressed a preference for the practical aspects, indicating that the balance between theory and practice could be further refined.

The results of this study align with the theoretical frameworks of Intelligent TPACK and Connectivism, which guided the curriculum design and assessment.

The significant improvement in learners' knowledge of AI concepts, tools, and the overall AI understanding, as evidenced by the pre- and post-test results, demonstrates the effectiveness of the curriculum in enhancing their Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The hands-on exploration of AI tools and their application in educational contexts fostered the development of TK and PK, while the theoretical instruction on AI concepts strengthened CK. This aligns with the Intelligent TPACK framework, which emphasizes the importance of balancing these three knowledge domains for effective technology integration in education.

The positive participants' feedback on the module's practical and interactive nature, as well as their expressed desire for more opportunities to explore AI tools, reflects the principles of connectivism.

The curriculum's emphasis on self-directed learning, exploration of online resources, and the final project activity fostered a learning environment where learners could connect with information, build their own knowledge networks, and engage in autonomous learning. The focus group discussions further highlighted the participants' ability to connect AI concepts to their existing knowledge and envision using these tools in their future classrooms, demonstrating the connectivism principle of knowledge construction through connections and interactions.

However, the non-significant improvement in AI applications suggests more opportunities for students to connect AI applications to real-world problems and explore their potential impact on society, aligning with the connectivism emphasis on the relevance and applicability of knowledge. Additionally, providing more explicit guidance on how to evaluate and critically analyze AI applications could further enhance learners' TK and PK, as emphasized by the Intelligent TPACK framework.

8. Conclusion

This study highlights the importance of a comprehensive and engaging approach to AI education for future teachers. By combining theoretical instruction with hands-on exploration of AI tools and emphasizing ethical considerations, educators can empower students with the knowledge and skills necessary to navigate the evolving landscape of AI in education. The positive feedback from participants and the significant improvement in their AI knowledge and self-esteem attest to the effectiveness of the proposed curriculum. However, the study also highlights areas for further refinement, such as increasing the focus on practical application and exploring the reasons behind the non-significant findings regarding AI applications. These insights can inform the development of future AI curricula and contribute to the ongoing conversation about the role of AI in education. In addition, a room should be spared for the ethical and responsible use of AI in education. With a no clear vision or refinement on how higher-education students can use AI, questions arise if lesson preparation with AI and video preparation using AI has to be considered under plagiarism or to be allowed for teachers in their classrooms. Further research is deemed concerning the AI integration with different learning approaches in particular those related to the student-centered learning.

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