



Towards A Sustainable Urban Environment: Teacher Competences and Artificial Intelligence to Strengthen Civic Engagement in Future Generations

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Annotation. The article examines the interaction between civic education, teacher competencies, and MI in promoting sustainable urban development. Recognizing civic engagement as a cornerstone of urban sustainability, teachers play a crucial role in shaping future citizens through culturally grounded and technologically enhanced pedagogical practices. The study uses a semantic and systematic literature review, using Scopus MI and PRISMA 2020 methodology to identify the latest theoretical insights.

Keywords: *civic engagement, civic education, community, cultural context, sustainable urban environment, teacher competences, AI integration.*

Introduction

Teachers are that part of society that, through their personal example, values, beliefs, communication culture in the local community and professional competencies,

is able to promote the growth of the new generation, the transformation of knowledge and understanding in accordance with the needs of modern society (Siliņa-Jasjukeviča et al., 2024; Zhou et al., 2024), use artificial intelligence in all areas of life, and fight against such long-term global challenges as climate change, urban urbanization, which contributes to environmental pollution, and social and economic inequality. Therefore, it is very important to pay attention to the quality of the development of teachers' competencies, which will also be analyzed in this study.

One of the fundamental prerequisites for the development of a sustainable urban environment is the active engagement of citizens in shaping their cities. Sustainable urban development is affected by the actions of citizens and entrepreneurs who shape urban regeneration through everyday practices (Horelli & Wallin, 2024). The role of community engagement in sustainable urban planning is recognized as one of the most important factors for a sustainable city (Bokolo, 2023; Deep, 2023; Wang, 2025).

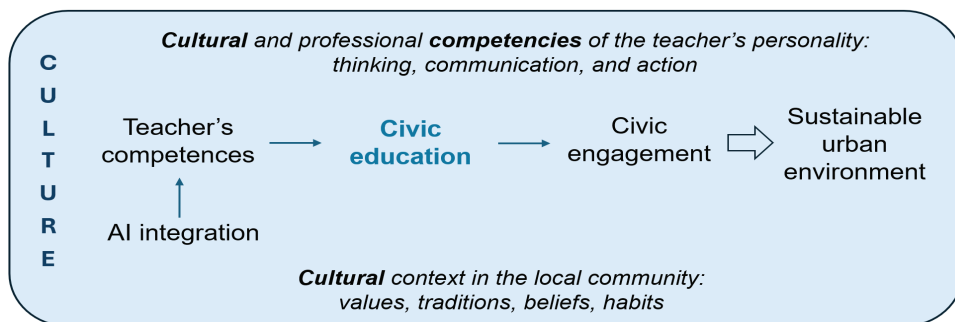
In the global context, the leaders of 192 UNESCO member states are discussing the role of culture in sustainable development at the Mondiacult 2025 forum, writing in the introduction to the appeal: "Culture is not only a mirror of our societies, but also a significant driver of change, cohesion, and development. It is through culture that identities are formed, creativity is promoted, and innovative responses to contemporary challenges are created. Culture connects us with our past and guides us into our future, which is the basis of social, economic, and environmental well-being." The concept highlights the need to find solutions to the range of global problems listed in the Mondiacult 2022 declaration, adopted in Mexico City, related to climate change, ecological disasters, risks of the introduction of artificial intelligence, social inequality, and geopolitical peace. One of the solutions to the problems is the synergy of culture with education, which can promote the transformation of the culture of thinking, communication, action, and the transfer of values and traditions from generation to generation (UNESCO, 2022; 2025).

Figure 1 illustrates the role of civic education in achieving sustainable urban development, taking into account the personal competencies of the educator, as well as the cultural context of the local community.

As mentioned previously, civic engagement is one of the key drivers of sustainable urban development, and civic education plays a vital role in enhancing civic engagement in society. There is the assumption that civic education plays a key role in youth's political sophistication (Alscher, 2022). Civic education is equipping individuals with the knowledge, skills, values, and attitudes necessary for active engagement in civic life (Altaany & Abdelbary, 2024; Kamboni et al., 2025). So, active civic engagement depends on qualitative civic education.

Figure 1

The Role of Civic Education in Achieving a Sustainable Urban Environment: Considering the Cultural and Professional Competence of the Educator and the Cultural Context of the Local Community



Quality of civic education, in turn, depends on teachers' competencies. There are different skills that civic education teachers must have to be successful in civic education. Among them, the acquisition of skills in information and technology is of paramount importance (Gomez & Suarez, 2023). As technological advancements and shifts in social behaviour continue to redefine the digital landscape, it is important to examine the role of artificial intelligence (AI) as a tool for enhancing civic engagement through the meaningful integration of civic education.

The aim of the research is to identify contemporary theoretical insights, trends, and strategies at the intersection of AI, civic education, and sustainable urban environment, particularly in the context of teacher professional development.

Research questions:

1. How can teacher competencies and artificial intelligence strengthen civic engagement in creating a sustainable urban environment for future generations?
2. What are the theoretical findings of the last six years and their trends in the development of teachers' professional competences in the context of AI and the level of civic engagement of students in general education?
3. What specific digital AI competencies should teachers develop to promote civic education for students in the context of future urban development?

Research tasks:

1. Using the expert method and the snowball method in literature selection to explore the concepts of scientific research conducted so far, in the last 8 years, on the role of civic engagement in a sustainable urban environment and the role of teacher competencies in civic education in the context of sustainable urban development, to later compare these findings with the results obtained

- in the semantic systemic literature analysis, which would be commented on in the discussion part.
2. Find the methodological justification for using the Scopus AI semantic systemic literature selection tool, performing the mechanical process of PRISMA 2020 systematic literature selection, using the expert method and Boolean variables, ensuring the validity of using this method for conducting scientific research.
 3. Perform a semantic systemic literature analysis in the Scopus scientific article database, creating a researcher dialogue with the AI tool to verify the accuracy of artificial intelligence in searching for the latest, the last 6 years of scientific findings, generating summaries, and visualizing keywords in the mind maps.
 4. Using the expert method and the PRISMA 2020 method, perform a 2-step analysis, evaluate the scientific articles selected by the Scopus AI semantic literature selection tool to verify the scientific validity and validity of the conclusions and summaries generated by the Scopus AI tool.
 5. Using the expert method, perform a thematic analysis of the full texts of the selected articles to compare with the conclusions generated by Scopus AI, and then compare the results.

Previous research on civic education and student engagement in sustainable urban development

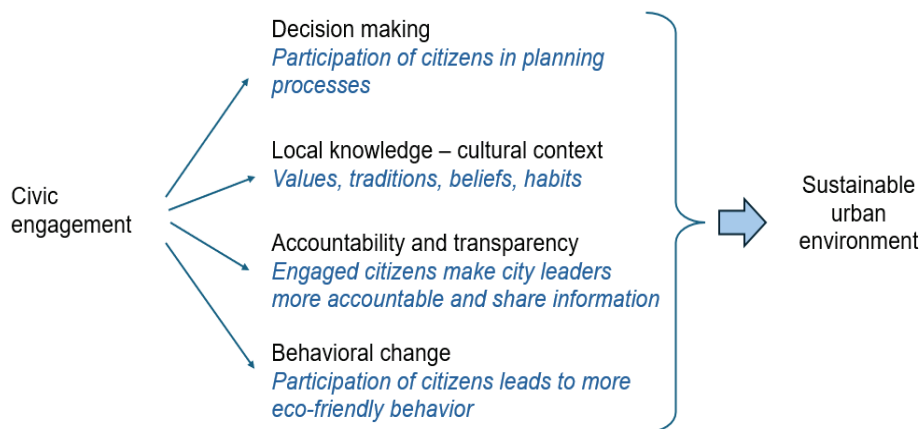
Using the expert method and the snowball method in literature selection, the concepts of previous scientific research conducted in the last 8 years on the role of civic engagement in sustainable urban development and the role of teacher competencies in civic education in the context of sustainable urban development were summarized.

Role of civic engagement in the sustainable urban environment

Civic engagement is an important aspect of the sustainable urban environment. Active civic engagement helps to create and maintain urban sustainability. Main aspects of how residents of the city can engage and promote sustainable urban development are summarized in Figure 2.

Figure 2

Aspects of Civic Engagement to Ensure a Sustainable Urban Environment



The role of civic engagement in sustainable urban development through decision-making and urban planning is one of the most studied questions in scientific articles. The main conclusion in the articles is that the presence and participation of people in sustainable urban planning and decision-making are necessary and inevitable (Samadi & Rafatshahmari, 2017; Hoffman, 2024). Wang (2025) pointed out that “community engagement is increasingly recognized as an essential element of the planning process, especially in addressing social, environmental, and economic sustainability”. Horelli and Wallin (2024) argue that although civic engagement is recognized as an important factor for sustainable urban development, in real life, citizens are not sufficiently involved in the urban planning process. The authors revealed that in the urban planning process, it is necessary “to extend the focus of civic engagement from public participation to self-organisation and everyday life practices”.

Civic engagement is the way in which local knowledge can help to ensure sustainable urban development. Remr (2023) studied the usefulness of civic engagement in smart cities, taking into consideration the sustainability aspects of the smart city. He concluded that active engagement in civic activities contributes to the development of local communities. People representing local communities understand the local conditions better; they can provide context-specific solutions or participate in the preservation of cultural heritage, both tangible and intangible. Berceanu (2024) noticed that public administration authorities are responsible for safeguarding cultural and natural heritage but often fail to provide sufficient financial and management resources for heritage sites. In this case, voluntary community engagement in safeguarding cultural and natural sites is of great importance. But it is necessary to note that the transfer

of local knowledge to the city administration depends on the capacity of citizens to organize themselves in order to pursue community goals” (Pesch et al., 2018, p. 301).

Civic engagement is essential not only for partnership with local authorities but also for cooperation with companies. The study of Liu et al. (2025) reveals that public participation leads to stricter environmental regulations, thereby reducing greenwashing practices in companies. Public sector organizations can benefit from introducing new instruments that can empower citizens and facilitate the accessibility of information (Nguyen et al., 2024). Civic engagement will help to change the behavior of the citizens, and especially, environmental sustainability can be enhanced through better civic engagement (Linkhart, 2018). If citizens are following recycling principles in their daily life (for example, sorting of waste, clothing reuse), or they are participating in other initiatives like urban gardening (Zrnic & Rubic, 2018; Cloutier, 2023), clean-ups (Jorgensen, 2021), maintenance of green areas in the courtyards of urban residential buildings (Miśkowiec, 2023), then the urban environment will be more sustainable.

Role of teachers’ competencies in civic education in the context of sustainable urban development

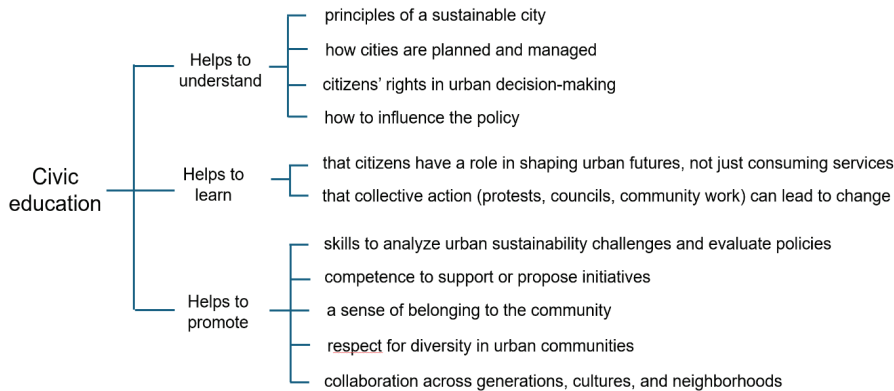
At first, civic education is important to enhance civic engagement because it provides citizens, especially youth, with knowledge about sustainability and skills, values, and motivation to follow sustainability principles. The summary of how civic education can help to increase civic engagement is illustrated in Figure 3.

Civic education gives people an understanding of sustainable city principles, in particular, an understanding of city planning and management (Aldegheishem, 2023), citizens’ rights in the urban decision-making process (Chanda, 2023), and possibilities to influence the policy. Kamara (2025), in the study about civic education’s impact on peace and sustainable development, revealed that civic education impacts sustainable development and that the government should encourage civic education in schools, starting from primary school to tertiary education institutions.

Studies show that civic education increases students’ future levels of voting and other forms of political engagement, for example, participation and organization of protests, participation in NGO’s, and in community work (Owen & Iron-Groth, 2020). Civic education also helps to promote the skills of the citizens necessary to understand, analyse, and evaluate policies related to the sustainable development of the city. With active participation in qualitative civic education, students gain competencies to responsibly participate in political and civic life (Alscher et al., 2022).

Figure 3

Ways in Which Civic Education Can Contribute to Civic Engagement in the Context of Sustainable Urban Development



Effective civic education helps promote such important aspects of a sustainable urban environment as an individual's sense of belonging to the community, knowledge, and respect for its values, traditions, beliefs, and customs, respect for diversity, and cooperation. By learning and respecting the values accepted in the community, students improve their quality of life within this community (De los Reyes Villareal et al., 2023). The results of the Arifin (2019) study about the role of citizens' education in forming the attitude of diversity tolerance prove that civic education can build tolerance among students.

The role of teacher competencies in civic education is crucial in promoting sustainable urban development, as teachers can help young people understand, engage, and act by the principles of sustainable development and the cultural traditions of the local community. It should be noted that teacher competences are multidimensional, as they are influenced by the character of a particular personality, temperament, stress resilience, amount of knowledge, length of pedagogical experience, and the ability to metacognitively self-analyze their thinking, feelings, and actions. Of course, this is influenced by various factors, including the policy framework of the educational ecosystem and the specific institution, and the communication culture in which the teacher works. The teacher's attitude towards what he does also plays a significant role in the process of educating and raising students. Teacher competence, grounded in a deep understanding of subject content, pedagogical processes, and the learners themselves, particularly emphasizes addressing students' diverse social, emotional, and academic needs. It represents a continuous process of professional development that is closely linked to teaching effectiveness and the delivery of high-quality instruction. This competence manifests through the activation of students' cognitive and metacognitive abilities, as well as through positive classroom management practices

that provide meaningful support to students (OECD, 2025). Thus, the foundation of a teacher's professional competence can be conditionally defined by four core elements: knowledge, understanding, attitude, and agency. These elements pertain to: the diverse processes of teaching and learning and their mutual interaction; the cognitive and metacognitive development of the student; the content framework of the subject matter and its significance within the broader educational curriculum; and the legal framework governing the pedagogical process.

AI integration in teachers' competencies

The role of AI in education is a hot topic among scientists around the world, but one that has not been widely studied to date. Alamelu et al. (2025) concluded that AI can help: (1) to automate repetitive administrative tasks (teachers have more time with students); (2) to switch to personalised learning, identifying each student's strengths and weaknesses; (3) to improve the engagement of each student; (4) to select and organize AI-generated content for studies. Teachers must continue professional development and adopt new technologies to implement AI-enhanced education (Alamelu, 2025).

Methods

Semantic, systematic literature review by search tool Scopus AI

The Scopus AI tool is a randomized, subscription-based feature that utilizes the Scopus database of peer-reviewed research articles. It processes queries using an enhanced, sentence-level, generative, pre-trained transformer developed by OpenAI for its ChatGPT, and then retrieves the most relevant documents from a vectorized search index (Georgieva-Trifonova et al., 2020; Thomas et al., 2017).

The specificity of the Scopus AI query determines the depth of detail provided in the response. The prompt engineering that drives the large language model uses factors such as 1) relevance, 2) recency, and 3) citation count to prioritize the articles included in the AI-generated summaries. The initial summary typically cites up to 10 articles. Later, based on the researcher's choice, an extended summary by using RAG (Retrieval-Augmented Generation) fusion technology to explore the query from various and alternative perspectives – may include up to 20 items.

This approach ensures that Scopus AI supports its responses with Scopus content based on three criteria:

- 1) All claims must be backed by references.
- 2) Results must meet standards of quality and coherence;
- 3) Reliability – referencing reduces the likelihood of inaccuracies.

During the search process, search criteria are algorithmized and prioritized, and standardized strategies are developed – for example, cosine similarity calculation – to

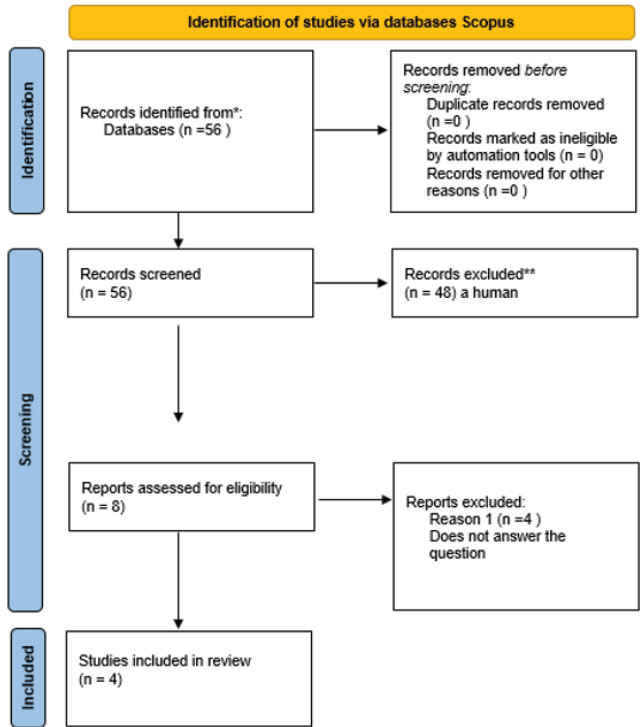
find the most relevant summaries for documents. These are then passed to the large language model, which evaluates whether the summaries can be used to generate a valid response to the query. The specificity of the query also determines the depth of detail in subsequent query generations through iterative and subordinate functionalities. The researcher engages in a dialogue with Scopus AI (Thomas et al., 2017).

The PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) scheme (Page et al., 2021) was used for systematic literature analysis. Scientific studies that support and describe the Scopus AI semantic literature analysis methodology were searched for.

Keywords with Boolean operators were entered into the Scopus database search engine: methodology AND for AND systematic AND semantic AND search AND from AND literature. 56 scientific articles were obtained and selected according to 3 criteria: (1) relevance to the defined topic and question; (2) literature in English; (3) open access.

As a result, 8 publications were selected from 56 publications that meet all 3 criteria and relate to the semantic methodology of systematic literature review. Of these, only 4 help explain the artificial intelligence-driven research tool available in the Scopus database for semantic publication search and analysis (see Figure 4).

Figure 4
PRISMA 2020 for Systematic Semantic Scopus AI Tools Methodology



The research methodology used the PRISMA 2020 scheme for systematic literature review, as well as the AI semantic literature search tool from the Scopus database. The functionality of this tool determined the boundaries of the study – scientific articles were searched only in the Scopus database, excluding other databases and registers.

Innovations in the methodology:

1. Authors engaged in an interactive dialogue with the Scopus artificial intelligence semantic literature search tool.
2. Readers are encouraged to apply critical thinking by directly reviewing the responses generated by the Scopus artificial intelligence and comparing their insights with the findings and conclusions of the researcher, the author of the article.

Research strategy:

1. Using the Scopus artificial intelligence semantic literature search tool, review the initial summary and graphic concept map of the research topic.
2. Expand the search using an interactive dialogue with the Scopus artificial intelligence.

Limitations:

The authors of the article, when citing the Scopus AI-generated answer to the research question, removed references that Scopus AI had included to avoid including studies in the article’s bibliography that may later be excluded after quantitative and qualitative evaluation. The authors have retained the original Scopus AI file.

An expert method for evaluating scientific articles selected by Scopus AI

The 40 articles selected by Scopus AI were evaluated by 2 experts based on 10 quantitative exclusion criteria (Table 1). If an article meets at least one exclusion criterion, it is excluded from further evaluation.

Table 1
Evaluation Result of 10 Quantitative Exclusion Criteria

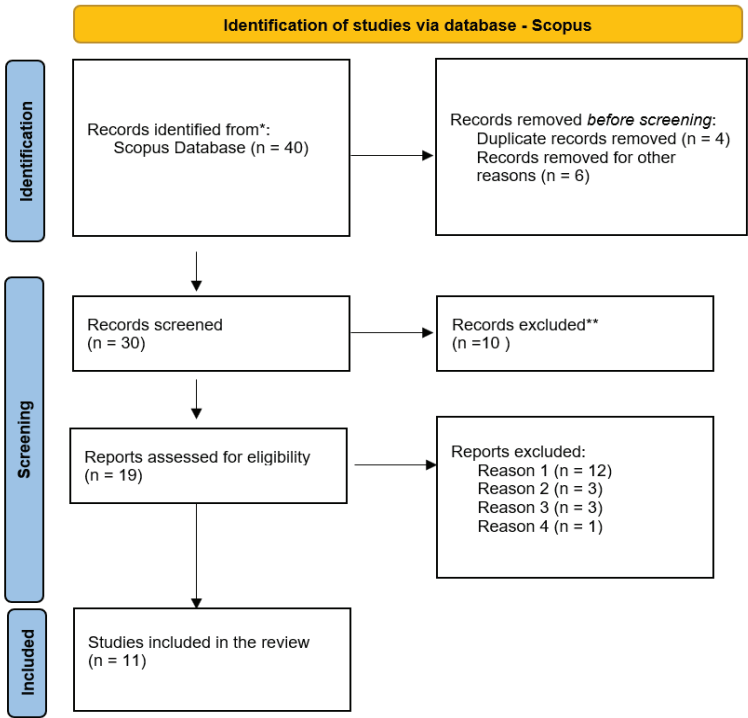
Criterion		Description of Criterion	n=40
1	Articles are duplicates in the first and second Scopus AI selection rounds.		n=4
2	Articles do not reflect scientific concepts from the last 6 years, as they were published in 2018 or earlier.		n=2
3	The article does not have a DOI link.		n=1
4	The article is not in English.		n=1
5	The article is published in a Russian journal.		n=1
6	The article justifies the PRISMA research methodology and does not refer to content analysis.		n=1
Total excluded articles:			n=10
Number of articles for further evaluation:			n=30

Criterion	Description of Criterion	n=40
7	Articles are not freely available for full-text review.	n=12
8	In the articles, 70% of the referenced literature is older than the last 10 years.	n=3
9	The topics, keywords, and abstracts of articles are not related to Educational Sciences.	n=3
10	The article has not been cited at least once (not applicable to articles from the year 2025).	n=1
Total excluded articles:		n=19
Final result:		n=11

As a result, out of 40 articles selected by Scopus AI, 29 articles were excluded, and 11 were forwarded for further assessment of thematic relevance according to 4 qualitative criteria.

The quantitative assessment of the systematic literature, carried out according to the previously defined criteria, is schematically summarized in PRISMA 2020 (Figure 5).

Figure 5
PRISMA 2020 for Systematic Literature Review by Experts



As a result of the articles selected by Scopus AI and quantitatively evaluated by 2 experts, the remaining 11 articles are further evaluated according to 4 qualitative, thematic criteria, with 2 experts reading abstracts, studying keywords, and full articles.

Results

Scopus AI Semantic, Systematic Literature Search Process

In the Scopus AI semantic literature search tool, the following phrase was entered: How can teacher competencies and artificial intelligence strengthen civic engagement in creating a sustainable urban environment for future generations? Copilot generates the answer (Figure 6):

Figure 6

Copilot Answers the Question: How Can Teacher Competencies and Artificial Intelligence Strengthen Civic Engagement in Creating a Sustainable Urban Environment for Future Generations? (Scopus AI, 2025)

Performing keyword search:

("teacher" OR "educator" OR "instructor" OR "facilitator") AND ("competence" OR "skill" OR "ability" OR "proficiency") AND ("artificial intelligence" OR "ai" OR "machine learning" OR "deep learning") AND ("civic participation" OR "community engagement" OR "public involvement" OR "citizen participation") AND ("sustainable" OR "eco-friendly" OR "green" OR "environmentally friendly") AND ("urban" OR "city" OR "metropolitan" OR "town") AND ("environment" OR "ecosystem" OR "landscape" OR "setting")

Summary

To create a sustainable urban environment, integrating teacher competencies and artificial intelligence (AI) to strengthen civic participation in future generations is essential. Here's how these elements can be synergized:

Teacher Competences in Sustainable Education

1. Digital Literacy and AI Competence:

- Teachers need to develop digital literacy and AI competencies to effectively integrate these technologies into their teaching practices. The Teacher Digital Competence (TDC) framework, which includes personal-ethic and personal-professional competencies, is crucial for preparing teachers to navigate and utilize AI in educational settings.
- AI can enhance sustainable education by providing personalized learning experiences and data-driven insights, helping teachers tailor their methods to better engage students.

2. Pedagogical Approaches:

- Incorporating AI into sustainability education can transform traditional practices, fostering a culture of continuous improvement and creativity among students.
- This includes using AI to teach concepts such as circularity and power systems, which are vital for understanding sustainable development.
- Pedagogical techniques that integrate sustainability into the digital literacy curriculum can equip students with the skills needed to address global concerns in an AI-driven society.

AI to Strengthen Civic Participation

1. Enhancing Civic Engagement:

- AI technologies can optimize resource utilization, enhance mobility, and improve service delivery in urban environments, thereby fostering citizen participation and creating more sustainable cities.
- Responsible AI, promoted through open laboratories, can cultivate civic and democratic skills, aligning technological advancements with the Sustainable Development Goals (SDGs).

2. Challenges and Opportunities:

- While AI has the potential to enhance civic participation, its opacity and resource requirements can impede meaningful engagement. Addressing these challenges requires a multidisciplinary approach that blends insights from smart cities, public policy, and computer science.
- AI literacy, developed through social learning ecosystems, can empower students to engage in scientific citizenship and authentic learning, promoting social justice and sustainable development.

Strategies for Implementation

1. School Support and Policy:

- Effective implementation of AI in education requires supportive school policies and a culture that fosters digital learning. This includes providing the necessary infrastructure and addressing ethical, safe, and productive functioning in digital environments.
- Schools should adopt a comprehensive strategy that combines technological advancements with eco-centric principles to foster environmentally conscientious learners.

2. Teacher Training and Development:

- Continuous professional development and interdisciplinary collaboration among school members are essential for teachers to effectively integrate AI into their teaching practices.
- Training programs should focus on developing teachers' AI competencies and their ability to use AI to enhance sustainability education.

Conclusion

Integrating teacher competencies with AI can significantly enhance sustainable education and civic participation. By developing digital literacy, adopting innovative pedagogical approaches, and fostering supportive school environments, educators can prepare future generations to contribute to sustainable urban environments.

The authors of the article evaluated the results generated by Scopus AI and, through dialogue, requested an extended summary (Figure 7).

Figure 7

Expanded Summary by Copilot (Scopus AI, 2025)

Expanded summary

Based on the user's query, the integration of artificial intelligence (AI) into education presents significant opportunities and challenges for educators. To effectively integrate AI into civic education, teachers need specific competencies and an understanding of the ethical implications associated with these technologies. Here are the key points to consider:

Key Competences for Teachers:

- *Teachers need competencies in AI literacy, digital skills, and ethical considerations to effectively integrate AI into civic education.*
- *A study found that AI competence for teachers involves six dimensions, and professional learning opportunities are needed to develop these competencies.*
- *Continuous professional development is essential for teachers to stay up to date with new tools, including AI, and enhance their digital competence, which is vital for citizenship rights.*

Contribution of AI to Civic Participation:

- *AI-enhanced teaching models have been shown to significantly boost student engagement and learning achievements in civic education, highlighting the effectiveness of AI in elevating the quality of civic education through personalized and efficient learning experiences.*
- *AI applications in civic engagement, such as citizen participation platforms and social media, have the potential to enhance citizen participation, public discourse, and governance efficiency.*

Potential Benefits and Drawbacks:

- *The use of AI in education can improve educational outcomes while safeguarding stakeholder interests through interdisciplinary collaboration and continuous evaluation.*
- *However, challenges such as the digital divide, algorithmic bias, lack of transparency, and concerns about data privacy persist, which are central obstacles to AI's adoption in civic engagement.*

Ethical Considerations and Challenges:

- *Ethical considerations in the use of AI in education include legal compliance, data privacy, ethical standards, bias mitigation, transparency, and accountability.*
- *The responsible use of AI in education focuses on supporting and enhancing student learning experiences without compromising ethical requirements such as privacy, security, and human autonomy.*

Current Trends and Best Practices:

- *Most teachers have the highest qualifications, an average level of digital competence, and a low level of AI literacy, indicating the need to improve teachers' skills in the implementation of AI.*
- *The regulatory environment in the field of AI in education is becoming increasingly dynamic, with the adaptation of existing or the adoption of new comprehensive laws and legal frameworks at both national and international levels to ensure the ethical use of AI in education.*

In conclusion, while AI presents significant opportunities to enhance civic participation in future generations, teachers must develop competencies in AI literacy, digital skills, and ethical considerations. The responsible integration of AI into civic education requires addressing challenges such as digital divide, algorithmic bias, and data privacy, while continuously evaluating its impact on educational outcomes and safeguarding stakeholder interests. Furthermore, the regulatory environment is evolving to ensure the ethical and inclusive use of AI in education.

Below are the Scopus AI-generated mind maps for the terms (Figure 8). They summarize and visualize the findings described above into structured categories.

Figure 8
Scopus AI Terms Graphs (Scopus AI, 2025)



The authors of the article examined the concept maps generated by Scopus AI, questioning their validity, which they assessed based on previously acquired knowledge and insights related to the article's topic. The authors then engaged in a discussion about the additional questions generated by Scopus AI (Figure 9).

Figure 9
Additional Questions Generated by Copilot (Scopus AI, 2025)

Go deeper

1. *What are the key teacher competencies needed to effectively integrate artificial intelligence into civic education?*
2. *How can artificial intelligence be used to enhance civic participation among future generations in educational settings?*
3. *What ethical considerations should be taken into account when leveraging artificial intelligence to strengthen civic participation in education?*

It was decided not to continue with the branched-out exploration but instead to review the full-text articles already cited by Scopus AI.

Semantic, Systematic Literature Review by Experts

Experts set 4 thematic criteria in accordance with the research questions. The evaluation task is to determine what percentage of the semantically selected Scopus AI scientific literature corresponds to the research topic and its thematic subunits (Table 2).

Table 2
Result of the Evaluation of 4 Qualitative Criteria

No.	Authors of the article, year	Article relevance to the topic: 0 - does not match, 1 - partially matches, 2 - matches				Total points of the authors of one article
		Teacher Competencies In Learning AI Tools	Teachers' AI competencies in the context of citizenship education	Teachers' AI competences in the context of civic engagement	Teacher AI competencies in the context of sustainable urban development	
1.	Arranz-Garcia et al. (2025)	2	0	0	0	2
2.	Ayanwale et. al. (2025)	2	0	0	1	3
3.	Chiu et al. (2024)	2	0	0	0	2
4.	Delcker et. al. (2025)	2	0	0	0	2
5.	Filiz et. al. (2025)	2	0	0	1	3
6.	Lim et al. (2023)	2	0	0	0	2
7.	Lin et al. (2023)	0	0	0	2	2
8.	Lu (2024)	0	2	2	0	4
9.	Ren & Wu (2025)	2	0	0	0	2
10.	Shi et al. (2024)	1	0	0	0	1
11.	Zhao et al. (2022)	2	0	0	0	2
Summary:		17=77.27%	2=9.09 %	2=9.09 %	4=18.18%	25=28.41%

11 scientific literature articles in total correspond to the interdisciplinary theme of the study, only 28.41%. However, the highest correspondence, 77.27% is for the thematic criterion: “Teachers’ competences in mastering AI tools.” However, these competences related to civic education, civic engagement in the context of sustainable urban development, 9.09% and 18.18% are insufficient to form a discussion about the latest discoveries and determine trends in a given topic. Such data cannot be representative of the opinion of researchers on a given topic. Consequently, the Scopus AI

algorithm for generating summaries, conclusions, and drawing mind-map graphs is also questionable.

Researchers from different countries represent the 11 articles selected for in-depth thematic analysis; therefore, some articles cannot be unambiguously identified with a specific country, as the team of authors is international. Therefore, the countries will be named according to the numbering assigned to the articles in Table 2: 1. Spain; 2. Africa; 3. China, Japan, Australia; 4. Germany; 5. Turkey; 6. Singapore; 7. Taiwan; 8. China; 9. USA; 10. USA; 11. China. China is the most represented ($n = 3$). In general, Asia and the Pacific countries ($n = 9$). The opinion of European countries is relatively less represented: $n = 4$. Publications from the last 4 years are represented, of which mostly: $n = 8$ are scientific studies from the last two years. Systematic literature analysis articles: $n = 5$; empirical research articles: $n = 6$.

In partial response to Research Question 2 on identifying opinion leaders: the most cited articles: 7. Lin et al. (2023) = cited 213 times (viewed: 60,000 times); 11. Zhao et al. (2022) = cited 74 times (viewed: 15,000 times); 6. Lim et al. (2023) = cited 41 times (viewed: 17,000 times). Of note is 2. Ayanwale et. al. (2025), which has already been cited 25 times and has reached 8,514 views, indicates the relevance and popularity of the article among researchers. The authors of article 2 can be considered opinion leaders on the topic: Ayanwale, M. A., Frimpong, E. K., Opesemowo, O. A. G., & Sanusi, I. T. "Exploring Factors That Support Pre-service Teachers' Engagement in Learning Artificial Intelligence." This is different from the opinion authors identified by Scopus AI: Li, Mao M., Farthing, Pamela P., Kleib, Manal M., Boscardin, Christy Kim C. K., Golde, Polo Black P. B., Gin, Brian C. B. C.

Thematic analysis of selected articles is a qualitative method of theoretical literature analysis that helps to gain deeper insight into the data, emerging themes to answer the research questions. Methodology of thematic analysis:

1. Two researchers read the articles and included the research questions, main conclusions in an MS Excel spreadsheet, and, studying the methods of data collection, processing, analysis, and quantity, judged their representativeness for use in generating conclusions.
2. Answers to 3 research questions were sought.
3. Similar concepts were identified and grouped into thematic clusters, with the researchers discussing and harmonizing the perceived information.
4. The researchers prepared a report on the results.

Research Question 1. How can teacher competencies and artificial intelligence strengthen civic engagement in creating a sustainable urban environment for future generations?

Although previous research showed that AI integration in teachers' competencies is essential for civic education to foster civic engagement, which plays a crucial role in

sustainable urban development (Altaany & Abdelbary, 2024; Gomez & Suarez, 2023; Hoffman, 2024; Owuondo, 2024; et al.), there were no articles (among 11 selected articles) about the role of teacher competencies and AI in civic engagement in the context of a sustainable urban environment. But it was possible to find some aspects of sustainable development in 3 articles. Ayanwale et al. (2025) reported that pre-service science teachers have shown high awareness of social responsibility in human welfare, safety, and a sustainable environment. (p. 209) Filiz et al. (2025) mentioned that AI tools can be used to create presentations on various topics, such as sustainable development, and Autodesk Generative Design is useful in creating optimized designs for sustainability issues. But relations between sustainable development and AI use were not analysed. Lin et al. (2023) paid attention to sustainable education as part of sustainable development. They concluded that “sustainable education aims to foster a learning culture that values diversity, creativity, and participation and empowers learners to develop sustainably (p. 1–2).

Research Question 2. What are the theoretical findings of the last six years and their trends in the development of teachers’ professional competences in the context of AI and the level of civic engagement of students in general education?

Most of the 11 selected articles recognize AI tools as vital in teaching, especially as a useful tool for improving critical thinking, problem solving, and student engagement (Arranz-García et al., 2025), but there is a lack of articles on the role of AI and teacher competencies in strengthening civic engagement to build a sustainable urban environment.

The analysis of the full texts of the selected articles leads to the following topics discussed in the articles (Figure 10):

Those topics do not give an answer to the second research question about the development of teachers’ professional competencies in the context of civic engagement. Only one research study was related to civic engagement education and civic engagement. This study was done by Lu (2024), and it is a significant work with practical importance, which confirms that the meaningful and justified application of AI as a multifactorial learning model through multidimensional citizenship education significantly contributes to student engagement and learning achievements. The developed model emphasizes the importance of continuity of the pedagogical process, values, individual characteristics, feedback, and personalization.

Figure 10
Topics Discussed in the Selected 11 Articles

Limitations of the AI implementation

motivation, confidence, and competencies of teachers and the basic knowledge, skills, and attitude of students (Arranz-García et al., 2025)

technical problems, curriculum inconsistency, ethical concerns, and cultural barriers (Filiz et al., 2025)

insufficient infrastructure, limited resources, as well as a lack of awareness and involvement (Lin et al., 2023)

the lack of systematic monitoring that would allow mapping the current situation in the use of AI by educators and summarizing existing challenges to which education policy makers and implementers should respond (Shi et al., 2024)

Capacity and performance of educational institutions

the issue of the capacity and performance of educational institutions themselves must be updated to ensure the necessary support. As a result, the overall educational process is fragmented and not viewed from the perspective of the whole, where the activities of educational institutions in overcoming challenges are detached from the policy of local government and the state (Chiu et al., 2024)

AI has significant potential in ensuring inclusive and high-quality education, but everything depends on responsible state policymaking, support for educational institutions, and ensuring the professional development of teachers (Zhao et al., 2025)

theoretically grounded systematic considerations on supporting the sustainability of AI-supported teaching and learning ecologies in higher education. However, the provision of support and available resources is not emphasized (Ren and Wu, 2025)

educators themselves are the driving force and cornerstone of the use of AI in the education system (Shi et al., 2024)

Requirements to implement AI tools and increase teachers' digital competencies

to successfully implement AI tools and increase teachers' digital competencies, the parties involved in the process must be equally ready to acquire and construct new knowledge (Arranz-García et al., 2025)

it is relevant to integrate an AI-related study course into the training of pre-service teachers (Ayanwale et al., 2025)

a further necessity in the educational environment would be a discussion about the mutual synergy of the two concepts "digital competence" and "AI competence" and a specific level description for updated teacher competence, which would allow for the formation of a cross-section of professional teachers in the future (Delcker et al., 2025)

Ethical considerations

Important aspects of AI integration are ethical considerations. Five main archetypal research topics on ethical considerations are analyzed (Lim et al, 2023)

ethical considerations are paramount in the adoption of AI in education. It is necessary to develop strong regulatory frameworks to address issues such as data privacy, algorithmic biases, and academic integrity (Arranz-García et al., 2025)

Research Question 3. What specific digital AI competencies should teachers develop to promote civic education for students in the context of future urban development?

Shi et al. (2024) noticed that teachers' pedagogical strategies and interactions with the AI system appear closely aligned with their perceptions of AI's role in education. Teachers' competencies affect students' academic performance. To ensure that students will use AI responsibly, it is necessary for teachers to have different competencies, not only digital ones. Arranz-García et al. (2025) concluded that teachers' reflective attitude, self-efficacy, and professional development significantly influence students' performance. Of course, digital competencies, technological knowledge, and AI language knowledge are very important for integrating AI into the teaching process.

Chiu et al. (2024) pointed out that "Teacher digital competence (TDC) frameworks, such as the substitution, augmentation, modification, and redefinition (SAMR) framework and the technological pedagogical content knowledge (TPACK) framework, have been used to design teacher professional development activities" (p. 2). But it is necessary to expand them by adding personal and socio-cultural aspects.

Delcker et al. (2025) identified six dimensions of AI competence for teachers. They are theoretical knowledge about AI; knowledge about legal framework and ethics, implications of AI in education, attitude toward AI, teaching and learning with AI, and ongoing professionalization.

The findings of Ren & Wu (2025) and Zhao et al. (2022) showed that AI literacy and readiness are essential technological knowledge needed for effective AI integration. AI literacy is mentioned as one of the most important competencies teachers must have to successfully integrate AI tools into teaching.

Discussion

The fundamental literature selected by the Scopus AI semantic search engine (4 units), whose abstracts Scopus AI has served to generate the main conclusions, indeed has the highest citation rate, but the scientific literature references used in these articles are older than the last 10 years. This calls into question the relevance of the conclusions in modern society. Findings written long ago, when cited for 10–15 years, also slowly accumulate a high citation rate, which is not so high for articles published in 2025. This calls into question the effectiveness of using this quantitative criterion in constructing scientific findings. If an article from 2025 has achieved a high citation rate in a short time, then this indicates the relevance of the topic and its findings for modern society.

The reviewed articles provide a multifaceted yet often fragmented picture of the current landscape of AI integration in education. While there is a consensus regarding the potential of AI to enhance critical thinking, student engagement, and

problem-solving (Arranz-García et al., 2025), the broader implications for civic engagement and sustainable urban development remain largely underexplored.

A significant ambiguity arises from the interplay between teacher competencies and institutional support. Several studies (e.g., Chiu et al., 2024; Zhao et al., 2025) stress that teachers are both willing and motivated to integrate AI tools. However, the fragmented nature of institutional strategies and insufficient infrastructural support create a discrepancy between intent and practical implementation. Moreover, while teacher competence, particularly in digital and AI literacy, is repeatedly identified as critical (Delcker et al., 2025; Ren & Wu, 2025), the absence of personalized, adaptive professional development paths poses challenges.

Further contradictions are evident in the relationship between national policy and local implementation. Lin et al. (2023) and Filiz et al. (2025) note that AI integration suffers from disjointed efforts between policy makers and educational institutions. Although national frameworks may exist, the lack of alignment with local needs results in varied outcomes. This raises concerns about the feasibility of a unified approach to AI implementation, especially when local contexts – resources, culture, infrastructure – differ widely.

The ethical considerations surrounding AI adoption are uniformly acknowledged as essential (Arranz-García et al., 2025; Lim et al., 2023), yet there is limited empirical data on how teachers interpret or apply ethical principles in everyday teaching. The importance of data privacy, algorithmic bias, and academic integrity is emphasized, but the practical understanding and implementation of these concepts by teachers is under-researched. This lack of empirical grounding, also noted by Shi et al. (2024), leaves a gap between normative ethical ideals and actual classroom practices.

Although the integration of AI into education is widely recognized as a transformative opportunity, the reviewed studies reveal a range of contradictions and critical uncertainties that must be addressed to ensure sustainable and equitable implementation. Firstly, while many authors emphasize the positive impact of AI on student engagement, critical thinking, and autonomous learning, these outcomes are conditional upon both teacher and student readiness. Arranz-Garcia et al. (2025) argue that the success of AI integration hinges not only on teachers' competence but equally on students' metacognitive skills and attitudes – an area that remains insufficiently addressed in current implementation strategies. This raises the question: can technological innovation truly revolutionize learning if foundational educational disparities persist?

Delcker et al. (2025) highlight the lack of differentiation in AI training, noting that the diverse prior knowledge of teachers is often neglected, thus reducing the effectiveness of professional development programs. Similarly, Ayanwale et al. (2025) advocate for a unified, state-level strategy for integrating AI-related content into teacher education, yet this top-down approach may conflict with the decentralized realities noted

by Chiu et al. (2024) and Lin et al. (2023), who point to institutional fragmentation and the disconnect between local and national policies.

The ethical and socio-cultural dimensions of AI in education also remain underexplored. While Lim et al. (2023) offer a framework for ethical assessment design, Filiz et al. (2025) draw attention to unresolved ethical and cultural barriers, curriculum inconsistencies, and technical limitations. These insights underscore that the adoption of AI cannot be solely evaluated through pedagogical outcomes but must also consider broader systemic and societal factors.

Conclusions

The review of literature using expert selection methods and the snowball technique revealed that civic engagement plays a pivotal role in achieving a sustainable urban environment. It also highlighted the indispensable contribution of teachers' competencies in fostering civic education within the broader context of sustainable urban development. Interestingly, the conclusions derived through Scopus AI regarding the structure and significance of teachers' AI-related competencies do not correspond meaningfully with the enhancement of civic education or the promotion of civic engagement. They fail to support the diversification of pedagogical approaches and instructional methods in general education institutions, thereby limiting their relevance in contemporary educational discourse. Furthermore, these AI-generated insights overlook the importance of local cultural contexts in cultivating teachers' digital competencies for civic education. The absence of cultural sensitivity in current findings diminishes their applicability, especially in educational settings that prioritize contextual relevance.

A notable gap in recent scholarship, spanning the last six years, is the lack of focus on teachers' AI usage competencies, particularly in differentiating teaching methodologies and pedagogical approaches in subject-specific contexts such as Social Studies, as well as within character development programs. This omission suggests a broader need for research into discipline-sensitive AI integration. Moreover, Scopus AI's conclusions disregard the influence of a teacher's personal attributes and cultural competence in adopting and implementing AI tools for digital civic education. The role of teachers as cultural figures who model ethical and moral values is crucial, especially in shaping responsible civic engagement through AI-enhanced educational practices. Despite posing research questions that explicitly address sustainable urban development, the semantic search via Scopus AI failed to establish a relevant connection. This disconnect likely stems from a lack of existing literature examining this intersection, which underscores the novelty of the present inquiry. The innovative perspective introduced by the authors opens pathways for future dialogue among global education stakeholders, particularly policymakers, educators, and cultural leaders, within the framework of

international initiatives such as the Mondiacult 2022 declaration and the upcoming Mondiacult 2025 forum.

Ultimately, while the integration of AI in education holds significant promise, its efficacy is contingent upon several interdependent factors: the digital competencies or MI competencies (the theoretical concepts reviewed in the semantic and systematic literature review revealed different ideas and approaches in the context of professional development for teachers concerning the relevance and necessity of digital and AI competencies in line with current trends) of educators, supportive policy frameworks, institutional readiness, and students' capacity to engage. A coordinated strategy (both theoretical and practical) is essential for cultivating an inclusive and sustainable educational ecosystem.

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Tvarios miesto aplinkos link: ateities kartų pilietinio įsitraukimo stiprinimas pasitelkiant mokytojų kompetencijas ir dirbtinį intelektą

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Santrauka

Straipsnyje nagrinėjama sąveika, atsirandanti tarp pilietinio ugdymo, mokytojų kompetencijų ir dirbtinio intelekto, ir kaip tai skatintų tvarų miestų vystymąsi. Pripažįstant, jog pilietinis aktyvumas yra miestų tvarumo pagrindas, taip pat reikėtų pažymėti, kad mokytojų vaidmuo ugdant būsimus piliečius yra labai svarbus, nes būtent jie pasitelkia kultūriškai pagrįstas ir technologijomis sustiprintas pedagogines praktikas. Naudojantis „Scopus DI“ (angl. *Scopus AI*) ir PRISMA 2020 metodikomis buvo atlikta semantinė ir sisteminė literatūros analizė, siekiant nustatyti naujausias teorines išvagas ir tendencijas. Straipsnių analizė atskleidė didelę spragą, susidariusią tarp mokytojų DI kompetencijų, pilietinio aktyvumo ir tvaraus miestų vystymosi. Diskusijoje autoriai atkreipia dėmesį į keletą prieštaravimų dabartiniuose tyrimuose. Pavyzdžiui, nors DI siūlo įvairių transformacinių galimybių, tačiau siekiant veiksmingai tai įgyvendinti reikia išsamių strategijų, kuriose būtų atsižvelgiama į mokytojų pasirėngimą, institucinę paramą ir sociokultūrinius kontekstus. Straipsnio pabaigoje prieinama prie išvados, kad būtina atlikti tolesnius tyrimus, pavyzdžiui, detaliau išnagrinėti mokytojų kompetenciją (skaitmeninę ir (arba) DI kompetenciją), įskaitant kultūrinius ir etinius aspektus, siekiant užtikrinti, kad DI taptų veiksminga priemone pilietinei atsakomybei skatinti ir tvariai formuoti miestus ateityje.

Esminiai žodžiai: *pilietinis įsitraukimas, pilietinis ugdymas, bendruomenė, kultūrinis kontekstas, tvari miesto aplinka, mokytojų kompetencijos, dirbtinio intelekto integracija.*

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