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PAPER

The Potential of Artificial Intelligence in Education: Supporting Educational Transformation for Learners and Educators

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ABSTRACT

The advent of text-generating artificial intelligence (AI) started a new era in education, offering transformative possibilities for both learners and educators. This article explores the potential of AI in education, its constructive applications in classrooms, and the necessary changes that must occur in higher education institutions and schools to integrate AI into learning processes. The paper explores potential benefits, challenges, and the importance of teacher-student collaboration in an AI-enhanced educational landscape. To address this, the paper discusses a multi-method comparative study focusing on students' and pupils' attitudes and preferences toward text-generating AI in classrooms and lecture halls.[1] The study was implemented in two university courses and high school classes. A particular interest lies in data showing similarities and differences between pupils' and students' experiences with and attitudes towards text-generating AI. The study uses semi-qualitative and quantitative interviews through written feedback forms. It analyzes the experiences and attitudes closely and in detail, thus investigating how pupils and students use AI in educational contexts and how they reflect their experiences. The paper also discusses how the results can be constructively implemented to improve future options for integrating AI tools in the higher education and school sectors.

KEYWORDS

artificial intelligence, education, text generating AI, empirical study, higher education, school

1 TEXT CREATING AI AND POSSIBLE IMPACTS ON LEARNERS AND EDUCATORS

The educational landscape in the 21st century has undergone significant transformations, primarily driven by technological advancements, including

[1] In the following, the term "pupils" always refers to pupils in grades 9, 10 and 11. The term "students" always refers to students at a university.

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artificial intelligence (AI) [1]. In education, two forms of AI are usually discussed: (1) Generative AI, which harnesses digital content like video, images, graphics, and audio to analyze patterns and distributions, ultimately generating synthetic content. (2) Text-generating models that excel in reading and producing human-like text across multiple languages, showcasing creativity in generating content ranging from paragraphs to entire research articles [2]. Text-generating models have garnered significant attention due to their potential to assist learners and educators in various aspects of teaching and learning [3]. Against this backdrop, this article examines the possible potential of text-generating AI for education, its constructive applications, and the changes required to integrate AI into educational settings effectively. To this end, pupils in schools and students in teacher training universities are asked whether and how they use AI in their everyday learning and what experiences they have had with AI so far. The complementary perspectives of pupils and students in teacher training can provide new insights into school and university settings that have the potential to show unknown interrelations and help to identify ways of a constructive implementation of AI tools for pupils, students, and educators [4].

2 AI IN EDUCATION AND POTENTIALS FOR TRANSFORMATION: A LITERATURE REVIEW

The transformative impact of AI on classroom learning can be observed in today's classrooms and lecture halls: Students and pupils interact with artificial intelligence across a spectrum of subjects and for various tasks [5]. Emerging possibilities are currently under consideration in the academic field [6], and early research findings [7] are shedding light on the potential with which AI can transform learning experiences. Building upon the established scientific groundwork, potentials for the advancement of learning can be identified [8]. These potentials can subsequently be tested and, if deemed viable, further extended through the empirical perspectives of this study. Against this background, a meta-analysis of current literature on AI in schools and universities reveals four central categories that are of interest to the present question.

2.1 Personalized learning

An often-discussed potential of AI in education is its ability to personalize learning experiences [9]. Personalized learning aims to tailor instruction, content, pace, and assessment to meet each student's individual needs, interests, and learning preferences. It recognizes that learners have diverse learning styles and strengths. The goal is to create an educational environment that accommodates these differences, fostering a flexible framework for better learning outcomes [10]. AI-powered systems can analyze individual student data and adapt instructional materials to match the student's pace and learning style. In addition, learners can get personal support and complete tasks on their own responsibility. This can promote a more inclusive and effective learning environment, catering to diverse learning needs [11].

2.2 Information retrieval and content generation

Integrating AI models can facilitate efficient information retrieval for pupils and students. Learners can employ AI to access a diverse range of educational content,

promoting cognitive processing and a more profound comprehension of subjects. Text-generating AI can create educational content, including study materials, quizzes, and instructional narratives. Learners can utilize AI for assistance in content creation, encompassing tasks such as searching and generating images and videos, developing and translating texts, and collecting and structuring essential content [12]. AI can enable learners to receive personalized support, simplify complex texts, and provide an overview of intricate topics. This technology aids in tailoring assistance to individual needs, making learning more accessible and comprehensible for each learner [13]. These options are closely linked to personalized learning and represent just some of the key support options AI facilitates to enhance the learning experience.

2.3 Language skills

AI-driven language learning applications have the potential to assist learners in improving their writing skills and structuring texts. In addition, AI can help master new languages by offering pronunciation guidance, translation services, and contextual usage examples [14]. This can support language acquisition and cultural understanding. AI models can play a pivotal role in language learning by offering conversational practice, grammar explanations, and vocabulary assistance. AI has the potential to help learners improve communication proficiency and linguistic competence [15]. Again, this kind of support can be used in highly personalized ways.

2.4 Cognitive development and study skills

AI has the potential to assist learners in cognitive development and study skills through systematic support mechanisms. By providing explanations, examples, and clarifications on academic concepts, AI can contribute to enhanced cognitive processes. This can aid learners in grasping complex subjects more efficiently [16]. Moreover, AI's role in reinforcing study skills is evident in its ability to assist with study-related queries, fostering the development of effective learning methodologies. This can be especially efficient when learners use AI to generate examples from their real-life experiences for learning tasks; they gain practical references and heightened motivation, enhancing their engagement and understanding [17].

3 CONSTRUCTIVE USE OF AI IN SCHOOLS AND HIGHER EDUCATION

The above discussion indicates the possible potential of AI in the educational landscapes of pupils, students, and teachers. Among other things, this raises the question of how AI can be constructively and responsibly integrated into learning processes. This, in turn, directly affects teacher training. Only if students are familiarized with the potentials and risks of AI in educational contexts at an early stage can they develop strategies that can later lead to constructive development of learning potentials through AI in the classroom. Against this background, the current scientific discourse is directly compatible and relevant, as the topics of (a) teacher training, (b) curriculum adaptation, (c) ethical considerations, and (d) collaboration are frequently discussed.

3.1 Teacher training

To unlock the benefits of AI in education, teachers should develop the ability to reflect on the possibilities AI offers [18]. Training in AI tools and applications might be helpful for this reflection. Professional development programs should be specifically crafted to equip educators with the skills and knowledge necessary for constructive integration of AI into their teaching practices. This approach would ensure that teachers are not only familiar with AI technologies but are also capable of leveraging them to enhance the learning experience for learners. To reflect the full potential of AI in education, teachers should receive adequate training in AI tools and applications [19].

3.2 Curriculum adaptation

By identifying educational and societal developments, institutions can ensure that pupils and students are equipped with the knowledge and skills needed for future technologies and challenges. In this context, adopting AI and AI-related issues in the curricula of universities and schools becomes a crucial step toward a structured implementation of AI in the field of education [20]. AI literacy and AI thinking are currently in the initial stages of implementation in school curricula across different countries [18]. One of the main goals of these curricular discussions is the development of AI literacy: AI literacy encompasses the skills needed for an individual to navigate and participate adeptly in a society integrated with AI. Proficiency in AI literacy empowers an individual to critically assess AI, communicate effectively and collaborate with AI, and skilfully utilize AI as a tool [21]. Against this backdrop, AI literacy becomes a crucial competency for pupils and students in teacher training.

3.3 Ethical considerations

The use of AI in education necessitates ethical considerations [22]. Educational institutions must establish guidelines for data privacy, algorithm transparency, and fair use of AI-generated content. Ensuring equity and avoiding algorithmic bias should be paramount. Furthermore, the question of independent work arises anew. While plagiarism could often be proven, the traceability of, for example, text-generating AI is very difficult. It seems essential that pupils and students are made aware of how to use AI responsibly, especially with regard to independent work [23].

3.4 Collaboration

Collaborative processes among learners, teachers, and the AI are crucial in creating AI-supported learning experiences that complement rather than supplant traditional teaching methods [24]. By working closely together, learners and educators can leverage their respective expertise to ensure that AI technologies are beneficial to the educational process. Within this process, the reflection of human-AI collaboration also plays an important role [25]. Transparent data sharing is essential in this collaboration, facilitating a clear understanding of how AI impacts

the learning environment. Open communication among educators and learners is crucial to success, allowing for the exchange of insights, feedback, and adjustments to optimize the integration of AI in education without compromising the fundamental role of traditional teaching methods. Against this backdrop, collaboration with governments and educational bodies also becomes vital, as these stakeholders should establish clear policies and regulations to guide the ethical and responsible use of AI in education. These policies should address data security, privacy, and access [26].

This brief overview is not comprehensive but serves as a basic outline of the current scientific discussions on how AI may benefit pupils and students. The review of the current scientific discourse illustrates the multifaceted potentials of AI for learners and teachers and helps categorize the data of this study. The above discussion leads to a first deductive structure showing the possible potential of AI in education: (a) personalized learning, (b) information retrieval and content generation, (c) language skills, and (d) cognitive development and study skills. These deductive categories should permanently be reflected under the discussed topics of teacher training, curriculum adaptation, ethical considerations, and collaboration. The evaluation and interpretation of the data in this structure's context can help develop a basic understanding and ideas of how AI-assisted learning can impact and augment the educational landscape in schools and universities.

4 DESIGN OF THE MULTI-METHOD COMPARATIVE STUDY

The study focuses on the participating pupils' and students' reflections and discussions concerning their experiences with text-generating AI. It uses a multi-method approach that focuses on learners' attitudes and preferences toward using AI in school (pupils) and higher education (students). The aim of the study is to find indications of the experiences and handling of AI by pupils and students and to develop possible consequences for teacher training. Therefore, students in teacher training courses at Ludwigsburg University of Education and pupils at a state school were interviewed with a very similar semi-structured interview guide.[2] The study was conducted in the fall of 2023; the sample consists of two university courses in teacher education (n = 18) and three classes at a high school (years 9, 10, 11/n = 46). The sample does not claim representativeness, the samples were generated randomly. Factors such as subject affiliation or school type were disregarded – the focus of the research is to gain perspectives and experiences from students and pupils regarding their ideas on the use of AI. The complex research focus – learners' experiences with AI in educational contexts – asks for an innovative approach to observing perspectives through (a) a partly qualitative and (b) a partly quantitative approach. Against this backdrop, the study looks for partly representative quantitative data and subjective qualitative feedback to gain a more comprehensive view. The questionnaires were available via a digital platform and were offered asynchronously. Using this mixed method approach, the study looks for data which offers partly representative data for the samples and a comprehensive view through individual, reflected, subjective feedback [27].

The discussion of fundamental pedagogical characteristics in the context of AI in education leads to a theoretical framework for the development of the questionnaires and the analysis of the data (see 2 + 3). The deductive categories were built based on

[2] See appendix for questionnaire. The data is recorded digitally and can be viewed via the Authors.

the reflection of these frameworks focusing on AI in educational contexts. The data is structured, analyzed, and interpreted based on these categories and the related topics. The three main quality criteria for the analysis are Objectivity, reliability, and validity [27]. The discussion of the data has a particular focus on the interconnected perspectives of pupils in high school and students in teacher training. After a brief presentation of the findings, the outcome of the study is discussed in the context of the deductive categories.

5 FINDINGS

64% of the students and 61% of the pupils interviewed used AI tools in educational contexts. All answers referred to text-generating AI tools and mainly focused on "Chat GPT" and similar text generating AI.

5.1 *"To generate ideas..."* Motivations for using AI in schools and universities

Shared perspectives. The data from both students in teacher education and pupils shows various shared motivations for the use of AI. Both groups emphasize using AI tools for generating ideas, creating outlines, and structuring essays. The notion of AI tools providing inspiration for writing is present in both datasets, emphasizing the creative support these tools offer learners.

Both datasets also indicate experimentation as a reason for using AI tools, with students exploring the capabilities of the tools and pupils testing their utility in specific scenarios. Diverse applications, such as literature searches and studying, are mentioned in both datasets. Both students and pupils mention using AI tools to facilitate oral contributions, indicating that these tools play a role in preparing for discussions or presentations in educational contexts. This aligns with a shared need for support in the initial phases of the writing process. Both groups emphasize the importance of AI for the improvement of writing skills. Another strong and often discussed motivation is efficiency and the aspect of time-saving. The quick generation of content for assignments and oral contributions is highly valued in both datasets.

Approximately 90% of the students and pupils using AI express a positive inclination toward recommending AI tools to their peers. They cite various common reasons, including time efficiency, idea structuring, and information gathering.

Unique emphases. The student dataset highlights diverse applications, such as requesting questions from AI for study purposes and opening up new perspectives and viewpoints. This suggests a more extensive usage range among students in teacher education. Pupils specifically mention using AI tools to meet course requirements, indicating a practical application of these tools in fulfilling assignments and improving grades.

Comparative analysis. Both groups share many common motivations, emphasizing the importance of time efficiency, idea generation, and experimentation in using AI tools. Students in teacher education appear to have a broader range of applications, possibly reflecting the use of AI tools for diverse educational purposes. On the other hand, pupils have a more explicit focus on meeting course requirements, highlighting a practical and task-oriented use of AI tools in their educational context.

5.2 *"I use it just like a search engine..."* Methods of implementing AI by students and pupils

Shared perspectives. The datasets highlight a diverse range of techniques students and pupils employ when utilizing AI. Commonly discussed practices include organizing and outlining ideas, searching for and verifying information, rephrasing texts, conducting research, proofreading grammar and spelling, and generating ideas for presentations and essays.

Unique emphases. The pupils interviewed predominantly focus on concrete applications like homework and test preparation, while students tend to reflect less specific examples during the discussions.

Comparative analysis. The data suggests that both students and pupils utilize AI for comparable reasons and through similar methods. The dataset encompasses a diverse range of examples, with both groups discussing various methods of AI utilization.

5.3 *"I never rely on it..."* Confidence in the accuracy and reliability of AI tools

Shared perspectives. Both groups exhibit cautious optimism, emphasizing the importance of verification and recognizing the imperfections of AI-generated content. Both datasets also acknowledge the potential for improvement in AI technology but highlight the need for ongoing advancements.

Unique emphases. The pupils interviewed in school generally express higher confidence levels, while students in teacher education demonstrate a more skeptical and cautious approach. The pupils show a higher confidence in the quality and accuracy of the generated output, whereas the dataset from the students shows a rather critical approach.

a) Rather strong confidence in the reliability of AI-generated results: Approximately 40% of the pupils in the study exhibit strong confidence in the reliability and accuracy of AI tools, while only 10% of the students share this level of assurance.
b) Rather intermediate confidence in the reliability of AI-generated results: About 40% of the pupils and the students demonstrate some confidence but underline the significance of additional research and thorough verification.
c) Rather low confidence in the reliability of AI-generated results: Conversely, roughly 20% of the pupils and 50% of the students harbor high skepticism regarding the accuracy of AI tools, with many articulating substantial concerns about their reliability.

Comparative analysis. The data suggests that university students are more reserved in their trust and assessment of the accuracy and reliability of AI tools, displaying a considerable degree of skepticism. Conversely, school pupils tend to place greater trust in these tools and exhibit less reflection than their university counterparts regarding potential errors in AI-generated results.

5.4 *"...it (AI) sometimes doesn't understand my question."* Challenges and limitations in the use of AI

Shared perspectives. Students and pupils report many similar limitations and challenges when dealing with AI. Frequently discussed are incorrect answers to

specific questions as well as missing or incorrect sources. Additionally, prompting seems to be a challenge for some users in this study.

Unique emphases. The students interviewed frequently express concerns about the absence of accurate references to scientific literature, while pupils highlight the issue of incorrect answers in STEM contexts. Moreover, some students express concerns about the elevated language proficiency in AI-generated results. Consequently, they hesitate to discuss these outcomes with their teachers due to apprehensions related to potential cheating.

Comparative analysis. The data indicates that both groups encounter constraints and difficulties in utilizing AI for educational purposes. These limitations vary slightly based on the distinct topics and academic levels involved.

5.5 *"... mainly warnings"*. Guidance and instructions on the use of AI tools from teachers

Approximately 50% of the pupils state that their teachers addressed the utilization of AI in educational contexts with them. In around 70% of these instances, the teachers imposed restrictions on the use of AI or outright prohibited it. Only 30% of the pupils report constructive discussions with their teacher on the use of AI.

Only around 30% of the students indicated that their lecturers discussed using AI in educational contexts with them. In about 70% of these cases, the lecturers imposed restrictions on the use of AI.

The data suggests that teachers and lecturers generally avoid discussing the use of AI with their students. When AI tools are addressed in educational settings, the tone tends to be negative, focusing on limitations and restrictions rather than promoting their use.

6 DISCUSSION OF THE FINDINGS IN THE CONTEXT OF THE THEORETICAL FRAMEWORK

The categories discussed here were developed based on deductive category formation (meta-study of literature) and inductive category formation (analysis and interpretation of the data).

6.1 Personalized learning

Both groups demonstrate a remarkably personalized utilization of artificial intelligence in their distinct educational settings. The datasets reveal a shared focus on personalized learning through AI tools, which play a crucial role in the initial phases of writing processes for both pupils and students. Furthermore, both groups express a willingness to experiment with AI capabilities, utilizing these tools in literature searches, studying, and oral presentations.

The chance to use AI to personalize learning offers a constructive solution to a fundamental challenge in education: heterogeneity. With AI, diverse learning groups can receive tailored and suitably differentiated tasks, enabling the development of individualized learning methods. Both groups rate the possibilities of personalized learning as very high and thus confirm the assumptions of previous studies from two perspectives [28].

6.2 Information retrieval and content generation

Both students and pupils in this study employ AI for various purposes, including organizing and outlining ideas, searching for and verifying information, rephrasing texts, conducting research, proofreading grammar and spelling, and generating ideas for presentations and essays. In the context of teacher education, students place a greater emphasis on professional writing skills and exploring diverse applications of AI for study purposes. On the other hand, pupils concentrate more explicitly on meeting school requirements, leveraging AI tools to enhance their assignments and improve grades within the framework of personalized learning.

AI offers the possibility to find, organize, and reproduce information in new ways. Pupils and students can be provided with a tool that offers them individual and context-specific ways of accessing information and acquiring knowledge [29]. Once again, both groups show a high degree of similarity: Information Retrieval and Content Generation are seen by pupils and students as important characteristics of AI in education.

6.3 Language skills

While the discussion among students and pupils in this study is minimal regarding the explicit development of language skills in the context of AI, specific instances, such as employing AI for text translation, grammar, and spelling checks, or reshaping written content, suggest that AI is implicitly used in diverse ways for enhancing language skills. The examples in the study data indicate that learners develop linguistic skills in dealing with AI, as they first have to generate prompts autonomously and then read, classify, and control the results of the AI [30]. This can be used constructively by teachers, for example by proofreading and improving AI-generated texts.

6.4 Cognitive development and study skills

The datasets indicate that incorporating AI through explanations, examples, and clarifications of academic concepts holds the potential to enhance cognitive processes. AI support can facilitate a more efficient understanding of complex subjects. Furthermore, AI's role extends to strengthening study skills by assisting with study-related queries, thereby fostering the development of effective learning methodologies. The efficacy of AI is particularly notable when learners leverage it to relate real-life experiences and learning tasks. This approach provides practical references and enhances motivation, increasing engagement and understanding. AI's systematic and personalized nature can emerge as a valuable tool, enabling learners to refine cognitive abilities and optimize study strategies within their individual educational environments [31].

7 OUTLOOK

AI tools, especially text-generating AI, are poised to reshape education, offering personalized learning experiences, efficient content generation, and enhanced assessment methods. To fully realize these benefits, collaboration among educators,

institutions, and policymakers seems essential to ensure ethical, equitable, and goal-aligned AI integration. Education is already closely connected with AI [32]. Thoughtful integration of this technology has the potential to enhance and personalize learning experiences for learners and provide valuable tools for educators facing heterogeneous learning groups. Continuous professional learning, facilitated by AI, can be crucial for ongoing improvements in teaching practices, aligning with the emphasis on the need for ongoing professional development [33]. This is especially important as the study indicates that learners only inadequately explore the full spectrum of AI possibilities in learning; there seems to be a need for more creative and versatile applications of AI.

Against this backdrop, teacher training programs should prioritize enhancing educators' proficiency in AI tools, ensuring they can adeptly guide learners through creative processes, literature searches, and various other tasks.

In connection with this, curriculum adaptation is crucial, with recommendations emphasizing the inclusion of modules that teach students and pupils how to effectively use AI for various purposes, aligning with their heterogeneous educational levels and goals. In this context, ethical considerations in AI education should be reflected upon, featuring discussions on the limitations and imperfections of AI tools. Encouraging a balanced and critical approach to their use is paramount, including fostering reflection on issues such as, e.g. plagiarism.

In all of this, collaborative initiatives are essential, with recommendations urging teachers, students, and pupils to share experiences and insights on how AI tools can be constructively utilized for various educational tasks. The research indicates that integrating AI in educational institutions is a subject that needs more acceptance among many teachers and students. Instead of fostering collaborative engagement, mutual distrust appears to impede the constructive utilization of AI in learning processes. Rather than experiencing shared exchange and collaboration, resistance and obstruction are frequently observed. Swift transformation is imperative through cultivating an environment characterized by openness and trust. An initial step in this direction could involve collaborative experimentation with AI-supported learning in universities and schools [34].

Reflections on teacher training, curriculum adaptation, ethical considerations, and collaboration underscore the need for a comprehensive and context-specific approach to integrating AI tools into education. These considerations should guide educators, curriculum developers, and policymakers in creating an environment that constructively uses the benefits of AI while addressing challenges and ethical concerns [35]. While AI tools offer various benefits, the findings suggest a need for educators to provide clear guidance and support to help students and pupils make informed decisions and navigate challenges associated with AI use in learning environments. In conclusion, fostering AI literacy across all levels should stand as a collaborative objective, uniting institutions, educators, and learners in a shared commitment to the constructive use of AI in learning.

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9 APPENDIX

9.1 Questionnaire

Thank you for participating in this survey. Your participation is completely anonymous. This survey is about the use of text-generating AI (e.g., ChatGPT) in our course.

- Thank you for participating in this survey. Your participation is completely anonymous. This survey is about the use of text-generating AI (e.g., ChatGPT) in our course. (Y/N)
- Have you ever used text-generating AI tools such as chatbots or language models for academic purposes? (Y/N)
- What are the main reasons you use text-generating AI tools in our course? (e.g., saving time, generating ideas, improving writing skills)
- Do you think the topics of AI and culturally/religiously sensitive education are connected in any way? If yes - please explain.
- Which specific text-generating AI tools have you used for academic tasks? (Please provide examples if possible)
- How confident are you in the accuracy and reliability of the content generated by text-generating AI tools?
- Have you experienced any challenges or limitations when using text-generating AI tools for academic tasks? If yes, please elaborate.
- Have you received any guidance or instructions from your teachers, professors, or institution regarding the use of text-generating AI tools? If yes, please describe the guidelines or possible policies in place.
- Please give some specific examples of how you used/what you asked the KI to get results.
- Would you recommend the use of text-generating AI tools to your peers? Why or why not?

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