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HOW CAN AI HELP TO RESEARCH AND POTENTIALLY ENHANCE THE CURIOSITY OF ELEMENTARY SCHOOL CHILDREN?

Abstract: *Curiosity is essential for children's cognitive development, with question-asking being a vital component of this process. This paper presents the methodology of a newly adjusted (specially prompted) AI-driven tool designed to measure and potentially enhance curiosity by improving students' question-asking skills. This tool uses natural language processing (NLP) to analyze and categorize questions into types like school-related or curiosity-driven, providing real-time, adaptive feedback that encourages deeper inquiry. The tool aids teachers by offering insights into student engagement. Ethical considerations, such as data privacy and avoiding bias in AI feedback, are addressed to ensure responsible use. By focusing on the methodological aspects of the tool, this paper contributes to advancing AI applications in education, offering a framework for fostering curiosity-driven learning environments.*

Keywords: *curiosity development; AI in education; large language models; question-asking; teacher-student platform*

Jak může umělá inteligence pomoci zkoumat a potenciálně rozvíjet zvídavost žáků na základní škole?

Abstrakt: *Zvídavost je klíčová pro kognitivní rozvoj dětí a kladení otázek je zásadní součástí tohoto procesu. Tento článek představuje metodologii nově adaptovaného (speciálně napromptovaného) nástroje, který je poháněn umělou inteligencí (AI) a navržen tak, aby měřil a potenciálně podporoval zvídavost žáků prostřednictvím zlepšení jejich dovedností kladení otázek. Tento nástroj využívá zpracování přirozeného jazyka (NLP) k analýze a kategorizaci otázek, jako jsou otázky týkající se školy nebo zvídavosti, a poskytuje okamžitou, přizpůsobenou zpětnou vazbu, která podporuje hlubší zkoumání. Tento nástroj nejen pomáhá učitelům tím, že poskytuje přehled o zapojení žáků, ale také slouží jako výzkumný nástroj, který shromažďuje dlouhodobá data o zvídavosti. Článek se zabývá etickými otázkami, jako je ochrana dat a předcházení zaujatosti v AI, aby byla zajištěna odpovědná využití. Zaměřením na metodologické aspekty nástroje tento článek přispívá k rozvoji aplikací AI ve vzdělávání a nabízí rámec pro podporu prostředí zaměřeného na zvídavost.*

Klíčová slova: *rozvoj zvídavosti; umělá inteligence ve vzdělávání; large language models; kladení otázek; platforma pro učitele a studenty*

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1. Introduction

Curiosity, cognitive development, and question-asking are interconnected aspects that significantly influence educational processes.[1] The concept of curiosity has been extensively studied in various theoretical frameworks. For instance, Loewenstein's information gap theory posits that curiosity arises from the perception of a gap in knowledge,[2] functioning similarly to other drive states like hunger.[3] Additionally, developmental theories highlight the importance of curiosity in cognitive processes during childhood.[4] Furthermore, studies describe curiosity as a cognitive-induced deprivation that motivates individuals to seek knowledge and understanding.[5] The ability to ask questions is also crucial in learning, as evidenced by theory of question-driven understanding, which suggests that effective question-asking leads to better learning outcomes.[6]

Some studies focus on analyzing evidence from teachers' questions as a means to bridge the gap between educational theory and practice.[7] Other tools, like the CIAC questionnaire, aim to measure primary school children's images of and attitudes towards curiosity.[8] However, there are gaps in existing tools, particularly in effectively stimulating and assessing curiosity in students.

There are several tools available to measure the curiosity of children, with one of the most prominent being The Five Dimensional Curiosity Scale

[1] R. Abdelghani, E. Law, C. Desvaux, P. Y. Oudeyer, and H. Sauzéon, "Interactive Environments for Training Children's Curiosity through the Practice of Metacognitive Skills: A Pilot Study," in *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference*, eds. Michael S. Horn et al., 495–501 (New York: ACM, 2023).

[2] G. Loewenstein, "The Psychology of Curiosity: A Review and Reinterpretation," *Psychological Bulletin* 116, no. 1 (1994): 75–98.

[3] C. Kidd and B. Hayden, "The Psychology and Neuroscience of Curiosity," *Neuron* 88, no. 3 (2015): 449–60.

[4] M. Elban and S. Aslan, "The Adaptation of the Social Curiosity Scale into Turkish: A Validity and Reliability Study," *Opus Toplum Araştırmaları Dergisi* 19, no. 49 (2022): 683–95.

[5] A. Ram, "A Theory of Questions and Question Asking," *Journal of the Learning Sciences* 1, no. 3–4 (1991): 273–318.

[6] Ram, "A Theory of Questions and Question Asking."

[7] Y. Shaharabani and A. Yarden, "Toward Narrowing the Theory–Practice Gap: Characterizing Evidence from In-Service Biology Teachers' Questions Asked During an Academic Course," *International Journal of STEM Education* 6, no. 1 (2019).

[8] T. Post and J. Molen, "Development and Validation of a Questionnaire to Measure Primary School Children's Images of and Attitudes towards Curiosity (the CIAC Questionnaire)," *Motivation and Emotion* 43, no. 1 (2018): 159–78.

(5DC) developed by Kashdan et al.[9,10] This scale measures different facets of curiosity, such as Joyous Exploration and Deprivation Sensitivity, and has been validated across various age groups. Other tools like the Curiosity and Exploration Inventory-II (CEI-II)[11] also measure curiosity, particularly focusing on the individual's desire to seek out new experiences and their willingness to embrace uncertainty. In addition, the diagnostic instrument by Piotrowski et al.[12] allows parents or teachers to rate the curiosity of their children or students.

However, traditional self-report questionnaires face significant limitations. Like all survey methods, they are susceptible to social desirability bias, where participants may alter their responses to appear more favourable.[13] Additionally, respondents often struggle to provide accurate self-assessments of their own behaviors and tendencies.[14]

A second key limitation relates specifically to measuring children's curiosity. Most existing curiosity assessment tools were developed and validated for adults, raising questions about their applicability to younger populations who may struggle to comprehend complex survey items or accurately reflect on their own cognitive processes.[15] Furthermore, these instruments typically capture only static snapshots rather than the dynamic, context-dependent nature of curiosity.[16] This is where AI instruments can enhance measurement by providing continuous, real-time assessment of student curiosity levels.

[9] T. B. Kashdan, M. C. Stiksma, D. J. Disabato, P. E. McKnight, J. Bekier, J. Kaji, and R. Lazarus, "The Five-Dimensional Curiosity Scale: Capturing the Bandwidth of Curiosity and Identifying Four Unique Subgroups of Curious People," *Journal of Research in Personality* 73 (2018): 130–49.

[10] T. B. Kashdan, D. J. Disabato, F. R. Goodman, and P. E. McKnight, "The Five-Dimensional Curiosity Scale Revised (5DCR): Briefer Subscales While Separating Overt and Covert Social Curiosity," *Personality and Individual Differences* 157 (2020): 109836.

[11] T. B. Kashdan, M. W. Gallagher, P. J. Silvia, B. P. Winterstein, W. E. Breen, D. Terhar, and M. F. Steger. "The Curiosity and Exploration Inventory-II: Development, Factor Structure, and Psychometrics," *Journal of Research in Personality* 43, no. 6 (2009): 987–98.

[12] J. T. Piotrowski, J. A. Litman, and P. Valkenburg, "Measuring Epistemic Curiosity in Young Children," *Infant and Child Development* 23, no. 5 (2014): 542–53.

[13] Post and Molen, "Development and Validation."

[14] Kashdan, "The Curiosity and Exploration Inventory-II."

[15] Piotrowski, "Measuring Epistemic Curiosity in Young Children."

[16] Abdelghani et al., "Interactive Environments."

Artificial Intelligence (AI) is increasingly being integrated into educational settings to enhance cognitive skills development.[17] AI technologies can offer personalized learning experiences that adapt to students' needs and learning styles, fostering curiosity and engagement.[18] By leveraging AI algorithms, educators can create interactive platforms that stimulate curiosity through adaptive instruction and real-time feedback.[19] Moreover, AI can assist in measuring and assessing students' cognitive and affective states, providing valuable insights into their learning progress and areas for improvement.[20] The use of AI in education aligns with theories such as the Self-Determination Theory, which emphasizes the importance of fulfilling psychological needs for autonomy, competence, and relatedness to enhance motivation and learning outcomes.[21]

In recent years, there has been a growing interest in utilizing AI to measure and enhance curiosity in children, particularly in educational settings. Curiosity is widely recognized as a fundamental aspect of children's development and plays a crucial role in the learning process.[22] Research has shown that fostering curiosity in children can lead to improved academic achievement.[23] However, reports indicate that children often lack this skill, especially in formal educational environments.[24] To address this challenge, interventions have been proposed to enhance children's curiosity through specific training programs aimed at developing metacognitive skills involved in the curiosity process.[25]

AI has the potential to play a significant role in cultivating curiosity in children. By incorporating curiosity mechanisms into AI systems, a curiosity-driven learning framework can be leveraged to significantly enhance

[17] M. Demir, "Adaptive Artificial Intelligence to Teach Interactive Molecular Dynamics in the Context of Human-Computer Interaction," *bioRxiv* (August 28, 2023).
[18] Demir, "Adaptive Artificial Intelligence."
[19] Ibid.
[20] A. Tsiara, "Using Psychophysiological Measures to Assess Learners' Cognitive and Affective States in a Theory-Based Gamified MOOC," PhD diss., University of Ioannina, 2024.
[21] A. Makhija, M. Jha, D. Richards, and A. Bilgin, "Designing a Feedback Framework to Reconnect Students with Learning in a Game-Based Learning Environment," *ASCILITE Publications* (2022): e22115.
[22] J. Jirout, S. Zumbrunn, N. Evans, and V. Vitiello, "Development and Testing of the Curiosity in Classrooms Framework and Coding Protocol," *Frontiers in Psychology* 13 (2022).
[23] P. Shah, H. Weeks, B. Richards, and N. Kaciroti, "Early Childhood Curiosity and Kindergarten Reading and Math Academic Achievement," *Pediatric Research* 84, no. 3 (2018): 380–86.
[24] Abdelghani, "Interactive Environments."
[25] Ibid.

learning performance.[26] Adaptive AI technologies can provide personalized instruction and real-time feedback to students, creating opportunities to stimulate discovery curiosity in learners.[27] Moreover, AI can be integrated into educational platforms to encourage interactive learning experiences that promote curiosity and engagement among children.[28]

Traditional educational methods tend to prioritize the delivery of information over the cultivation of inquiry,[29] leaving a critical gap in the development of students' questioning skills and their natural curiosity. Recognizing this gap, we used the existing LLMs to prompt an AI-powered tool. The tool was developed as an innovative solution to measure and potentially enhance curiosity of elementary school students. The tool leverages the power of AI, specifically LLM (large language models), to create an interactive and adaptive platform that encourages students to ask questions, while simultaneously providing teachers with valuable insights into their students' cognitive engagement. By making the process of asking questions a regular part of classroom activities, our tool aims to transform the way curiosity is integrated into the learning process.

In this paper, we present the methodology behind the tool, detailing how it functions, its theoretical foundations, and its potential applications in educational settings. The focus is on the design and implementation of the AI system that underpins the tool, as well as the ways in which it can be used to enhance student learning and support research into the potential development of curiosity. Through this methodological exploration, we aim to demonstrate the tool's capacity to not only enrich the educational experience for students but also to contribute to a deeper understanding of how curiosity can be assessed in the classroom.

2. AI in Learning and Pedagogical Research

Generally, AI technology has become integral to learning and pedagogical research, transforming educational practices and enhancing learner out-

[26] C. Sun, H. Qian, and M. Chen, "From Psychological Curiosity to Artificial Curiosity: Curiosity-Driven Learning in Artificial Intelligence Tasks," *arXiv* (January 20, 2022).
[27] Demir, "Adaptive Artificial Intelligence."
[28] G. Kachergis, S. Radwan, B. Long, J. Fan, M. Lingelbach, D. Bear, and M. Frank, "Predicting Children's and Adults' Preferences in Physical Interactions via Physics Simulation," *PsyArXiv* (June 1, 2021).
[29] B. K. Khalaf and Z. B. M. Zin, "Traditional and Inquiry-Based Learning Pedagogy: A Systematic Critical Review," *International Journal of Instruction* 11, no. 4 (2018): 545–64.

comes. The application of AI in education encompasses various dimensions, from personalized learning to enhanced interaction between learners and instructors, and the optimization of educational content delivery. Research indicates that AI systems can improve communication and support, fostering a more interactive and engaging learning atmosphere.[30,31]

Machine learning algorithms analyze individual learning patterns and preferences to create tailored educational experiences. These systems adapt instructional materials based on student performance, accommodating diverse learning styles and paces.[32,33] Platforms utilizing AI can adjust the difficulty of tasks based on previous answers, providing a more supportive learning environment that caters to diverse abilities.[34] This customization ensures students master fundamental concepts before progressing to advanced material, fostering ownership over their learning journey and improving academic outcomes.[35,36,37]

AI technologies significantly enhance the interaction between learners and instructors, particularly in online environments. Intelligent tutoring systems (ITSs) and AI chatbots provide instant feedback and assistance, allowing instructors to focus on facilitating deeper learning experiences rather

[30] K. Seo, J. Tang, I. Roll, S. Fels, and D. Yoon. "The Impact of Artificial Intelligence on Learner–Instructor Interaction in Online Learning," *International Journal of Educational Technology in Higher Education* 18, no. 1 (2021).

[31] N. S. Sharifuddin and H. Hashim, "Benefits and Challenges in Implementing Artificial Intelligence in Education (AIED) in ESL Classroom: A Systematic Review (2019–2022)," *International Journal of Academic Research in Business and Social Sciences* 14, no. 1 (2024).

[32] E. S. Animashaun, B. T. Familoni, and N. C. Onyebuchi, "Advanced Machine Learning Techniques for Personalising Technology Education," *Computer Science & IT Research Journal* 5, no. 6 (2024): 1300–13.

[33] H. Munir, B. Vogel, and A. Jacobsson, "Artificial Intelligence and Machine Learning Approaches in Digital Education: A Systematic Revision," *Information* 13, no. 4 (2022): 203.

[34] M. N. O. Sadiku, T. J. Ashaolu, A. Ajayi-Majebi, and S. M. Musa, "Artificial Intelligence in Education," *International Journal of Scientific Advances* 2, no. 1 (2021).

[35] O. A. G. Opesemowo and V. Adekomaya, "Harnessing Artificial Intelligence for Advancing Sustainable Development Goals in South Africa's Higher Education System: A Qualitative Study," *International Journal of Learning, Teaching and Educational Research* 23, no. 3 (2024): 67–86.

[36] L. Chen, P. Chen, and Z. Lin, "Artificial Intelligence in Education: A Review," *IEEE Access* 8 (2020): 75264–78.

[37] H. Yi, T. Liu, and G. Lan, "The Key Artificial Intelligence Technologies in Early Childhood Education: A Review," *Artificial Intelligence Review* 57, no. 1 (2024).

than merely delivering content.[38,39] Tools like ChatGPT assist in generating ideas and promoting critical analysis, while AI facilitates collaborative learning experiences by connecting students with peers and resources.[40,41,42] This collaborative approach helps students explore complex topics more deeply and develop their analytical skills through guided inquiry.[43,44]

The real-time assessment and feedback capabilities of AI represent a significant advancement over traditional educational methods that often involve delayed feedback. AI systems can provide immediate assessments and suggestions, allowing students to adjust their learning strategies promptly.[45,46] This immediate response mechanism not only aids in reinforcing concepts but also helps build resilience and adaptability in learners as they navigate educational challenges.[47] By utilizing AI as a collaborative partner, students can develop key competencies such as critical thinking, problem-solving, and effective communication skills.

3. Conceptualisation of Curiosity

Curiosity has long been studied as a key component of human behavior, with recent developments offering more comprehensive frameworks for

[38] R. Jiang, "How Does Artificial Intelligence Empower EFL Teaching and Learning Nowadays? A Review on Artificial Intelligence in the EFL Context," *Frontiers in Psychology* 13 (2022).
[39] V. Kuleto, M. Ilić, M. A. Dumangiu, M. Ranković, O. Martins, D. Păun, and L. Mihoreanu, "Exploring Opportunities and Challenges of Artificial Intelligence and Machine Learning in Higher Education Institutions," *Sustainability* 13, no. 18 (2021): 10424.
[40] S. Athanassopoulos, P. Manoli, M. Gouvi, K. Lavidas, and V. Komis, "The Use of ChatGPT as a Learning Tool to Improve Foreign Language Writing in a Multilingual and Multicultural Classroom," *Advances in Mobile Learning Educational Research* 3, no. 2 (2023): 818–24.
[41] C. K. Boscardin, B. Gin, P. B. Golde, and K. E. Hauer, "ChatGPT and Generative Artificial Intelligence for Medical Education: Potential Impact and Opportunity," *Academic Medicine* 99, no. 1 (2023): 22–27.
[42] M. Nasir, M. Hasan, A. Adlim, and M. Syukri, "Utilizing Artificial Intelligence in Education to Enhance Teaching Effectiveness," *Proceedings of International Conference on Education* 2, no. 1 (2024): 280–85.
[43] Opesemowo and Adekomaya, "Harnessing Artificial Intelligence."
[44] C. Chembe, N. B. Nasilele, and R. Msendo, "The Fuss about Artificial Intelligence in Education Sector: Should We Worry?," *Zambia ICT Journal* 7, no. 2 (2023): 30–35.
[45] A. Q. Sarwari, and H. Mohd Adnan, "The Effectiveness of Artificial Intelligence (AI) on Daily Educational Activities of Undergraduates in a Modern and Diversified University Environment," *Advances in Mobile Learning Educational Research* 4, no. 1 (2024): 927–30.
[46] Chen, "Artificial Intelligence in Education: A Review."
[47] T. Glushkova and A. Malinova, "Advantages, Problems, and Challenges in the Application of AI Technologies in School Education," *E-Learning & Artificial Intelligence* 45–56 (2023).

its assessment. The Five Dimensional Curiosity Scale (5DC) by Kashdan et al.[48] represents a synthesis of decades of research, providing a multifaceted approach to understanding curiosity. This scale, validated across multiple countries, captures the complexity of curiosity through five distinct dimensions, emphasizing both the emotional and cognitive processes that drive curious behavior.

One of the key distinctions made in the 5DC is between two emotional experiences associated with curiosity: Joyous Exploration and Deprivation Sensitivity. Joyous exploration reflects the intrinsic pleasure derived from exploring the world, leading to a sense of fascination and higher well-being. In contrast, Deprivation sensitivity is marked by the discomfort and frustration of recognizing information gaps, which one is driven to resolve. Together, these two facets demonstrate the varying emotional valences of curiosity.[49,50] A complete assessment of curiosity must, therefore, account for these emotional contrasts while acknowledging the cognitive triggers that initiate curiosity, such as novelty, complexity, and ambiguity.

Traditionally, curiosity was viewed as a simpler construct, typically defined by one or two factors.[51] However, Kashdan and colleagues argue that curiosity is better conceptualized as a multifaceted phenomenon. This aligns with broader trends in personality psychology, where narrowing down global traits into specific facets allows for a more nuanced understanding of individual differences and their predictive power in various life outcomes.[52]

Beyond joyous exploration and deprivation sensitivity, the 5DC includes other important dimensions: Stress Tolerance, Thrill Seeking, and Social Curiosity. Stress Tolerance reflects an individual's capacity to handle anxiety when faced with new stimuli, while Thrill Seeking captures a desire for arousal from new and exciting experiences. Social Curiosity encompasses the desire to understand others' thoughts and behaviors, which Kashdan et al. (2020)[53] later split into two types: Social Curiosity General and Social

[48] Kashdan, "The Five-Dimensional Curiosity Scale: Capturing the Bandwidth of Curiosity and Identifying Four Unique Subgroups of Curious People."
[49] Kashdan, "Curiosity and Exploration Inventory-II."
[50] G. Loewenstein, "The Psychology of Curiosity: A Review and Reinterpretation," *Psychological Bulletin* 116, no. 1 (1994): 75–98.
[51] J. A. Litman, "Interest and Deprivation Factors of Epistemic Curiosity," *Personality and Individual Differences* 44, no. 7 (2008): 1585–95.
[52] D. J. Grüning and C. M. Lechner, "Measuring Six Facets of Curiosity in Germany and the UK: A German-Language Adaptation of the 5DCR and Its Comparability with the English-Language Source Version," *Journal of Personality Assessment* 105, no. 2 (2023): 283–95.
[53] Kashdan, "The Five-Dimensional Curiosity Scale Revised (5DCR)."

Curiosity Covert. This refinement enables a more precise measurement of curiosity's social aspect, distinguishing between overt interest in others and more secretive, indirect inquiries.

The revised Six Dimensional Curiosity Scale (5DCR) not only refines these categories but also introduces a more efficient structure with fewer items, maintaining robust reliability while reducing response time. The facets of the 5DCR, supported by factor analysis, are moderately correlated, indicating their partial independence. Studies have also demonstrated that these dimensions have meaningful associations with broader personality traits and human values, particularly Openness, Extraversion, and self-direction and stimulation in Schwartz's model of basic human values.[54] This supports the idea that curiosity is a multi-dimensional trait that stands on its own, intersecting with various personality factors and values.

By combining emotional, cognitive, and social components, the 5DCR provides a thorough understanding of curiosity as a diverse and dynamic psychological construct, offering valuable insights into how individuals explore, experience, and seek to understand the world around them.

While viewing curiosity through the lens of joyous exploration and deprivation sensitivity focuses on internal motivational states, examining it through question-asking patterns reveals how these drives manifest in concrete learning behaviors. In this case, the ability and willingness to ask divergent questions. To operationalize the curiosity of children as an ability and willingness to ask divergent questions, it is essential to explore the interplay between curiosity, question-asking, and educational practices. Divergent questioning, characterized by open-ended and exploratory inquiries, serves as a key indicator of a child's curiosity and cognitive engagement.[55,56] This operationalization can be approached through a combination of pedagogical strategies, interactive environments, and the integration of technology.

Curiosity is a fundamental driver of learning and exploration in children. It is defined as the intrinsic motivation to seek out new information and experiences, which often manifests in the form of questions.[57] Research

[54] Ibid.
[55] R. Abdelghani, P. Y. Oudeyer, E. Law, C. de Vulpillières, and H. Sauzéon, "Conversational Agents for Fostering Curiosity-Driven Learning in Children," *International Journal of Human-Computer Studies* 167 (2022): 102887.
[56] R. Abdelghani, Y. H. Wang, X. Yuan, T. Wang, P. Lucas, H. Sauzéon, and P. Y. Oudeyer, "GPT-3-Driven Pedagogical Agents to Train Children's Curious Question-Asking Skills," *International Journal of Artificial Intelligence in Education* 34, no. 2 (2024): 483–518.
[57] Abdelghani, "Conversational Agents."

indicates that children who exhibit higher levels of curiosity are more likely to engage in divergent questioning, which involves generating multiple possible answers or exploring various perspectives on a topic.[58] For instance, Koutstaal et al.[59] found a significant positive correlation between curiosity and originality in divergent thinking tasks, suggesting that curious children are more adept at generating novel ideas and questions.[60]

To cultivate children's ability to ask divergent questions, educators can implement specific pedagogical strategies. One effective approach is the use of pedagogical agents, which are designed to encourage question-asking behaviors. Abdelghani et al. demonstrated that conversational agents can foster curiosity-driven learning by engaging children in dialogues that prompt them to ask questions, thereby enhancing their inquiry skills.[61] This aligns with findings from Abdelghani et al.,[62] which suggest that interventions focused on encouraging divergent-thinking questions can significantly benefit children with higher curiosity traits.[63]

Creating interactive environments that promote metacognitive skills is another crucial strategy for enhancing children's curiosity and question-asking abilities. Abdelghani[64] conducted a pilot study that highlighted the importance of metacognitive training in fostering curiosity.[65] By engaging children in activities that require them to reflect on their thinking processes, educators can help them develop the skills necessary to formulate and ask more complex, divergent questions. This approach not only enhances children's questioning abilities but also supports their overall cognitive development.

The integration of technology, particularly generative AI, can further enhance children's ability to ask divergent questions. For instance, Abdelghani et al.[66] explored the use of GPT-3-driven pedagogical agents to train children's question-asking skills. These AI-driven tools can provide person-

[58] M. Alaimi, E. Law, K. D. Pantasdo, P. Oudeyer, and H. Sauzéon, "Pedagogical Agents for Fostering Question-Asking Skills in Children," in *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, eds. Regina Bernhaupt et al. (New York: ACM, 2020).
[59] W. Koutstaal, K. Kedrick, and J. Gonzalez-Brito, "Capturing, Clarifying, and Consolidating the Curiosity-Creativity Connection," *Scientific Reports* 12, no. 1 (2022).
[60] Abdelghani, "Conversational Agents."
[61] Ibid.
[62] Ibid.
[63] Ibid.
[64] Abdelghani, "Interactive Environments."
[65] Ibid.
[66] Abdelghani, "GPT-3-Driven Pedagogical Agents."

alized feedback and encourage children to explore various angles of a topic, thus promoting a culture of inquiry and curiosity. The findings suggest that such technology can significantly enhance children's willingness to engage in divergent questioning.

We believe that the tool designed to encourage children to ask high-quality, divergent, and open-ended questions serves as a valuable tool for both measuring and enhancing their epistemic curiosity – the drive to acquire knowledge and resolve information gaps. By guiding children to formulate more thoughtful, exploratory questions, the tool stimulates the cognitive processes associated with curiosity, particularly the dimensions of joyous exploration and deprivation sensitivity. Through repeated practice in generating questions that probe deeper into topics, children engage with the world in a way that nurtures their innate desire to learn and understand. This process not only provides us with a practical method for assessing their epistemic curiosity, as we can track the complexity and originality of their inquiries, but it also actively contributes to cultivating a more curious mindset. Over time, we expect that children who regularly use the software will show an increase in both the quality of their curiosity and their willingness to seek out new knowledge, leading to a long-term boost in their overall curiosity levels.

4. Methodology

4.1 Conceptual Framework

The tool is designed around the concept of measuring and potentially enhancing curiosity in elementary school students by facilitating the process of asking questions. The underlying theoretical foundation draws from educational psychology, emphasizing the role of curiosity in learning and the importance of question-asking as a means of cognitive development. Since the tool measures children's curiosity and may also bolster it, it can serve both as a measurement instrument and as a potential intervention.

We base our work on the previously mentioned conceptualisation of curiosity, which differentiates between two types – (1) joyous exploration and (2) deprivation sensitivity. In this study, however, we focus solely on the "joyous exploration" dimension because (a) we consider it more important for children's learning, and (b) analyzing both types would be too complex.

4.2 Technological Background and Parameters

The AI tool uses the Claude Sonnet 4 model (by Anthropic), selected for its reliable performance in educational contexts and its tendency to generate conservative, safe, and age-appropriate responses. We did not perform any fine-tuning of the model. Instead, prompt engineering is used to provide task-specific instructions and examples. Parameters such as temperature (typically 0.7), maximum token length (usually 512), and top-p are set to default values and can be adjusted if needed.

The AI tool is implemented as a web-based application designed for classroom use. The frontend is built using the Blazor framework (.NET), which allows for fast and responsive user interactions directly in the browser. This interface enables students to submit their questions through a tablet or computer in real time during lessons. Teachers can access a separate dashboard for monitoring student engagement and analyzing the types of questions asked.

On the backend, the tool is built around the LlmTornado library, an open-source middleware that facilitates interaction with various large language model APIs. LlmTornado handles the orchestration of prompt engineering, model switching, response parsing, and error handling. This library has been previously used in other educational tools such as ScioBots or Mapa školy (School map) and supports modular integration of different AI models. In our case, it currently interfaces with the Claude Sonnet 4 model via API access.

All interaction data is stored in a Microsoft SQL Server database. Each entry includes: (1) the student's pseudonymized identifier, (2) the full text of the questions submitted and responses generated, (3) timestamps and (4) metadata such as session ID and classroom context.

Data is stored in structured JSON format, which enables later analysis of question sequences, follow-up complexity, and categorization history. The data is encrypted both in transit (via HTTPS) and at rest in the SQL database using AES encryption. Personally identifiable information is not collected – no names, school locations, or contact details are stored. Each dataset is linked only to an anonymized device ID.

This setup ensures reproducibility, as the software stack is composed of open technologies, and the data format is transparent and accessible. It also supports scalability and security, allowing the system to be deployed across multiple schools while maintaining high standards for data protection in compliance with GDPR and national regulations.

4.3 The Prompt Used in the AI Tool

The prompt engineering includes examples of questions of real kids from real school classes, including the rating of the level of curiosity of these individual questions. The prompt also includes safety instructions (ignoring controversial topics suggested by children) and pedagogical context (so the AI tool interacts with the child in a pedagogically meaningful way, including the length and complexity of the questions tailored for elementary school children). The AI tool is currently not personalised for the purpose of each individual child that interacts with it. However, the next step is to personalize the tool so that it remembers the conversations it had with each individual child (based on a unique login ID such as email) so that the tool can "evolve" and adapt its suggestions to each individual child.

4.4 Design and Development of the AI Tool

The tool operates as a digital platform where students, guided by their teachers, are prompted to ask questions during specific moments in their lessons. So far, the instrument is available only for Scio schools and only in the Czech language. The process begins with the teacher generating a unique QR code, which students scan using their mobile devices, tablets, or PCs. This prompts them to enter up to five questions within a limited time frame (typically five minutes), where asking one question is mandatory and asking four more is optional. The teacher simultaneously records the contextual details of the situation, such as the lesson topic, classroom dynamics (current mood of students, interesting topics that students have heard today, student's rank of the current lesson), and any noteworthy events (e.g., disruptions or announcements). This context is crucial as it allows the AI to better analyze the nature of the questions in the context of the current environment. The tool gives the teacher a summary of anonymous questions. Since the tool gives the teacher the overall self-evaluation of the mood in the class by students, the teacher can understand better if the students are interested in the topic. The tool allows the teacher to quickly gain an overview of student engagement, their understanding of the topic, areas of interest, and to adjust their strategy.

Table 1: Example of student's questions and follow up questions of the AI

Student question	AI follow-up question
What would happen if whales could fly?	That is an interesting question. Do you think they would eat birds?
What would happen if whales went extinct?	That is a good question. Do you think that the ocean ecosystems would collapse if whales went extinct?
Why do whales make such loud noises?	That is a very good question. Why do you think that is?

The students are encouraged by the AI to ask more questions by providing immediate feedback. The feedback is always in the form of a question that further encourages the student to ask even more interesting, deeper, divergent, conceptually open questions (Table 1). The AI takes the student's question and further develops its core idea, provoking more divergent thinking from the student. The students' questions, along with the contextual data, are immediately sent to an AI system that categorizes them into several types: "school-related," "curiosity-driven," "inappropriate/out of context," and "other" (Table 2). The AI uses predefined prompts (Appendix) to classify these questions and generate a summary report for the teacher. This report provides insights into the types of questions students are asking, the proportion of questions that align with the lesson context, and suggestions for follow-up questions that are worth discussing. The feedback is designed to be immediate so the teacher can promptly access the current mood in the classroom as well as students' interest in the current topic. The level of curiosity in the classroom is evaluated by the AI based on the quality and quantity of the questions. The AI rates as more curious the questions that are conceptually open, grammatically open, divergent, resembling the topic, and further developing the topic. Studies suggest that the more such questions the child asks, the more curious she or he can potentially be.[67] The AI then summarizes the overall results of the class in a short summary (Figure 1). The AI then summarizes the mood of the group and rates whether the group is overall curious or not while pinpointing the most curious questions using the rating described above in this paragraph. Finally the AI suggests two most interesting open questions that are worth discussing together and

[67] Abdelghani, "Interactive Environments."

expanding on. It also suggests two inspiring questions of its own that the class can discuss.

The student asks the first question (mandatory).	→	The AI gives a follow-up question.
	↙	
The student asks the second question (optional).	→	The AI gives a follow-up question.
	↙	
The student asks the third question (optional).	→	The AI gives a follow-up question.
	↙	
The student asks the fourth question (optional).	→	The AI gives a follow-up question.
	↙	
The student asks the fifth question (optional).	→	The AI thanks for the questions.
		↓
The student submits the questions or the AI ends the session after three minutes.		
		↓

The AI collects and analyzes all the questions based on their quality, creating a summary and giving the summary to the teacher. The summary has the following information:
What interested the students the most in today’s class.
How students rated today’s class.
What was the average mood (and mood distribution) in today’s class.
What were the most interesting questions that students asked.
If the class is overall curious and interested in the current topic.
Which questions are worth expanding on in a discussion.
Which newly generated questions by the AI are suggested to be discussed further.

Figure 1: The complete scheme describing how the AI tool uses the online platform to collect student’s questions and converts their summaries into a summary for the whole class.

Table 2: The four types of questions that the AI recognizes and differentiates, including factors that the AI uses to determine whether the question fits in the specific category or not.

Question type	**Example of a fitting question**	**Factors fitting the question type**	**Fact. NOT fitting the question type**
school-related	Who is Napoleon Bonaparte?	related to school subjects (or school topics) in general	not related to school subjects (or school topics) in general
		related to the current topic of the class	not related to the current topic of the class

Question type	Example of a fitting question	Factors fitting the question type	Fact. NOT fitting the question type
curiosity-driven	What would happen if the Earth rotated twice as fast?	divergent question (cannot be answered with a simple yes/no answer, requires complex answer, significantly expands the topic, gives the topic another dimension)	convergent question (can be answered with a simple yes/no answer, requires simple answer, asks for specific information, fills a specific knowledge gap
		original questions	non-original questions
		complex questions	simple questions
		deep questions (questions that go deeper into exploring the subject and show interest in understanding the subject, or discovering new connections, information, and concepts)	shallow questions (questions that only touch the surface, are not exploratory, do not attempt to explore the subject/ context, do not attempt to obtain interesting new information)
inappropriate/ out of context	What is Jane wearing today?	out of topic or context	synergistic with the topic or context
other	Please let me leave.	is not a question	is a question

4.5 Validity of the AI Tool

Validity of the tool was tested using two independent methods: (1) testing the level of agreement between independent evaluators and the AI and (2) testing how the AI separates questions between four tested categories.

In the first case, we asked an AI tool (ChatGPT 4) to generate 30 questions regarding the topic of climate change that 12–13 year old children would generate during class. Then, we asked eight adults from the educational environment to individually and independently rate each individual question on a scale 1–10 (1 = not a curious question at all, 10 = a super curious question). After that, we asked the AI to rate the same questions using the same method. We calculated the agreement level between human and AI rating using the Pearson correlation coefficient using R Software (R Core Team, 2025) between (a) the AI and the average rating of humans and (b) the AI and individual human ratings pooled together.

As a result, the level of agreement between human evaluators and the AI was quite high in both cases: (a) the AI and the average rating of humans ($mean_{human} = 5.5$, $mean_{AI} = 7.5$, $r = 0.89$, $t = 10.41$, $df = 28$, $p < 0.01$, 95%CI = 0.78–0.95) and (b) the AI and individual human ratings pooled together ($mean_{human} = 5.5$, $mean_{AI} = 7.5$, $r = 0.61$, $t = 12.52$, $df = 268$, $p < 0.01$, 95%CI = 0.53–0.68).

In the second case, to evaluate the AI tool's question classification accuracy, we employed a controlled testing protocol involving five researchers with expertise in educational assessment. One researcher served as session moderator while four researchers systematically generated questions designed to test the tool's ability to categorize items into four predetermined categories: (1) school-related, (2) curiosity-driven, (3) inappropriate/out of context, and (4) other. The question generators deliberately formulated inquiries with varying characteristics across multiple dimensions including complexity levels, thematic relevance, cognitive demand (convergent vs. divergent thinking), appropriateness for educational contexts, and structural coherence. Questions were strategically designed to represent each target category: school-related items connected to educational curriculum, curiosity-driven questions demonstrating originality and intellectual depth, inappropriate content unsuitable for educational settings, and non-coherent statements lacking meaningful inquiry structure (for example see Table 2).

Subsequently, the AI tool's classification outputs were compared against the researchers' expert assessments using the same evaluative criteria. Rather than conducting formal statistical analyses of inter-rater agreement between human and automated classifications, each researcher individually evaluated the degree of alignment between the tool's categorizations and their own expert judgments. Following individual assessments, the research team engaged in structured group discussion to determine whether the AI tool's performance met established expectations and criteria. Through this consensus-building process, the team concluded that the tool demonstrated satisfactory classification accuracy, with its evaluative outputs generally corresponding to human expert assessments across the four designated question categories.

Together with testing the quality of the questions, the tool also considers the number of questions asked, meaning that the more questions a person asks, the more curious he or she appears to the AI.

We have not yet performed any longitudinal research regarding repetitive collection of questions from individual children to see if there is any real progress in curiosity of children who use the tool. It is because the tool does not save data for long-term purposes of longitudinal analyses regarding the progress in curiosity of individual children. Therefore, we have no data regarding the question whether the AI tool can boost the curiosity of children in the long-term.

Table 3: Protocol for teachers regarding using the AI tool in a class.

Step	Instructions
1	You can use the tool for any lesson regardless of the topic, however it's advisable to combine it with other tools so that children don't get bored.
2	First, announce the topic that will be covered in the lesson to the children, and give them a moment to think about the topic. Meanwhile, log into the tool from the teacher's position and enter the topic being discussed in the school lesson into the tool.
3	Then determine based on the mood in the classroom and according to your needs as a teacher whether you want to use the tool immediately, in the middle of the lesson, or before the end of the lesson.
4	Tell the children to log into the tool system from the student position using their specific identifier via mobile phone, tablet, or PC.

Step	Instructions
5	After logging in, tell the children that they can ask up to five questions that interest them about today's topic and that they would like to know the answer to. Announce that they have five minutes to ask questions from the moment they log into the system. Then show the children the QR code through which they will log into the tool.
6	After five minutes elapse, the application will close for the children. Then it automatically collects and analyzes the questions and summarizes the results for you. The subsequent work with the tool's results is up to you – you can point out interesting questions, suggest a different topic (if the children aren't interested in the given topic), develop one or more of the questions, or search for answers to the questions together with the children.

4.6 Real Life Testing of the AI Tool

The tool was implemented in the practical setting of Scio schools. In total, data were collected from 282 students across 141 class sessions led by 28 individual teachers. The mean group size per class was 10 students (range = 8–13), and each teacher used the AI tool in five separate sessions. The mean age of participating students was approximately 12–13 years; however, exact age distribution (and standard deviation) as well as gender information are unavailable, as the application does not collect these variables, and Scio school classes typically comprise mixed-age groups. The AI tool was used following the protocol described in Table 3.

4.7 Implementation in Educational Settings

The tool is intended to be used regularly in classrooms, with teachers integrating the tool into their existing lesson plans. The system is flexible, allowing it to be used across various subjects and age groups (classes in elementary and middle school, adults), although initial trials have focused on elementary school students, partially because other tools that measure curiosity proved to be less useful for elementary students.[68] The interface is designed to be user-friendly, requiring minimal training for teachers.

[68] Piotrowski, "Measuring Epistemic Curiosity."

One of the key design considerations has been to minimize disruption to the classroom routine while maximizing the benefits of real-time data collection. The tool's ability to operate across different devices ensures that it can be used even in classrooms with limited technological resources. For younger students or those with limited access to personal devices, adaptations such as shared devices or simplified input methods are being explored.

4.8 Ethical Considerations

The tool prioritizes data privacy and security, ensuring that all student data is anonymized and stored securely. Additionally, efforts have been made to ensure that the AI's feedback does not give students a false sense of definitive answers, thereby encouraging ongoing inquiry and critical thinking rather than a reliance on AI-generated responses. It is important for the participating children to know that their answers are anonymous, which the tool guarantees.

5. Potential Applications and Implications

5.1 Impact on Student Learning

We assume that this tool has the potential to significantly enhance student learning by fostering a culture of curiosity in the classroom. Regular use may help students develop the habit of asking questions, which could contribute to deeper cognitive engagement and the development of critical thinking skills. The primary aim of the AI tool is to encourage students to formulate deeper and more complex questions, rather than simple inquiries with limited informational value. Such use could lead to long-term benefits, including increased motivation and a more personalized learning experience. However, we have not yet examined whether the AI tool genuinely develops students' curiosity, and we propose that this question should be addressed in future research.

5.2 Teacher Workload and Classroom Dynamics

One of the key advantages of the tool is its ability to streamline the feedback process for teachers. The AI-generated summaries provide valuable insights into student engagement and understanding, reducing the need for lengthy feedback sessions and allowing teachers to focus on more targeted instructional strategies. Additionally, the tool can help identify patterns in student behavior, such as the types of questions that are frequently asked or the subjects that generate the most curiosity, enabling teachers to tailor their lessons more effectively.

5.3 Long-Term Educational Outcomes

In the long term, the tool could contribute to a shift in educational practices, where curiosity is recognized as a critical component of learning and is systematically nurtured in the classroom. The data collected through the tool can inform broader educational research, providing insights into how curiosity develops over time and how different teaching methods influence this process. This could lead to the development of new pedagogical approaches that prioritize inquiry-based learning and the cultivation of curiosity.

5.4 Research Implications

From a research perspective, the tool offers a unique opportunity to study the dynamics of curiosity in a natural environment. So far, the tool has collected data regarding questions of students from 141 teaching classes (hours). Researchers could use this data to examine the impact of various contextual factors, such as the time of day, lesson content, or classroom environment, on the types of questions students ask. This could lead to a deeper understanding of the mechanisms underlying curiosity and how it can be effectively supported in educational settings.

In conclusion, the tool is not only a tool for enhancing student curiosity but also a valuable resource for teachers and researchers. Its potential applications extend beyond the classroom, offering insights that could shape the future of educational practices and contribute to the ongoing development of AI-driven educational tools.

6. Discussion

The methodology described in this paper centers around the development and implementation of the tool, an AI-driven platform designed to enhance and measure curiosity in elementary school students by facilitating question-asking within classroom settings. The tool integrates natural language processing (NLP) to analyze the questions submitted by students, providing teachers with immediate feedback and insights that can inform instructional strategies.

6.1 Methodological Strengths

One of the primary strengths of the tool methodology lies in its innovative approach to integrating AI into everyday classroom activities. By leveraging NLP, the tool provides real-time analysis and feedback on student questions, which is a significant advancement over traditional methods that often rely on post-hoc analysis. This allows the AI to promptly intervene and encourage the student to ask even more curious questions. In addition, feedback from the AI can be more useful in comparison to feedback from a teacher. Studies found that some people may enjoy an interaction with AI more than they enjoy an interaction with people.[69] This immediacy allows teachers to promptly adjust their teaching strategies, promoting a more responsive and adaptive learning environment. Moreover, the tool's design ensures that it can be seamlessly integrated into existing educational frameworks, making it accessible and user-friendly for teachers and students alike.

Another notable strength is the tool's dual functionality as both an educational aid and a potential research instrument. It supports teachers in fostering a culture of inquiry within the classroom, and, in the future, it could also collect data on student curiosity, offering valuable insights into the factors that influence this trait. This data-driven approach could enable a more nuanced understanding of how curiosity evolves over time and how different contextual factors may impact students' propensity to ask questions. The ability to analyze curiosity in a long-term manner is critical since studies found that epistemic curiosity changes slowly over time and is quite stable.[70] We believe that such an instrument can boost students' curiosity over time because similar experiments where the AI tried to enhance students' ability to ask questions were successful.[71,72]

Another scientific strength of the tool is the ability to assess curiosity using an experiment that actively tests the ability of the student to ask questions, measuring curiosity more directly. As previous studies have shown,[73,74] this is a more reliable method in comparison to other research

[69] F. Chopra and I. Haaland, "Conducting Qualitative Interviews with AI," CESifo Working Paper No. 10666, 2023.
[70] Piotrowski, "Measuring Epistemic Curiosity."
[71] Abdelghani, "Conversational Agents."
[72] Abdelghani, "GPT-3-Driven Pedagogical Agents."
[73] Abdelghani, "Conversational Agents."
[74] Abdelghani, "GPT-3-Driven Pedagogical Agents."

instruments that use self-evaluating questionnaires.[75,76,77,78] Currently, there is no validated self-evaluation instrument for curiosity that can be used for children to evaluate themselves. There is a questionnaire tool that allows a parent or teacher (or another third person) to evaluate a child's curiosity[79] which is based on a self-evaluation tool by Litman.[80] However, it is complicated to assess what these self-evaluation tools are measuring since curiosity itself is an elusive and complicated concept that has been conceptualized in many different ways.[81]

6.2 Challenges and Limitations

Despite its strengths, the tool also faces several challenges and limitations. One of the primary challenges is ensuring consistent student engagement with the tool. Given that the tool relies on students' active participation in asking questions, there is a risk that some students may not fully engage, particularly if they do not find the process intrinsically motivating. To address this, future iterations of the tool may need to incorporate additional motivational features, such as gamification elements or personalized feedback that is more directly relevant to each student's interests. Gamification of tools to measure and boost curiosity and similar traits has been used before.[82,83] However, there is a concern whether students ask similarly in a gamified environment in comparison to the real world.[84]

Another limitation is the potential for technical issues, particularly in classrooms with limited access to technology or where students share devices. Ensuring that the tool is accessible to all students, regardless of their technological resources, is critical for its widespread adoption. Ad-

[75] Litman, "Interest and Deprivation Factors of Epistemic Curiosity."
[76] Piotrowski, "Measuring Epistemic Curiosity."
[77] Kashdan, "The Five-Dimensional Curiosity Scale."
[78] Kashdan, "The Five-Dimensional Curiosity Scale Revised (5DCR)."
[79] Piotrowski, "Measuring Epistemic Curiosity."
[80] Litman, "Interest and Deprivation Factors of Epistemic Curiosity."
[81] J. Jirout and D. Klahr, "Children's Scientific Curiosity: In Search of an Operational Definition of an Elusive Concept," *Developmental Review* 32, no. 2 (2012): 125–60.
[82] T. J. van Schijndel, B. R. Jansen, and M. E. Raijmakers, "Do Individual Differences in Children's Curiosity Relate to Their Inquiry-Based Learning?," *International Journal of Science Education* 40, no. 9 (2018): 996–1015.
[83] A. Makhija, M. Jha, D. Richards, and A. Bilgin, "Use of Gamification to Enhance Curiosity and Engagement through Feedback Strategies," *ASCILITE Publications* (2021): 137–42.
[84] A. To, S. Ali, G. Kaufman, and J. Hammer, "Integrating Curiosity and Uncertainty in Game Design," in *Proceedings of DiGRA/FDG 2016 Conference* (DiAGRA Digital Library, 2016).

ditionally, the effectiveness of the tool depends heavily on the quality of the input provided by teachers, both in terms of the contextual information they enter and the way they introduce and integrate the tool into their lessons. Teacher training and support will be crucial to overcoming these challenges. Since the spread of AI and robots into research of curiosity in children has been accelerating,[85] we believe that the lack of technological equipment and know-how will not be an issue. We have tested the tool with students to see if they are capable of operating the software and if they understand the assignments. We have found that students from a certain age (nine or ten years and older) can operate this instrument enough to finish the tasks (our own observations). However, younger children under the age of nine had problems and needed help from the teacher. This is well in alignment with other studies that reported that children can operate such tools.[86,87,88] Studies reported that the best age group for such experiments is eighth grade or older as these children can operate software with relative ease.[89]

Further limitations exist in interpretation of the results, specifically grading the quality of student's questions using the AI. The AI rates the quality of the questions based on its own prompt which can differ from how a person would rate such quality. However, studies that used two independently rating evaluators found that the overlap of ratings is usually quite strong when rating traits like curiosity or creativity,[90,91] Students can also ask inappropriate and ethically incorrect questions which the AI may not always filter out. For example, the tool does not yet have the ability to detect current controversial social events and respond to questions about these events appropriately. However, with AI abilities on the rise, it is likely that future versions will be able to respond properly.[92]

[85] G. Gordon, C. Breazeal, and S. Engel, "Can Children Catch Curiosity from a Social Robot?," in *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction – HRI '15*, eds. Julie A. Adams et al. (New York: ACM/IEEE, 2015).
[86] Gordon, "Can Children Catch Curiosity from a Social Robot?"
[87] Abdelghani, "Conversational Agents."
[88] Abdelghani, "GPT-3-Driven Pedagogical Agents."
[89] S. Alan and I. Mumcu, "Nurturing Childhood Curiosity to Enhance Learning: Evidence from a Randomized Pedagogical Intervention," *American Economic Review* 114, no. 4 (2024): 1173–210.
[90] K. Urban, O. Pesout, J. Kombrza, and M. Urban, "Metacognitively Aware University Students Exhibit Higher Creativity and Motivation to Learn," *Thinking Skills and Creativity* 42 (2021): 100963.
[91] Abdelghani, "Conversational Agents."
[92] Chopra, "Conducting Qualitative Interviews with AI."

Finally, while the tool's AI component is a significant strength, it also introduces the risk of over-reliance on AI-generated feedback. There is a possibility that students may begin to view AI as the ultimate authority, potentially stifling their critical thinking and creativity. It will be important to strike a balance between providing useful AI-generated insights and encouraging students to continue exploring their questions independently. Studies found that a good balance between AI and human interaction is important,[93] so we recommend that the teacher-student interaction stays while the AI will be a useful helper.

6.3 Future Research Directions

Looking forward, there are several avenues for future research that could further enhance the tool and its applications. One key area for exploration is the tool's impact on different student populations. Future studies could investigate how factors such as age, gender, and prior educational experiences influence students' engagement with the tool and their development of curiosity. Another promising direction for future research is the refinement of the AI algorithms used in the tool. By continuously improving the NLP models and incorporating more sophisticated machine learning techniques, the tool could offer even more personalized and contextually relevant feedback to students and teachers. Moreover, exploring the potential of integrating the tool with other educational technologies, such as adaptive learning platforms or collaborative learning environments, could lead to more holistic educational solutions that address multiple aspects of student development.

7. Conclusion

In conclusion, while the tool represents a promising methodological innovation in the field of educational technology, its continued development and empirical testing will be essential for realizing its full potential. By addressing the challenges and building on the strengths identified in this discussion, the tool has the potential to make a substantial contribution to both classroom practice and educational research.

[93] Ibid.

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Appendix:

The following prompt was given to the AI to evaluate and provide feedback on children's questions:

1. **Task Overview**: A group of individuals (children) is given the task of asking between one to five questions. The AI's role is to evaluate these questions and provide a brief summary. The AI will always receive a table where each row contains the questions asked by one individual, along with their mood.

2. **Summary Instructions**: The AI must include the following in its summary:
   - Total number of questions asked and the average per person.
   - A description of the questions, their topics, and types.
   - Observations about the group based on the questions and mood; the AI is encouraged to be witty and propose hypotheses.
   - Selection of the two most interesting open questions worth discussing.
   - Flag any question requiring an immediate solution with two exclamation marks (!!).
   - Create two inspiring questions for the group.

3. **Question Types to Analyze**:
   - *School-related questions*: Simple, clear questions that a teacher could ask, with obvious answers.
   - *Curiosity-driven questions*: Original, interesting, or divergent questions that require deeper thought and connect different ideas.
   - *Inappropriate questions*: Confusing, trivial (e.g., "What time is it?"), or off-topic (e.g., "What's for lunch?").
   - *Other questions*: Questions that don't fit into any category.

4. **Analysis Focus**: When collecting and analyzing children's questions, the AI should focus on:
   - The total number of questions and the average per person.
   - Percentage breakdown of school-related, curiosity-driven, and inappropriate questions (with pie charts).
   - Percentage of context-relevant and off-topic questions (with pie charts).
   - Listing the most context-relevant questions.
   - Identifying the most interesting curiosity-driven questions for discussion.
   - Creating new inspiring questions based on the collected ones.

- Providing examples of school-related, inappropriate, and other types of questions.
- Offering insights about the group, including hypotheses based on their questions.

5. Feedback Instructions:
- The AI is instructed to briefly and wittily comment on each question's quality, with a focus on encouraging curiosity. The feedback should:
  - Be concise (maximum of 10 words).
  - Not answer the question.
  - Avoid giving advice on what to ask next.
  - Point out when a question is uninteresting or too simple.
  - Praise and encourage creativity, even when off-topic.
  - Always consider the age of the children when providing feedback and ensure the language is age-appropriate.
  - Use the word *curiosity* instead of *inquisitiveness*.

6. General Rules:
- Be brief, clear, and encouraging.
- Emphasize *curiosity* in feedback, not criticism.
- Use friendly, understandable language appropriate for the children's age group.

This prompt and these instructions guided the AI's interactions with children to promote deeper thinking and curiosity, thereby supporting an environment where students are encouraged to ask more thoughtful and exploratory questions.