Offline-First AI Tutoring Systems: Improving Personalized Learning for High School Students in Low-Connectivity Regions

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Abstract

The main purpose of this study is to examine the potential of offline-first artificial intelligence (AI) tutoring systems to improve personalized learning outcomes for high school students, particularly in low-connectivity regions. A survey of 30 students was conducted to explore current patterns of AI tool usage, perceived benefits, and limitations. Results show that students most often use AI tools for homework help, exam preparation, and subject practice in mathematics and science. Participants reported that AI simplifies complex concepts, saves time, and provides explanations that adapt to their preferred learning styles, thereby enhancing motivation and engagement. However, concerns were raised about the reliability of responses, the risk of over-reliance, and limited guidance due to direct responses. Notably, 50% of respondents indicated that lack of internet access, data, or devices restricted their ability to use AI tools consistently. The study concludes that offline-first AI tutoring systems that can be designed to be lightweight, curriculum-aligned, and capable of functioning without continuous connectivity, could address these challenges. Such systems hold strong potential to bridge the digital divide, increase equitable access, and provide more personalized, effective learning experiences for students in under-resourced educational contexts.

Introduction

Artificial intelligence, or AI as we commonly know is increasingly being incorporated in our day-to-day life. Now, it is even shaping student learning through tools like chatbots, research AI's like perplexity, and math solvers. These AI tools provide quick personalized feedback and explanations based on student input, which is far more efficient for students than traditional learning methods (Kestin et al., 2025). However, most modern-day AI systems rely on internet access and cloud-based servers, which makes them less reliable in low-connectivity regions such as schools with limited resources (Khan, Umer & Faruque, 2024).

This makes them less accessible for many high school students who do not always have consistent online access. On a broader scale, it contributes to the global issue of digital inequality (UNESCO, 2023). As a solution, adapting commonly used AI features to offline models could help spread the benefits of personalized learning to students in low-connectivity and low-resource areas. By focusing on high school students' actual preferences, there is an opportunity to design offline AI tutoring systems that combine accessibility with personalization. Offline-first tutoring systems also have the potential to reduce part of the digital divide, making learning tools more inclusive for all students (Amplyfi, 2025).

The objective of this study is to use high school student-reported usage and preferences from survey data to identify which AI support features are most valued by them. These findings will be used to highlight the importance and potential impact of designing offline tutoring systems for more global access to boost learning in areas with low resources and connectivity based on real student needs.

Unlike most existing research, which discusses AI in education at a general level, this study focuses specifically on high school students. By prioritizing student preferences, the research aims to suggest more practical designs for offline AI tutors that directly support personalized learning. This student-driven approach emphasizes practicality, ensuring that the proposed solutions reflect how learners engage with AI in real-world, low-connectivity environments.

Hypothesis:

Understanding high school students' preferred AI features in learning and integrating personalized offline-first tutoring systems will enhance personalized learning experiences, even in regions with limited internet access.

Methodology

Measures from the survey:

- AI usage frequency: How often students use AI (daily, weekly, rarely).
- Types of tools they use: Examples include ChatGPT, Google Translate, Duolingo, Perplexity and other learning tools.
- What they use AI for: Such as writing help, homework, problem-solving hints, general support, and exam preparation.
- Usefulness: students rated how easy AI is to use, how effective it feels for their learning, and whether it matches their learning style.

- ❖ Recommendations: What students suggest for improving certain AI features to support their learning.
- ❖ Personalization: How well students think AI can personalize learning experiences.

The main purpose of asking these questions was to identify firstly the students' opinions on AI and analyze the key patterns to conclude the research. The most popular features preferred by students will be used for designing offline tutoring systems and how they can improve traditional learning methods.

Data Analysis:

1. Preferred features: Calculate the percentage of students who reported using each feature. This shows which capabilities are most relevant to high school students.
2. Usefulness: Calculate the average usefulness ratings for each feature.This identifies which tools students believe have the greatest impact on learning.
3. Comparison of groups: Compare frequent AI users with infrequent users to see if their preferences differ.
4. Link to offline design: Map the top-rated features to possible offline implementations, to see how they could improve traditional teaching in low-connectivity settings.

The results will be presented in:

- ➢ Table 1. Purposes for which students use AI tools
- ➢ Figure 1. AI usage frequency
- ➢Figure 2: Common AI platforms used by students

Finally, the most highly rated features will be discussed, analyzed, and proposed for possible offline implementations. For example, summarization could be supported with a small local model or preloaded texts.

Ethical Considerations:

- ➢ The survey will remain anonymous and is voluntary to protect student privacy.

Results

A total of 30 high school students participated in the survey. As recorded, the majority were in the 16–18 age group (66.7%), followed by 13–15 (20.0%), while smaller numbers were under 13 (3.3%), 19–24 (6.7) and 25+ (3.3%). Hence, with a majority of high school responses, this research paper will focus on high school students

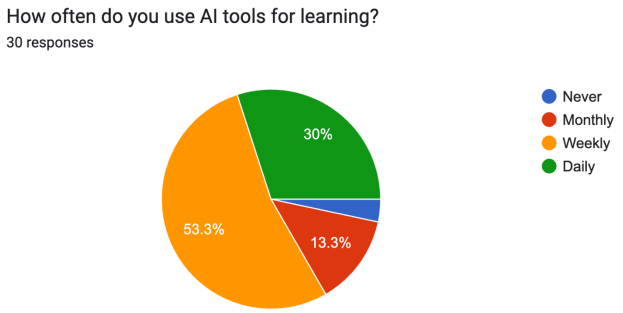

Figure 1. AI usage frequency

When asked how often they use AI for learning as seen in Figure 1, 53.3% reported weekly use, 30% daily use, 13.3% monthly use, and 3.3% never use. This indicates that AI has already become a regular part of many students' learning routines, with more than four out of five students using AI at least weekly.

Preferred AI Features for Learning:

As illustrated in Figure 1, the most commonly used AI features among students are homework assistance (used by 75% of respondents), problem-solving hints (68%), and exam preparation support (65%). Less frequently used features include general support and writing help, though they still represent significant portions of use. These findings reflect student priorities for practical learning support that directly assists them with immediate academic challenges, consistent with patterns highlighted in prior studies (Kestin et al., 2025).

Patterns of AI Tool Usage Among High School Students:

Purpose	Count	Percentage (%)
Homework help / explanations	25	83.3
Exam or test preparation	20	66.7
Math/science/subject practice	17	56.7
Learning languages	13	43.3
Improving reading/comprehension	10	33.3
Making flashcards	1	3.3
General queries	1	3.3
To know about any issue of interest	1	3.3
Not applicable (NA)	1	3.3

Table 1. Purposes for which students use AI tools

These results reveal extensive engagement with AI-based learning tools, highlighting the growing role of AI in secondary education. The sample of students voted for as many purposes for which they use AI as shown in Table 1. Students primarily use AI tools for homework help (83.3%), exam or test preparation (66.7%), and practice in core subjects such as mathematics and science (56.7%). Less frequently, students utilized AI for making flashcards (3.3%), general queries (33.3%) or other miscellaneous tasks.

These patterns indicate that students gravitate toward AI tools when immediate, actionable academic support is required. Tasks like homework help for completion, exam preparation, and

problem-solving dominate usage, suggesting that students perceive AI as a practical learning aid rather than a tool for exploratory learning or knowledge expansion. This aligns with prior research emphasizing that students value technology that reduces cognitive load and increases efficiency in learning activities (Luckin et al., 2016). Some students framed this idea of getting information quicker *as "spoon-fed information"* representing a majority idea of wanting efficiency without having to do the work itself.

Perceptions of AI for Learning:

- **Ease of use:** reported positively, with 73.4% rating AI tools as "easy" or "very easy" (scores 4–5 on a 5-point scale).
- **Faster learning:** perceived usefulness varied: while 40% agreed AI tools help them learn more quickly, 46.7% were neutral.
- **Motivation:** 57% felt AI tools made learning more enjoyable and motivating.
- **Trust:** most students expressed moderate skepticism: 40% rated their trust as "2" and 36.7% as "3," while no respondents selected "5" (complete trust).
- **Barriers:** 50% agreed that lack of internet, data, or devices limited their AI use.

Perceived Usefulness of AI Features:

We asked the sample of students for commonly used AI platforms in education. The results are presented in figure 2.

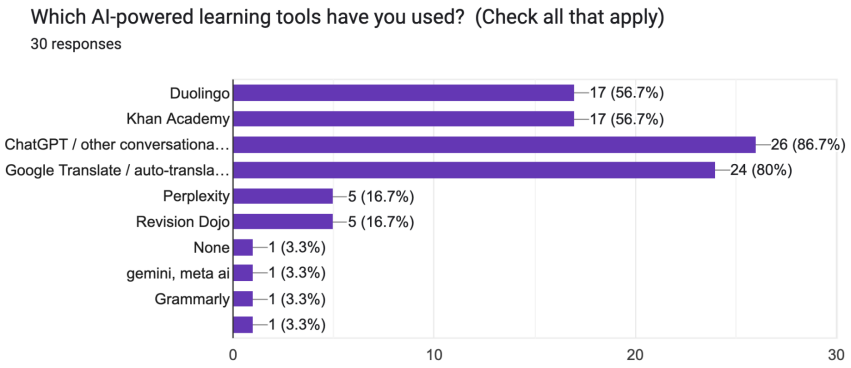

Figure 2: Common AI platforms used by students

ChatGPT (86.7%) and Google Translate (80%) were the most popular platforms, followed by Duolingo and Khan Academy (56.7% each). Less common platforms were also present.

Although the survey evidence presented focuses on usage patterns rather than numerical usefulness ratings, qualitative trends can be inferred:

- **ChatGPT/ other conversational bots**: Dominant usage suggests high perceived value in step-by-step explanations and personalized support.
- **Google Translate**: Strong demand for language and translation assistance.
- **Duolingo and Khan Academy**: Moderate use reflects appreciation of structured, subject-specific and non-personalized guidance.
- **Perplexity and Revision Dojo**: Lower uptake may reflect limited awareness or perceived overlap with chatbot features.

These patterns align with the expectation that students prioritize personalized, guided problem-solving and language-focused features over more specialized apps used by smaller groups. Moreover, the results indicate that students prefer tools that provide immediate feedback, explanations, and specific information, which are crucial for completing assignments and exam preparation. The general use for summarization and problem-solving also emphasizes the role of AI in clarifying and simplifying learning material. These results strongly support the hypothesis that personalized AI tutoring enhances learning effectiveness, aligning with conclusions drawn by Amplyfi (2025) regarding the importance of personalization in education technology.

Qualitative Findings:

Other than statistical data, there were open-ended questions in the survey such as “Do you feel AI has helped you for more personalized learning?” and “What features or changes would make AI tools more useful for you?” These can help to identify qualitative findings as listed below.

- **Positive impacts:** Students reported AI simplifies complex concepts, provides step-by-step explanations, helps with essay writing, and saves time. Many described AI as a “personalized teacher.” that responds immediately. Others appreciated the feature of getting information quickly without having to go to a search engine and manually searching through websites.

- **Concerns:** Some students worry that frequent use of AI can create dependency and reduce critical thinking. Others noted frequent inaccuracies and a lack of real personalization because it still feels generic compared to teachers. However, a majority of responses show a lack of trust for AI provided answers as mentioned earlier as well.
- **Personalization:** Many students felt AI adapts explanations to their preferred style. For example, a student (anonymous) stated that AI had improved learning experience by adding visual and interactive elements to help for a better understanding.
- **Suggested improvements:** Students recommended that AI can improve its accuracy by referring to credible sources and this is being improved with the new inclusion of source links. Some expressed their interest for more precise and reliable responses. A student phrased this as "Most AI tools feel very surface-level. Sometimes I feel like AI assumes I want quick answers, but what I really want is to understand things better — at my pace, not in a rush."
- **Limited access:** One student stated "my country Nigeria lacks the tools (phones or laptops) and internet needed to access AI tools… also removing subscription plans." which reflects the limitations of cost and location in having access to a rapidly growing technology.

Discussion

The findings demonstrate both the potential and limitations of AI for high school learning particularly in contexts where connectivity is a barrier.

Personalization and Learning Outcomes:

Students valued AI's ability to simplify complex ideas and adapt explanations to their preferences, specifically matching their comprehension style. For example, rephrasing textbook content, providing visual aids, or generating study guides tailored to their pace and preferences. Offline-first systems could build on this by storing and analyzing student progress locally, allowing sustained personalization even without the internet.

However, not all students felt that AI provided meaningful personalization. Some respondents criticized AI as surface-level or generic, stating that it only reacts to the last input without truly understanding the learner. This highlights a critical design requirement for offline AI systems: the need to combine adaptive learning algorithms with a memory of learner preferences, allowing for sustained and contextual personalization even without internet access. Given that students were divided on whether AI helps them "learn faster," offline-first systems need to focus on depth (adaptive practice, concept mastery) rather than just speed (quick answers).

Trust and Reliability:

Trust emerged as a critical challenge. Despite frequent use, most students doubted the reliability of AI outputs.No participant expressed complete trust, reflecting concerns about misinformation, generic responses, and over-simplification. 76.7% of students expressed skepticism mirroring mirrors broader debates about accuracy and bias in AI systems. Offline-first systems could incorporate credible, curriculum-aligned datasets, reducing misinformation risks. Integration of local content specific to location could also enhance credibility and contextual relevance, addressing student concerns about generic responses.

Equity and Inclusion:

An important insight is that internet connectivity, data availability and access to device limitations continue to exclude many learners. Half of respondents reported barriers due to limited internet or device access, underscoring the digital divide that continues to shape educational opportunities. This suggests that while AI has high utility, infrastructure constraints remain a critical barrier, particularly in low-resource or rural regions. This highlights that Offline-first AI has the potential to narrow the digital divide, particularly in under-resourced or rural schools. By operating without continuous internet access, these tools could extend AI's benefits to students who usually remain disadvantaged.

Ease of Use and Engagement:

The majority of students reported that AI tools are easy to use, with 46.7% rating their experience as 5/5 on ease of use. Similarly, 46.7% of students reported that AI tools allowed them to learn or teach more quickly, indicating that these tools can accelerate the learning process. AI also contributed to enjoyment and motivation, with 56.7% of students rating its motivational impact as 3 or higher on a 5-point scale, showing a positive learning environment that can continue to augment personal growth and learning.

Perceived Impact on Learning

Student perceptions of AI's impact on learning were largely positive but nuanced and this can help streamline the design of Offline-first AI tutoring systems to be the most effective. Many respondents highlighted the following benefits:

1. **Simplification of complex content:** AI was praised for breaking down complicated concepts into understandable steps or examples. Students noted, for example, that AI could "simplify concepts for easier understanding" and "provide additional relevant

information to connect topics with real-world contexts."

2. **Immediate feedback:** AI provides quick corrections and clarifications, allowing students to resolve misunderstandings promptly.

3. **Personalized learning support:** Students appreciated AI's ability to adapt content to their learning styles, including step-by-step explanations, simplified language, and alternative examples. Simple input prompts of customizing content to be in a specific format adjusts AI to tailor the content to each individual student's learning style. This helps them to understand better and is an issue which is neglected in traditional teaching methods. This reflects the promise of AI as a tool to guide like a personalized tutor.

4. **Time efficiency:** Several students emphasized that AI saved them time by consolidating information, generating summaries, or providing ready-made study guides. It was much more effective than a manual google search, saving the time for better time management towards studying for the actual work.

Despite these advantages, some students expressed concerns that AI could cause dependency and dull cognitive capabilities. A subset of respondents noted that reliance on AI sometimes led to superficial understanding or over-dependence on technology for answers ("It's like you get spoon-fed information instead of actually learning how to think it through yourself"). This is also presented in a research study stating that excessive reliance on artificial intelligence chatbots can lead to a decline in critical cognitive skills such as critical thinking, problem-solving, and creativity, a phenomenon termed "AI-chatbot-induced cognitive atrophy" (AICICA), where users may become overdependent on these tools and experience reduced mental engagement and stimulation (Dergaa et al., 2024).

Potential of Offline-First AI:

Survey results suggest strong interest and frequent use of AI among students (nearly all students have used at least one AI-powered platform), with most relying on it for homework help and exam preparation. This aligns with global trends showing rapid uptake of conversational and translation tools among youth learners and indicates a clear demand for AI as a learning companion. However, reliance on constant connectivity excludes students in low-bandwidth environments. This contributes to the global problem of the digital divide hence underlying the importance of creating offline-first AI systems to overcome this issue. Offline-first AI tutoring systems should be created to be capable of running basic adaptive functions without continuous

internet that would directly address the reported barrier of limited access, which half of respondents identified.

Here is the strong potential of offline-first AI systems to improve learning outcomes in low-connectivity regions:

1. **Bridging the digital divide:** Offline functions ensures that students can access AI tutoring without reliable internet or costly devices. Even accessible for low-resource areas which is the aim of the study

2. **Supporting personalized learning:** Offline AI can adapt content to individual learners, acting like a personal tutor by adjusting explanations, pacing, and feedback.

3. **Enhancing engagement and motivation:** Students reported higher motivation and enjoyment when using AI, suggesting that offline systems could make learning more engaging even in resource-limited classrooms.

4. **Reducing cognitive load and study time:** By summarizing content, providing stepwise explanations, and generating study plans, offline AI can make learning more efficient.

5. **Empowering teachers:** Teachers can integrate offline AI into lesson plans to complement instruction, offering adaptive exercises and targeted remediation without requiring continuous internet access.

Design features:

Finally, students offered clear recommendations for improvement: increasing accuracy, citing sources, integrating with personal study materials (e.g., syllabus), and reducing paywalls. This can help design features that would be most effective in the Offline-first AI model.

- ➢ **Accuracy and reliability:** Importance of trustworthy responses and verified sources, particularly when AI is used for learning complex or high-stakes subjects.

- ➢ **Curriculum alignment:** Students requested AI that can align explanations and exercises with specific syllabus, past papers, and exam formats.

- ➢ **Offline accessibility:** Access to AI without internet or high-data devices was emphasized as crucial, especially in under-resourced regions.

- ➢ **Interactive and adaptive feedback:** Beyond providing answers, students suggested that AI should ask guiding questions, present multiple solution paths, and engage learners in active problem-solving.

- ➢ **Resource linking:** Providing references or links to credible resources was considered essential for validating information and promoting independent learning.

These insights indicate that offline-first AI tutoring systems should prioritize lightweight, preloaded knowledge bases, offline interactivity, and adaptability to student needs, combining elements of traditional tutoring with modern AI personalization.

Educational learning features:

These include:

1. **Conversational tutoring** (chatbot-style explanations for problem solving).
2. **Translation and language support** (offline translation engines, preloaded bilingual dictionaries).
3. **Structured practice** (offline integration of tools like Duolingo-style exercises and Khan Academy problem sets).
4. **Step-by-step problem solving** could be supported by lightweight, locally hosted models for math and science subjects.
5. **Summarization tools** could be implemented using preloaded or smaller text summarization models.
6. **Translation and language support** could leverage offline translation engines, which already exist for some languages but need optimization for educational contexts.
7. **Writing feedback** could be facilitated with local natural language processing (NLP) models for grammar correction and structure improvement.

Mapping these top-rated AI features to offline implementations reveals promising opportunities for adaptation. For instance, summarization and homework assistance can be supported through lightweight local AI models or preloaded content libraries, making them feasible for offline environments. Problem-solving hints and personalized feedback may be partially enabled by rule-based systems or cached AI responses. Such adaptations could extend personalized learning benefits to students in low-connectivity and low-resource regions, thereby addressing digital inequality concerns emphasized by UNESCO (2023).

Comparison of Frequent and Infrequent AI Users:

Analysis comparing frequent AI users (daily) and infrequent users (rarely or weekly) reveals significant differences in preferences and perceived usefulness. Frequent users reported higher satisfaction across most features, especially for interactive feedback and exam support, suggesting that consistent AI interaction strengthens the perceived learning benefits. This pattern exemplifies the value of promoting regular AI tool use in schools to maximize educational impact. Infrequent users, while still acknowledging benefits, often emphasized concerns about reliability and internet dependence. This suggests that the barrier to wider adoption may not be the usefulness of AI features but rather accessibility issues tied to connectivity.

Comparison with Existing Literature:

These findings are consistent with Kestin et al. (2025), who emphasize the value of AI's personalized feedback. However, unlike prior research that assumes reliable internet connectivity (Khan, Umer & Faruque, 2024), this study emphasizes the practical barriers faced by students in low-resource areas. The results also extend UNESCO's (2023) argument on digital inequality by offering a concrete, student-driven pathway and offline AI tutoring systems are meant to bridge part of the divide. A study by Owen Henkel et al. (2024) evaluates the impact of an AI-powered math tutor called Rori on math performance of students in Ghana. The study shows significant learning gains for students using this AI tutor and discusses implications for scalable, cost-effective education support in low-resource settings. Specifically this AI model works on a singular mobile phone and overcomes barriers of low-resource settings. A clear representation of the potential impact of AI if expanded in the right way which can be done by the Offline-first AI tutoring system.

Limitations:

The findings highlight the potential of offline-first AI tutors to enhance personalized learning in educational contexts. This approach could reduce dependency on unreliable internet access while maintaining essential AI support features identified as valuable by students. However, there are several limitations. The study is limited by self-reported data, which may introduce bias in usage frequency and usefulness ratings. Additionally, survey participants may not fully represent all high school demographics, particularly those with very limited or no access to AI tools. Future research should include larger and more diverse samples, as well as pilot testing of offline prototypes to validate feasibility with real-world usage data..

- ➢ Small sample size (n=30).
- ➢ Lack of detailed usefulness ratings (future surveys should quantify this).

- Possible bias toward more tech-engaged students.

Future research should expand the participant pool and test offline-first prototypes to measure direct impacts on learning.

Further Considerations

AI shows promise however, the study highlights potential challenges:

- **Risk of superficial learning:** Over-reliance on AI may reduce critical thinking and deep comprehension.
- **Trust and accuracy concerns:** Students need mechanisms to verify AI-generated content.
- **Partial personalization:** Current AI models may lack contextual awareness or long-term memory for learners' unique needs, which should be addressed in offline systems.

While the survey revealed enthusiasm, qualitative responses also highlighted risks of over-dependence and reduced critical thinking. Offline-first AI should therefore be designed as a complementary tool, encouraging active learning (e.g. guided questioning) rather than direct answers. Teacher involvement will also remain crucial as AI cannot mimic the emotional guidance that teachers provide.

Conclusion

This study explored high school students' reported usage and preferences for AI tools, with a focus on identifying the potential of offline-first tutoring systems in low-connectivity regions. The results indicate that students most value features that provide immediate, practical learning support. By mapping these features to offline implementations, the study demonstrates and achieves the hypothesis of offline-first tutoring system to improve how personalized learning can be extended to students in low-resource settings where internet access is unreliable. There is strong potential for developing offline-first AI tutoring systems that address real student needs and reduce digital inequality. By focusing on chatbot-style explanations, translation tools, and subject-based practice modules, such systems could provide equitable, personalized learning in low-connectivity regions.

Real-world applications of this research include the development of lightweight, locally deployable AI tutors for schools in rural or low-connectivity environments. Future research

should focus on testing prototypes of these systems, evaluating their learning impact, and exploring how they can integrate with traditional teaching methods to maximize accessibility and effectiveness. By combining accessibility, contextual alignment, and adaptive features, such systems could bridge equity gaps while enhancing engagement and comprehension. However, concerns about trust, over-reliance, and accuracy highlight the importance of careful design and teacher integration. Therefore, this research contributes to bridging the digital divide by demonstrating how offline-first AI can make learning more inclusive.

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