



Guiding Research on the Use of ChatGPT for Teaching Computer Programming in Low and Middle-Income Countries

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Abstract: While numerous studies on ChatGPT's role in programming education originate from developed countries, contextualizing their findings in Low- and Middle-Income Countries (LMICs) remains challenging due to inadequate digital infrastructure. This limitation discourages educators from formally integrating ChatGPT into teaching programming lessons. However, some students still access ChatGPT via computers and mobile devices—a resource not universally available, raising a number of concerns including fairness and equity in assessment and feedback (e.g., performance disparities between students with and without access). To address this gap, our study synthesizes existing literature and student perspectives to propose five research questions. These are designed to guide LMIC researchers in systematically investigating the integration of ChatGPT, focusing on infrastructure, equitable access, pedagogical adaptation, ethical implications, and supportive policy frameworks. By highlighting these priorities, we aim to foster inclusive, context-relevant strategies for ChatGPT's integration in resource-constrained settings.

Keywords: Information Communication Technology, Artificial Intelligence, Policies, Curriculum, Primary Schools

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1. Introduction

In today's digital era, computer programming is highly useful in fields like education, agriculture, science, and finance where automation, artificial intelligence, and data analysis is at the core of their main operations. This application of programming to multiple fields makes students who can write and understand programs among the most demanded candidates in their fields (Tuomi et al., 2018). A computer programmer must build a wide range of skills such as: logical thinking, problem solving and design (Harimurti et al., 2019). These skills can be acquired through formal classes in schools, non-formal courses online, programming clubs, or informal events such as hackathons and programming jams. Either way, it is a step-by-step process where students learn and gradually improve their programming skills. Normally,

beginners will start with basic programming constructs and build up to advanced programming skills such as writing new programs with correct syntax, trace code, solve problems, develop algorithms, debug code, troubleshoot code etc.

For many years, learning how to program has been highly formal. Students would attend classes, and a programming teacher would guide their learning process in a very structured delivery of lectures and computer labs. Nowadays, technology allows students to attend programming classes online through different platforms, and schools can incorporate technology such as video games (Díaz et al., 2021), chatbots (Martinez-Araneda et al., 2024), and robots (Kurebayashi et al., 2006) for students to practice their programming skills anytime. Artificial Intelligence (AI) tools such as ChatGPT brings another opportunity for students to learn programming and improve their skills more

independently (Groothuijsen et al., 2024). While there are concerns around its integration into education, it can no longer be ignored that ChatGPT is highly used by students all over the world (Adeshola & Adepoju, 2024; Lo et al., 2024; Mbwambo & Kaaya, 2024). Our recent survey shows over 40% of 176 students who responded use ChatGPT daily and 30% use it weekly.

Since its release in November 2022, researchers worldwide have been actively studying ChatGPT's role in education, resulting in numerous published works. As ChatGPT establishes itself in education, more studies continue to showcase its beneficial role in various learning contexts (Firaina & Sulisworo, 2023). However, a large concentration of these publications originates from developed countries, and a very limited number are from LMICs. Our quick search on Springer Nature Link journal on the 27th of July 2025 using the keyword "*ChatGPT and Education*" returned ninety-nine (99) research articles published in the education and technology discipline within the past twelve (12) months. Out of those ninety-nine (99), only eight (8) were published from LMICs, a contribution of about 8%.

While ChatGPT is open for use worldwide, we must acknowledge that the conditions around its use and control in developed countries differ from LMICs. This difference presents a challenge in narrowing the knowledge gap between ChatGPT and its use in education fairly and equally. If the contribution to the global knowledge about ChatGPT use in education is not balanced between developed countries and LMICs, there is a risk of contextual mismatch if the findings in developed countries are applied directly in LMICs. This one-sided contribution worsens the digital divide by increasing the existing digital and AI literacy gap, and development of policies that do not serve well the students in LMICs. LMICs lack digital infrastructures, technological access, and digital pedagogical approaches, which prohibit direct application of findings in developed countries. Therefore, it is necessary that more studies are conducted in LMICs to contribute to the local and global body of knowledge about the use of ChatGPT in learning (Ojubanire et al., 2025)

1.1 Objective of the Study

This study aims to contribute to the growing body of knowledge on ChatGPT and its integration into education by developing a strategic framework that will guide researchers in LMICs. The framework is driven by the core question: *What research questions—and in what sequence—should researchers in LMICs investigate to effectively integrate AI tools such as ChatGPT into teaching contexts, particularly in computer programming education?*

2. Literature Review

Technology has been useful in cultivating students' motivation and engagement in learning for decades (Kukulaska-Hulme, 2012). In the early days, video games (Begel et al., 2021; Paliokas et al., 2011) and robots (Ching & Hsu, 2024) were highly used in teaching programming concepts to students for many years. Currently, technology has advanced, and others are emerging every day. Each new technology brings in new opportunities in learning. One of these technologies is ChatGPT.

The emergence of ChatGPT caught everyone off guard. Its quick rise in popularity and widespread adoption by students left educators uncertain about how to react to its use (Mbwambo & Kaaya, 2024). It became clear that more studies are needed to formally establish its impact on learning as early as possible. Now, numerous studies have been published, providing better insights on the impact of ChatGPT in learning. Among those studies is the work by Aviv et al., (2024) who explored the use of ChatGPT in learning how to program. Aviv et al. showed that students who had ability to write effective prompts for ChatGPT demonstrated more improvements in their programming knowledge. On the other hand, a study by Johnson et al (2024) discovered ChatGPT is a supportive tool to students learning how to program microcontrollers as beginners and does not contribute much to advanced self-driven programmers.

A study by Chen et al. (2024) took a different approach and positioned students as teachers. They studied how students can learn programming by using ChatGPT as a teachable agent. Students will guide ChatGPT to solve programming problems and in the process, they were expected to learn. The results showed students who engaged in teaching ChatGPT programming demonstrated significant greater knowledge gains in programming skills than those who went through a traditional learning route using online videos. By students taking the teaching role, it increased their engagement and comprehension skills, which supported an active engagement in programming education. The only reported drawback on this method was the limitation in error-correction and debugging skills. ChatGPT typically generates code that is highly error free depriving the students on working with codes with errors.

A very recent study investigated how different instructional interventions influence learning and dynamic interactions between students and ChatGPT in learning programming (Güner & Er, 2025). The authors investigated three instructional interventions: students' use of ChatGPT with no guidance, students' use of ChatGPT with training on effective prompting, and students' use of ChatGPT with lab guide on sample prompts. Findings indicate that ongoing support

significantly influenced how students interacted with ChatGPT, improving the quality of learning. Importantly, students who used ChatGPT for refining and improving their work rather than solely for generation of programs achieved better performance outcomes, highlighting the significance of active and critical engagement with the tool. Table 1 summarizes these studies, showing their origin, how ChatGPT was used in the experiment and the conditions for its applications.

To contextualize the results from studies such as those highlighted in Table 1 in LMICs, there is prior work that must be done both by the government and researchers. The government must address different challenges related to unequal access to digital facilities in learning institutions. Researchers must study how to effectively integrate ChatGPT in teaching courses such as programming while taking into account in many LMICs there are persistent challenges such as unreliable electricity, insufficient devices, low teacher digital competence, significant urban-rural digital divide, and inconsistent internet access (Cueto et al., 2023).

Table 1: Use and conditions for application of ChatGPT in programming

Recent Studies	Location	Application	Conditions
The Impact of ChatGPT on Students' Learning Programming Languages (Aviv et al., 2024)	Israel	Supporting Tool	Careful integration in educational settings Alignment with specific learning objectives
Using ChatGPT with Novice Arduino Programmers: Effects on Performance, Interest, Self-Efficacy, and Programming Ability (Johnson et al., 2024)	United States	Supporting tool	Novice programmers
Learning-by-teaching with ChatGPT: The effect of teachable ChatGPT agent on programming education (Chen et al., 2024)	China	Teachable agent	Carefully designed teaching tasks
AI in the classroom: Exploring students' interaction with ChatGPT in programming learning (Güner & Er, 2025)	Turkey	Supporting tool	Students allowed to use ChatGPT Guidance on Prompts

To many researchers, these existing challenges on digital access and infrastructure might suggest minimal use of technology such as ChatGPT by students. However, that is not the case. A cross-country survey of 24 developing nations in 2021 reports more than half the population in each country owned a mobile phone, with young people (aged 10–24) being especially active users (Feroz et al., 2021). In Tanzania, A study at the University of Dar es Salaam (UDSM) revealed that 73% of undergraduate students owned smartphones, 20% owned feature phones, and 7% had tablets (Mwabungulu & Mungwabi, 2017). Similar study at Moshi Co-operative University in 2019 found that 85.6% of students owned smartphones (Ramadhani, 2019). More recent statistics from Sokoine University of Agriculture reports 90.1% of 1,058 students surveyed own smartphones (Saidi et al., 2025). We also found that over 40% of 176 students who responded to our survey use ChatGPT daily and 30% use it weekly. These local statistics create a strong reason for LMICs researchers to engage in the research that considers local context rather than relying on the studies done in the developed countries.

The goal of this study is therefore to produce research questions that would guide future studies in integration of AI tools in education considering the actual context in LMICs. The questions are based on the following factors:

- a) Current results in different studies globally, see Table 1.
- b) Local context in LMICs, such as digital infrastructure, internet access, and actual use of mobile phones in universities.
- c) Students' perspectives on ChatGPT use in improving programming skills gathered through the survey.

3. Methodology

We performed a literature review on the use of ChatGPT in improving programming skills and identified the origins of these studies, understood how ChatGPT was used by learners and the conditions for its applications in classrooms. We used the location to understand the context of the study, and the conditions for applications assisted in

defining what is needed to contextualize the study in LMICs.

We have also conducted a descriptive, exploratory and survey-based study aiming at understanding students' perspective on ChatGPT use in improving programming skills. The approach chosen is student-centered with a goal to focus on student's own reflections, experiences, and skill development. The survey instrument was developed based on constructs from established educational and technology acceptance frameworks to capture students' experiences using ChatGPT. For perceived skills, confidence, and motivation when using ChatGPT, Bandura's Self-Efficacy Theory was employed (Bandura, 1997). We also employed technology acceptance model (TAM) for satisfaction, usefulness, intention to recommend, and ease of understanding map questions (Davis, 1989). To understand how ChatGPT supported understanding of programming concepts, or which students' skills improved by using ChatGPT, we employed DigCompEdu frameworks (Redecker, 2017). Open-ended items were included to capture qualitative insights into students' experiences with ChatGPT, informed by emerging work on human-AI collaboration in education (Luckin, 2018; Holmes et al., 2019).

The questions in the survey aimed at capturing data that will establish initial insights for future studies in ChatGPT. We did not test any specific hypotheses, but instead we captured patterns, themes, and trends from student responses, making it suitable for generating research questions that would guide future structured research in LMICs.

3.1 Participants and Sampling

The generated survey was distributed to students studying courses that use programming from two main universities in Tanzania. The survey link was sent to students, and participation was voluntary. We did not employ any formal sampling technique; therefore, no sample size was preselected. As such, the findings are based on a self-selected group and may not be generalizable to the entire student population. The study utilized a non-probabilistic convenience sampling method. Participants were selected based on their availability and willingness to respond to an online questionnaire. By the time the survey was completed, a total of one hundred and seventy-six students responded setting our sample size (N = 176).

3.2 Data Collection Methods

Data was collected using a self-administered online questionnaire designed using Google Forms. The questionnaire included a mix of closed-ended questions to

gather quantifiable data on usage patterns, skill levels, and perceived impact and open-ended questions to capture rich, qualitative feedback and personal experiences related to the use of ChatGPT for programming-related tasks.

3.3 Data Analysis

Both quantitative and qualitative analyses were conducted on the collected data. We used Microsoft Excel to perform descriptive statistical computations. Given the manageable sample size (N=176) and the concise nature of qualitative responses to our open questions, Excel also served as a practical tool for thematic coding and categorization. Responses were systematically coded, grouped into emergent themes, and analyzed to identify patterns in student perspectives. While specialized qualitative software exists, Excel provided sufficient functionality for our small-scale textual analysis while maintaining transparency in the coding process.

3.4 Ethical Considerations

In conducting this study, we observed all ethical principles for research involving human participants. All respondents were presented with a detailed consent form on the first page of the Google form prior to participating in the survey to ensure the ethical integrity of the research. The study was fully anonymous to protect participant privacy. We did not collect any personally identifiable information for anonymity and confidentiality. All data were collected and stored securely using Google forms, which employs robust encryption protocols.

The voluntary and self-selected nature of our sampling method is acknowledged as a limitation, and we will be cautious not to over-generalize our findings beyond the specific context of the participating universities. The survey questions were carefully framed to be neutral and non-judgmental to students to provide their free opinion on the matters. Furthermore, given the focus on an AI tool (ChatGPT), we included a disclaimer clarifying that the study was evaluating the tool's educational application and was not an assessment of the individual student's programming ability or academic performance.

4. Results and Discussion

Figure 2 presents a summary of the results for Questions 1 (Q1) through 4 (Q4), all asked in the questionnaire. Q1 examined whether students found ChatGPT helpful in understanding programming concepts. The results indicate that the majority of respondents (72.73%) rated ChatGPT as either "*Very Helpful*" or "*Helpful*" in enhancing their understanding of programming concepts. These results

suggest that ChatGPT played a substantial supportive role in facilitating the learning of various programming concepts.

To identify specific programming skills that students believed had improved through their interactions with ChatGPT, we asked them to select all skills they felt have improved in Q2. The most frequently cited skill was *logic and problem-solving* (selected by 121 students), followed by *syntax* (101), *debugging* (90), and *code optimization* (78). The emphasis on logic and problem-solving suggests that students found ChatGPT helpful in planning and structuring solutions — a key component of programming competency. Additionally, the high selection of *syntax* and *debugging* reflects its utility as a tool for both learning correct language structure and identifying/fixing errors.

To understand how students perceive the use of ChatGPT in academic settings, Q3 asked if they had any concerns on its use. The results indicate a near-even split in opinion, with 54% of students reporting no concerns. This suggests a slight majority of students perceive the tool as generally safe and beneficial for learning programming. On the other

hand, the fact that 46% did express concerns indicates that nearly half of the students remain cautious using ChatGPT.

For learners to achieve independent learning, ChatGPT should deliver answers, explanations, and feedback that are clear and easy to understand. Q4 examined students' perceptions on ChatGPT's clarity in explanation and suggestions it provides. Majority (93%) of respondents found ChatGPT's explanations are clear and easy to understand. This finding suggests effectiveness of ChatGPT at breaking down complex programming concepts into clear, digestible information valuable feature for novice programmers who may feel hesitant to ask questions in class or seek help from peers or instructors.

We also investigated how frequently students use ChatGPT for learning programming through Q5. As shown in Figure 2, 46% of the 176 respondents reported using ChatGPT daily, while 30% reported weekly use. These findings highlight the regular engagement students have with ChatGPT, which we believe is reinforced by the positive trends observed in Q1 to Q4.

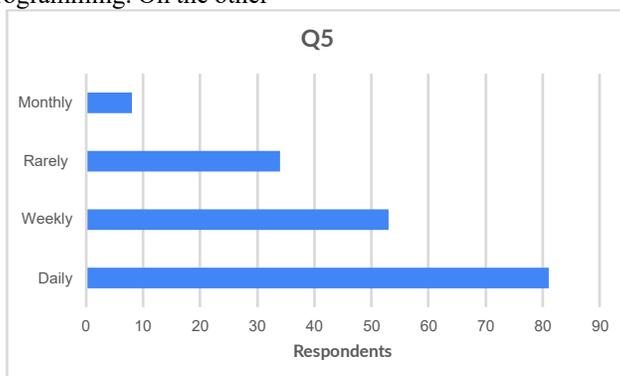


Figure 1: Use of ChatGPT by students

We also examined students' perspectives on academic institutions integrating ChatGPT into the curriculum and became part of their training. A thematic analysis of their responses revealed strong support for its inclusion, though with notable caveats. Approximately half of the participants advocated conditional integration, emphasizing the need for restricted or guided access to the tool. One particularly insightful student remarked:

'ChatGPT should be integrated as an assistive tool to support learning rather than as a primary resource that students rely on entirely.'

However, a minority of respondents either expressed no strong opinion or opposed its integration altogether, citing concerns over academic integrity or over-dependence on ChatGPT.

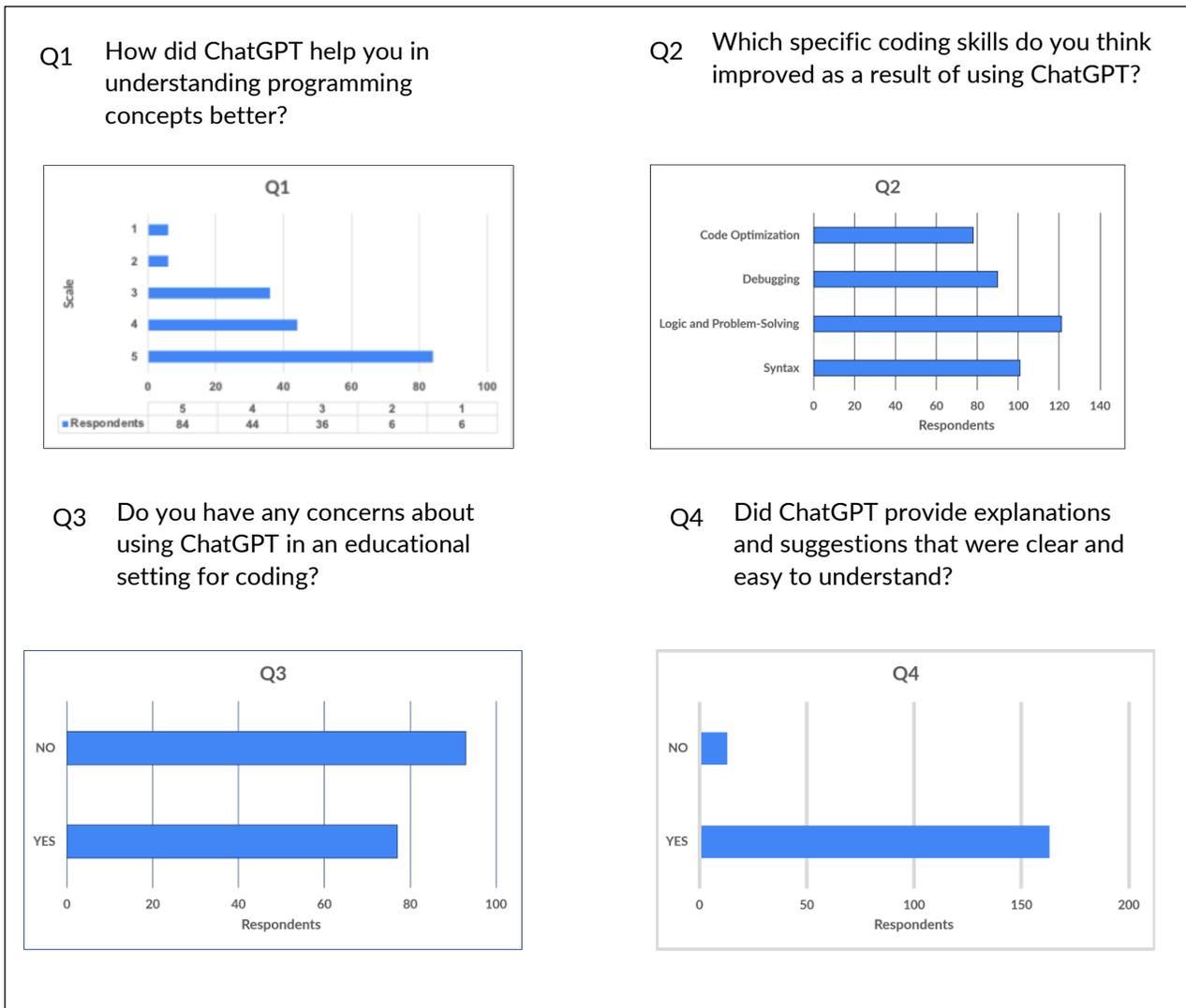


Figure 2: A summary of results for the four quantitative questions asked in the survey

As reported above, majority of students learning computer programming consider ChatGPT highly useful in learning. In fact, many of them report daily use. However, in several LMICs, this use is currently uncontrolled (checks for plagiarism and AI generated content are not set in place), raising an important question about fairness in assessment and its long-term impact. While existing studies generally position ChatGPT as a supportive tool used under monitored conditions, translating these conditions into local contexts in LMICs is a challenge due to systemic barriers such as inadequate digital infrastructure.

For instance, Aviv et al. (Aviv et al., 2024) highlight the use of ChatGPT in teaching programming but requires a careful integration into educational settings and alignment to specific learning objectives. Similarly, Chen et al. (Chen et al., 2024) needs well-designed teaching tasks and guided usage, and

Güner and Er (Güner & Er, 2025) proposes teaching of prompt-construction skills to learners before using ChatGPT. These conditions ensure effective use of ChatGPT, supporting students in learning.

Inadequate digital infrastructure in LMICs prohibits instructors who wish to incorporate ChatGPT as part of their programming lessons in class. Doing so in current situation means some students might not have access to the tool failing to complete provided learning tasks. Nevertheless, the widespread use of ChatGPT among students through their mobile phones cannot be ignored. Some students still complete their learning tasks using ChatGPT, which creates unfair assessment. Researchers in LMICs must explore practical strategies for ethical and meaningful engagement with ChatGPT in programming education. Based on this discussion, we propose our first research question (RQ1):

What instructional strategies can educators adopt in LMICs to teach programming in ways that encourage the responsible and skill-building use of ChatGPT, rather than its misuse for bypassing learning?

The unfairness in assessment is caused by unequal access to ChatGPT. As discussed earlier, many students currently own mobile phones, which grant them easy access to ChatGPT through mobile apps. But still, few students do not. Because current education systems in LMICs have not yet acknowledged the widespread use of ChatGPT by students, there are no proper systems to monitor or manage the use of AI in programming assignments. Therefore, in case of programming tasks, some students submit work entirely completed by themselves, while others use ChatGPT—creating unfairness in assessment and feedback. To study this issue of access, fairness and equity, we propose our second research question (RQ2): *How does unequal access to ChatGPT among students in LMICs affect fairness, equity, and the integrity of assessment in computer programming education?*

The above discussion underscores the importance of accessible digital infrastructure. Adequate infrastructure not only enables the direct contextualization of global research findings but also empowers instructors to confidently integrate ChatGPT into their programming classes knowing that their students will have equal access to the tool. Achieving such access requires researchers in LMICs to actively engage governments and policymakers. Consequently, we propose our third research question (RQ3): *How does unequal access to ChatGPT among students in LMICs affect fairness, equity, and the integrity of assessment in computer programming education?*

Another key finding of this study was the significant proportion of students who supported the formal integration of ChatGPT into their learning processes. While a minority remained skeptical or undecided—citing concerns about over-reliance or academic integrity—these divergent perspectives highlight a critical need for further research, particularly in LMICs. Investigating the varying stances on ChatGPT's integration (e.g., supportive, conditional, or opposed) could provide valuable insights into how ChatGPT can be adapted to diverse educational contexts while addressing ethical and pedagogical challenges. On that note, we propose two research questions: (RQ4): *How can ChatGPT be effectively integrated into curricula as an assistive tool—rather than a primary resource—to balance its benefits with concerns about academic dependency?* (RQ5): *What institutional policies and pedagogical frameworks are needed to address student concerns about over-reliance and academic integrity when using ChatGPT in LMIC educational contexts?*

5. Conclusion and Recommendations

5.1 Conclusion

Responding to our core question posed in the introduction: *What research questions should researchers in LMICs investigate to effectively integrate AI tools such as ChatGPT into teaching contexts, particularly in computer programming education?* This study has proposed five research questions to guide research conducted in LMICs concerning integration of AI tools such as ChatGPT into education. These questions will find:

- a) Right instructional strategies to use ChatGPT to teach programming
- b) Effects of unequal access to ChatGPT in teaching programming
- c) What needs to be done in policies and infrastructures to set right environment to the use of ChatGPT in education system
- d) How can ChatGPT be integrated into the curriculum while addressing concerns about students over reliance to ChatGPT.

Here are the five proposed questions not presented in any order:

1. (RQ1) *What instructional strategies can educators adopt in LMICs to teach programming in ways that encourage the responsible and skill-building use of ChatGPT, rather than its misuse for bypassing learning?*
2. (RQ2) *How does unequal access to ChatGPT among students in LMICs affect fairness, equity, and the integrity of assessment in computer programming education?*
3. (RQ3) *How does unequal access to ChatGPT among students in LMICs affect fairness, equity, and the integrity of assessment in computer programming education?*
4. (RQ4) *How can ChatGPT be effectively integrated into curricula as an assistive tool—rather than a primary resource—to balance its benefits with concerns about academic dependency?*
5. (RQ5): *What institutional policies and pedagogical frameworks are needed to address student concerns about over-reliance and academic integrity when using ChatGPT in LMIC educational contexts?*

5.2 Recommendations

To respond to the second part of our core question, the five questions proposed in this study can be studied all together or independently. Figure 3 provides the order of investigation as recommended by authors. RQ 3 is foundational and can be

studied first. RQ 1 is highly applicational and can rely on the results of prior studies addressing RQ 3, RQ5, RQ2, and RQ 4.

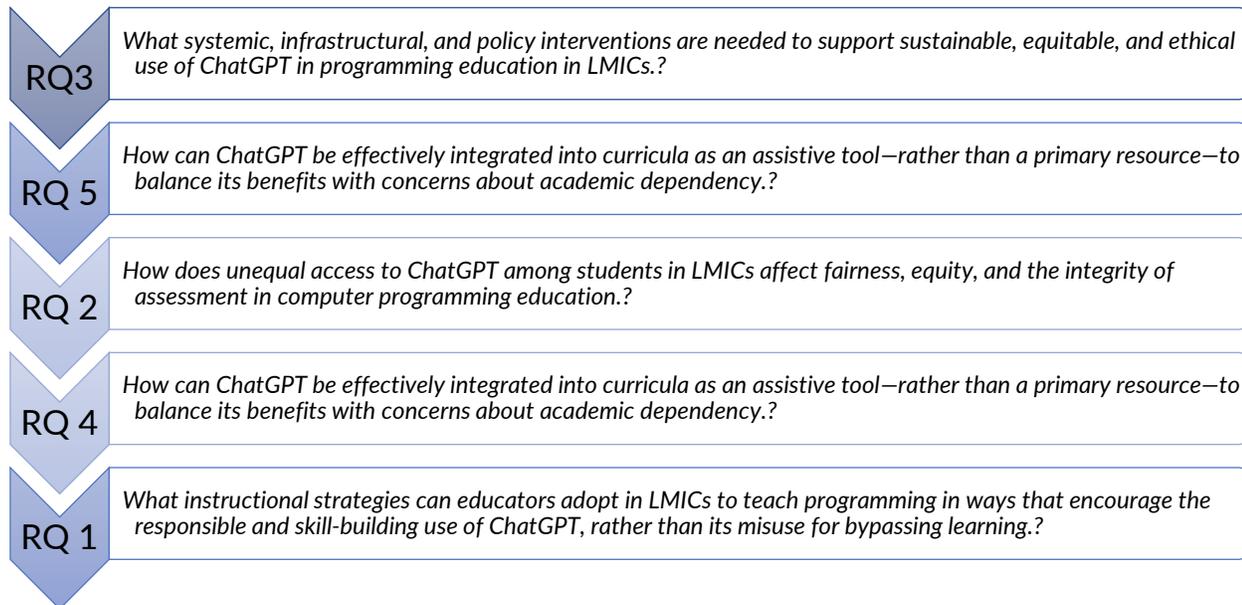


Figure 3: The order of approach to studying proposed research questions

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