Whole-class, high-quality peer tutoring is achievable with minimal effort or expense for teachers

Denis Reshetov

Correspondence: Denis Reshetov, email: reshetovdenis@gmail.com

Keywords

Peer Tutoring, Peer Instruction, Peer-Assisted Learning, Peer Tutoring Software, Peer Tutoring App, Peer Learning, PAL

Abstract

One-on-one tutoring by adults is among the most effective educational interventions, yet it remains prohibitively costly to scale. Peer tutoring offers a promising alternative, with substantial evidence supporting its efficacy for both tutors and tutees, but implementing it often requires additional time, planning, and teacher training—barriers that limit adoption. This paper presents Slonig (https://slonig.org), a lightweight, open-source peer tutoring app designed to overcome these challenges by ensuring proper student matching, guiding tutor behavior with a built-in algorithm, and controlling quality through structured feedback and game theory mechanisms. Slonig enables scalable, same-age peer tutoring with minimal teacher oversight, no lesson preparation, and integrated training for student tutors. Pilot classroom implementations with peer-led onboarding demonstrated rapid adoption and usability across age groups. While further research is needed to quantify learning gains, these early results suggest that peer tutoring, when supported by well-designed software, can serve as an effective and scalable instructional method even in resource-constrained settings.

Practitioner Notes

What is already known about this topic

- One-on-one tutoring with an adult can improve student learning outcomes by up to two standard deviations, but it is resource-intensive.
- AI-based tutoring, despite significant investment and promotion, is approximately 1.5 times less effective than professional tutoring and still cannot fully replace human instructors.
- Peer tutoring—students helping each other within or across age groups—has been shown to be effective for decades, but it is difficult to implement successfully and often falls short of the outcomes achieved through adult-led tutoring.
- Learning by teaching has a proven positive effect on students and should remain in place even if advanced AI tutors are developed.

What this paper adds

- Peer tutoring can be made easy to implement through dedicated software Slonig and structured onboarding methods.
- Tutor quality and learning outcomes can be improved through structured prompts and integrated social feedback mechanisms.

Implications for practice and/or policy

- Teachers can adopt the peer tutoring model presented in this paper to enhance classroom learning with minimal additional workload.
- Further randomized controlled trials (RCTs) are encouraged to assess the long-term effectiveness of Slonig peer tutoring approach across diverse educational settings.

Introduction

Tutoring Boosts Learning

In his influential and widely cited paper, Bloom (1984) demonstrated that students who received one-on-one tutoring combined with mastery learning achieved performance levels two standard deviations above those of students in traditional classrooms—placing them in the top 2% of the distribution.

Since then, numerous studies have attempted to replicate this effect at scale. A systematic review by Ritter et al. (2006) found that when adult nonprofessionals served as tutors, the average effect size was only 0.30—more than six times lower than the effect reported by Bloom, likely due at least in part to the lack of proper training among tutors.

A more recent meta-analysis by Nickow et al. (2020) further emphasized the importance of tutor quality, reporting an average effect size of 0.59 when tutoring was delivered by professional teachers, compared to just 0.21 when provided by nonprofessionals.

While one-to-one tutoring is widely recognized as educationally impactful, statistically significant, and robust in its effects (Dietrichson et al., 2017), its high cost makes large-scale implementation impractical for most societies (Bloom, 1984). Attempts to reduce costs by increasing the student-to-tutor ratio or shortening tutoring sessions significantly diminish the effectiveness of the intervention (Kraft, Matthew A. et al., 2024).

To address the financial burden of adult tutoring, researchers have explored the use of students as tutors—commonly known as peer tutoring. A recent meta-analysis by Alegre-Ansuategui et al. (2017) found that same-age and cross-age peer tutoring in mathematics yielded average effect sizes of 0.37 and 0.34, respectively. Although these effects are roughly half the size of those achieved through professional teacher-led tutoring, they remain substantial and hold promise for improving education globally. However, peer tutoring continues to demand additional time and effort from teachers (Hidayat & Saad, 2025) , who often report insufficient time to plan and integrate it into their teaching due to competing curricular priorities (Abbott et al., 2006).

Why Human Tutors Still Matter in the Age of AI?

Since the rapid rise of AI tutors, many in the education community have come to believe that these tools could serve as effective learning aids (Deng & Yu, 2023).

However, due to the wide range of AI tutors from different providers, the literature on their effectiveness presents conflicting findings. For example, Kestin et al. (2025), using an AI tutor to teach physics to 194 students in a randomized controlled trial, reported significant effects, with effect sizes ranging from 0.73 to 1.3 standard deviations.

In contrast, Martín et al. (2025) found that using Microsoft Copilot (powered by GPT-4) led to an effect size of 0.23 standard deviations in English performance. However, this study lacked a control group, and the intervention consisted of voluntary after-school sessions, making it difficult to determine whether the observed effects were due to the AI tutor or simply the additional study time.

On the other hand, Thoeni and Fryer (2025), in a randomized controlled field experiment involving about 450 undergraduate students, examined the effects of an AI tutor on key precursors to learning success (i.e., interest, self-efficacy, and engagement) as well as academic achievement. Contrary to expectations, they found no statistically significant impact on any measured outcome.

Meta-analyses in the field of AI in education also tend to present polarized findings.

Deng and Yu (2023), in their review of 32 empirical studies published between 2010 and 2022, found that students who used AI-tutors showed significant gains in both learning achievement ($d = 1.033$) and knowledge retention ($d = 0.691$) compared to control groups.

However, Laun and Wolff (2025) found a smaller effect size ($g = 0.381$) after accounting for publication bias, which tends to favor studies with small sample sizes and positive findings. They also included more recent data involving large language model (LLM) tutors and showed that these advanced tools performed no better than traditional, rule-based chatbots in terms of learning outcomes.

Although AI-tutors have proven to enhance learning outcomes, they are approximately 1.5 times less effective than professional tutors (Laun & Wolff, 2025; Nickow et al., 2020) and cannot replace human instructors (Dasari et al., 2024).

There is growing interest in overcoming these challenges through hybrid human–AI approaches. Thomas et al. (2024) found that combining human tutors with AI support positively affects students' proficiency and usage, with lower-achieving students appearing to benefit the most.

Similarly, Wang, Rose E. et al. (2024) showed that students whose tutors were randomly assigned access to Tutor CoPilot—a human-in-the-loop AI assistant—were 4 percentage points more likely to master math topics ($p < 0.01$), highlighting the potential of these hybrid models to enhance learning outcomes.

While it's tempting to believe that AI technologies will eventually become advanced enough to offer support comparable to professional tutors, this focus on AI distracts us from a crucial point: peer tutoring has a proven positive effect of 0.4 on the tutors themselves (Leung, 2019), students that teach their peers develop a deeper and more persistent understanding of the material (Fiorella & Mayer, 2013). If we rush to replace all tutoring with AI, we may eliminate this valuable opportunity for young people to learn through teaching. As we stand at a critical crossroads in the evolution of our educational systems, I advocate for strengthening peer tutoring rather than replacing it with AI-driven alternatives.

The practical issues involved stop teachers from using peer tutoring

Several challenges were identified in implementing same-level, equal-status peer tutoring (Widoro et al., 2024).

Peer tutoring can disrupt the traditional teacher-student relationship, causing teachers to feel a loss of control and conflicting with their teaching philosophy. It breaks the usual confidentiality between teacher and student and shifts roles in ways that may create tension (Biju, 2019; Kail, 1983).

Peer tutoring requires time and effort from both students and instructors to build trust and effective working relationships. Although it can enrich the learning experience, it also brings logistical complexities that are not typically present in traditional teaching methods (Biju, 2019; Hidayat & Saad, 2025). Scheduling sessions may require adjustments to the school timetable (Biju, 2019). Other challenges include making time for peer interaction, matching students appropriately, and managing differences in personality, background, and motivation—all of which can affect trust and engagement (Andrews & Fanning, 2015).

Chopra et al. (2020) raised concerns about the effectiveness of peer teaching, noting that it was "less impactful than desired because of lack of experience" and emphasizing that "seniors should be familiar with skills first and then teach." Tutors themselves echoed this sentiment, expressing a need for more training to feel adequately prepared for their roles. It has also been suggested that peer teaching may yield better results when introduced later in a student's training—once they have developed sufficient foundational knowledge and practical experience to teach effectively.

A related challenge lies in aligning the skill levels of tutors and tutees; mismatches can lead to frustration and disengagement on both sides (Anderson, 2024). Additionally, peer tutoring programs often struggle with student perceptions of their classmates' capabilities. When all students are assigned as tutors regardless of their competence or commitment, learners may question the reliability of the instruction they receive. Feedback from participants frequently reflects a lack of trust in peer tutors' academic abilities, suggesting that not all students view their peers as credible or effective sources of support (AlShareef et al., 2019).

At least at the beginning of implementation, peer tutors often struggle to take initiative during sessions, relying heavily on teacher support rather than confidently guiding the activity themselves. This issue is particularly evident in settings where students are not accustomed to providing pedagogical assistance and where the teacher traditionally plays a dominant instructional role (Durán Gisbert & Vázquez Rivas, 2021). Additionally, peer tutors may lack the teaching experience of professional educators, which can limit the learning outcomes for tutees. To address this, it is essential that peer tutors receive proper training before conducting sessions with their classmates (Biju, 2019; Falchikov, 2003).

One limitation of some peer tutoring programs is their reliance on voluntary student participation, which can result in uneven uptake depending on individual motivation (Allen et al., 2021; Chopra et al., 2020; Steck-Bayat et al., 2019). Even among those who do participate, maintaining active engagement poses an additional problem, as it is not easily regulated (Spivey et al., 2021).

Peer tutoring programs require consistent oversight to ensure their effectiveness. As Biju (2019) emphasizes, routine monitoring of peer tutoring sessions is necessary to track student progress and maintain quality. However, maintaining sustained engagement and accountability remains a significant challenge. Anderson (2024) notes that keeping both tutors and tutees motivated can be difficult, underscoring the need for structured support systems to foster commitment and active participation throughout the process.

A study on peer mentoring in online education found that the strongest effects were observed among students who were already high-performing before the intervention, suggesting that such programs may unintentionally increase inequality in academic outcomes. (Hardt et al., 2022).

Scaling Peer Tutoring: A Review of Software Solutions and Their Limitations

Numerous efforts have been made to scale and strengthen peer tutoring through dedicated software solutions.

For example, CWPT-LMS (Greenwood et al., 2001) supports teachers in organizing class-wide peer tutoring by helping them plan sessions, implement them, track outcomes, and evaluate progress.

Several platforms aim to facilitate tutor-tutee connections, either online or offline, by registering users and managing calendars and meeting logistics (*PeerKonnect*, 2017; *YTeach*, 2021).

The MENTOR app goes a step further by using predictive analytics to identify student tutoring needs and matching them with peers. It also coordinates in-person sessions using smartphone location data (Chung & Tan, 2022).

Knack (2015) offers tutor matching alongside real-time tools such as whiteboards, audio, video, and screen sharing.

Opal introduces the concept of online tutoring pools, managed either manually by instructors or automatically via "digital gates" that unlock access when students solve problems correctly (Evans & Moore, 2013).

Despite advances in software development, several key challenges in peer tutoring remain unresolved:

1. Effectively matching students into compatible pairs
2. Managing time when students alternate between tutor and tutee roles
3. Designing comprehensive and practical tutor training programs
4. Ensuring consistent quality control of tutoring sessions
5. Storing and utilizing tutoring outcomes to refine and improve future sessions
6. Providing curriculum-aligned materials specifically designed for peer tutoring contexts

To address these challenges, we developed Slonig, a lightweight peer tutoring platform designed to enable same-age peer tutoring during class time with minimal teacher oversight. This paper presents the design principles behind Slonig and examines its classroom implementation.

Materials and methods

Overview of the Slonig Software

Slonig – Slon Intellectual Game – is a peer tutoring app designed to make tutoring in schools more effective and engaging. It addresses common challenges by using game theory to help students form compatible pairs and by guiding them to alternate between tutor and tutee roles. The app includes built-in tools for quality control, feedback, and tracking learning outcomes, which are securely stored. Slonig also offers curriculum-aligned materials specifically tailored for peer tutoring. A single-lesson integration plan trains students to use the app effectively, preparing them to lead and learn in future lessons.

Design Principles

Open source, licensed under Creative Commons, and free to use

Slonig is fully open source, and all lesson materials are available under a Creative Commons license. The platform is free to use for students, teachers, and parents—without subscriptions, fees, or hidden costs.

User data is stored securely and privately

User data—including names, learning history, and tutoring progress—is stored only on the user's personal device. Slonig does not collect or transmit any contact information, ensuring full privacy.

Easing Teachers' Load

All tutoring content is integrated directly into the Slonig app, providing tutors and tutees with everything they need at their fingertips. Teachers don't need to plan lessons or prepare additional materials—Slonig is ready to use straight out of the box. To get started, teachers only need to complete a brief introductory training, which takes about 30 minutes and can be done online. While teachers remain engaged during lessons to support students, the overall workload—especially outside of class—is significantly reduced compared to preparing and delivering regular teacher-led lessons.

Continuously evolving lesson materials

Lesson content is initially developed by Slonig's team of subject experts, but it remains open to improvement. Like Wikipedia, the community can edit and enhance the materials, allowing the curriculum to evolve over time and errors to be promptly fixed.

Practical tutor training program

Slonig includes a one-lesson onboarding module that teaches students how to use the app. After this brief training, any student can begin tutoring effectively using Slonig's built-in tools and guidance.

Students match into compatible pairs and switch between tutor and tutee roles

Pairing students for tutoring is challenging—it requires understanding both their current skills and their personal compatibility. Slonig uses principles from game theory to address this challenge efficiently. It allows students to form pairs voluntarily, taking into consideration psychological compatibility, tutoring efficiency with a particular partner, and the partner's availability.

Students are matched for short, focused sessions (15–20 minutes) considering specific skills the tutor has mastered and the tutee still needs. Students can change partners at any point during the lesson at their own discretion. This dynamic matching mechanism avoids rigid scheduling and keeps sessions purposeful and productive.

To prevent some students from always acting as tutors while others remain tutees, Slonig introduces the concept of the Slon—an acronym for Student Learning Optimization Number. Each student starts with the same Slon, which represents the value the student has contributed to the classroom minus the value they have received in terms of tutoring support. When a tutor confirms that a tutee has gained a new skill, the tutor's Slon increases while the tutee's decreases by a certain amount. This amount, called the "Reward," can be set voluntarily by each pair through internal discussion. Tutors in high demand may request higher rewards, while less sought-after tutors may offer lower ones.

If a student's Slon level drops too low, they must take on the tutor role to raise it again. This creates a self-balancing system of mutual incentives, where students are motivated to both teach and learn. The mechanism draws on game-theoretic concepts such as Nash equilibrium and incentive alignment, ensuring that optimal outcomes arise when each participant acts in their own interest.

Skill-based learning

Slonig structures content into courses, each made up of modules, which consist of small, individual skills. Students master all the skills in one module before moving to the next. Every skill is linked to a pair of sample exercises and tracked in the system.
Examples:

- Mathematics:
  - Add fractions with the same denominators
  - Multiply fractions
  - Divide a fraction by an integer
- English Language Arts:
  - Use the Present Simple interrogative form with "he"
  - Replace a word with a synonym
  - Summarize a paragraph into a sentence
- Biology:
  - Transcribe DNA into protein
  - Identify molars in a mammal jaw
  - Adjust microscope focus
- Sports:
  - Hold a tennis racket (Eastern grip)
  - Do squats
  - Hold a plank

Since all educational content is broken down into very small, specific skills, a common concern raised by teachers is that complex student abilities cannot be reduced to just a sum of those parts. Even if a student masters each individual skill, it doesn't guarantee they will develop the full, integrated ability. Slonig addresses this by introducing complex skills—composite abilities that are taught only after the relevant foundational skills have been acquired. For example, the complex skill "Multiply mixed numbers" is taught only after the student has learned to: "Convert a mixed number to an improper fraction" and "Multiply fractions".

Built-in tutoring algorithm

Slonig guides the tutor step-by-step with a consistent algorithm designed to ensure effective learning (see Figure 1). The process begins with the tutor posing an exercise and assessing the student's response. If the response is incorrect, the tutor provides immediate feedback with the correct answer, and prompts the student to repeat it, leveraging the benefits of active recall and retrieval practice (Roediger & Butler, 2011). Once the student responds correctly, the tutor requests that they generate a similar exercise, engaging them in productive struggle and promoting transfer through student-generated examples (Ebersbach et al., 2020; Ramirez-Velarde et al., 2014). The tutor then deliberately introduces an error when attempting the student's exercise and asks the student to correct it—an application of the learning-by-teaching strategy, which has been shown to enhance metacognitive monitoring and conceptual understanding (Fiorella & Mayer, 2013). The student is awarded a digital badge only if their performance, including correction of the tutor's mistake, is perfect on that day; otherwise, the session is repeated the following day to harness the benefits of spaced repetition (Cepeda et al., 2006). This tutor-led algorithm supports mastery learning (Bloom, 1984) by ensuring that each student progresses only after demonstrating comprehensive understanding and the ability to apply, explain, and correct the target skill. When awarded a digital badge, the tutee gains the confidence to tutor the same skill to someone else.

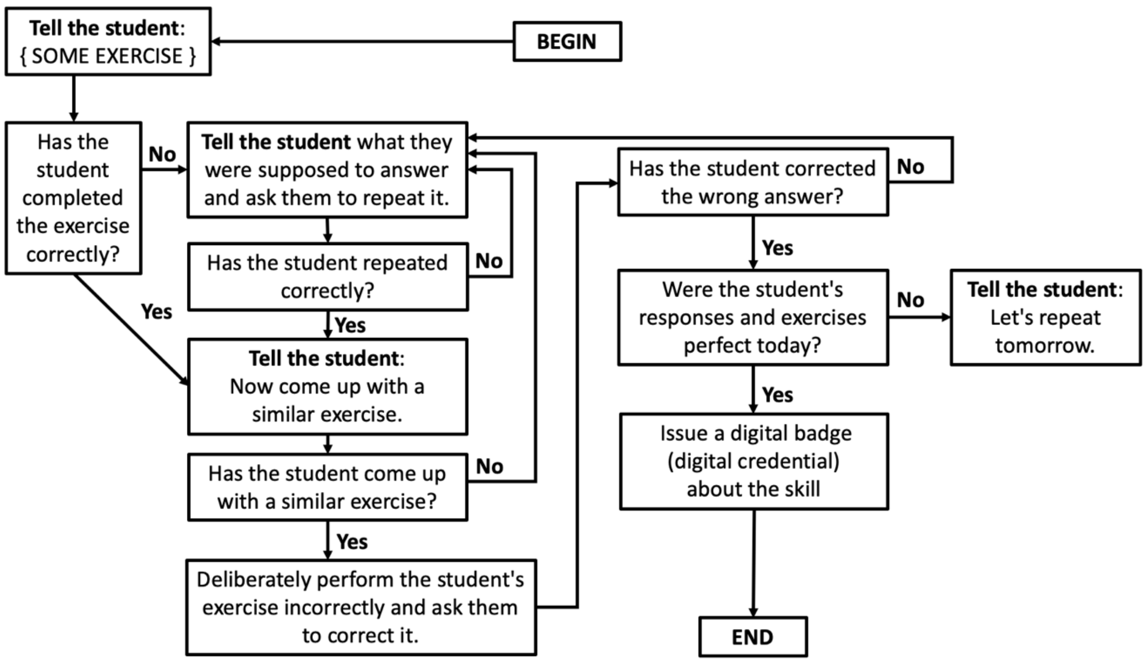

Figure 1. Slonig peer tutoring algorithm.
This flowchart illustrates the step-by-step process used by the Slonig platform to guide students through skill mastery. The algorithm begins with a student completing a given exercise. Based on their response, the system prompts corrective feedback, repetition, generation of a similar task, and a peer evaluation component (see Figure 2D-F). If the student consistently demonstrates understanding and accuracy, they are awarded a digital badge.

Mastery learning

A tutor cannot mark a skill as learned until the student has demonstrated proficiency, which is defined as completing all steps of the skill's learning algorithm without any errors during the current tutoring session (see Figure 2). This usually happens after two tutoring sessions on different days for the same skill.

Personalized learning track

Slonig tracks each student's acquired skills and suggests the next appropriate ones, ensuring learning remains within the student's zone of proximal development.

Quality control

At the end of each session, the tutor either awards a digital badge or suggests repeating the skill later. Badges include metadata: the skill ID, a cryptographic proof tied to the student, and a Slon stake placed by the tutor. If a badge is given without proper teaching, it can be challenged by another tutor, teacher, or parent—potentially lowering the tutor's Slon. While misuse is theoretically possible, it rarely occurs in practice. Since students typically tutor friends, they avoid actions that would harm those relationships.

Introducing new material without lectures

Slonig allows a teacher to convert all lessons into peer tutoring without introducing new material through lectures or textbooks. This approach carries the risk that the entire class might miss a specific skill, so to prevent this, the teacher first teaches the skill to one or two students. Although this may seem less efficient from the teacher's perspective compared to lecturing the whole class, in practice, lectures typically result in only 20% of students mastering the skill, while the rest passively listen (Bloom, 1984). When considering not just the teacher's time but also the collective time of all students, it becomes clear that spreading a new skill through the peer tutoring network is faster and more effective than repeatedly explaining the same concept in lectures with little success.
A typical skill (as defined above) takes about 10 minutes to teach using Slonig. During this time, the number of students who have mastered the skill—and can now teach it—doubles every 10 minutes. If only the teacher knows the skill at the start, then after 10 minutes, two people will know it; after 20 minutes, four; after 30 minutes, eight, and so on. This exponential spread means that a class of 30 students can learn a new skill in a single lesson, and an entire school of 1,000 students can be taught the same skill in just two lessons (see Table 1).

Table 1. Exponential growth of skill mastery among students using the Slonig peer tutoring method. This table illustrates how the number of students mastering a new skill increases over time through peer tutoring. Each cycle of 10 minutes results in a doubling of the number of skilled students, starting from a single trained individual. Within a typical lesson (~ 50 minutes), 32 students can acquire the skill. By the end of a second lesson (~ 100 minutes), over 1,000 students can be trained, demonstrating the scalability and efficiency of the method.

Lessons	Minutes after a skill introduction	Number of students mastered the skill
1	0	1
	10	2
	20	4
	30	8
	40	16
	50	32
2	60	64
	70	128
	80	256
	90	512
	100	1024

Figure 2. Step-by-step process of using Slonig in a tutee–tutor pair.
A – The tutee selects a module they wish to learn. **B** – Within the module, they can view which skills they have already mastered. **C** – The tutee activates the "Learn with a tutor" option, which generates a QR code to be scanned by the tutor. **D, E, F** – The tutor reads aloud the green-highlighted prompts and navigates through the algorithm (see Figure 1) by selecting "Yes" or "No" based on the tutee's responses. At the end of the session, the tutee earns digital badges for the skills they have successfully demonstrated.

Teacher and Parent Control Over Student Progress

Since Slonig awards badges, there is no need for additional assessments—every student's skills are visible within the platform (see Figure 2B). Moreover, a teacher can request permission from a student to assess their skills. This means the teacher has the right to revoke any badge if they believe the student has not truly mastered the corresponding skill. The same can be done by a principal or a parent, making education transparent for all stakeholders.

Schoolwide monitoring and metrics

It's possible to measure learning speed as the number of badges a student receives per lesson. From an administrative perspective, in addition to reviewing students' badges, evaluating teacher efficiency shifts from comparing average grades across teachers and classes to observing learning speed—which is harder to manipulate than grades.

Deployment

Slonig comprises a backend (Reshetov, 2024a) and a frontend (Reshetov, 2024b). For classroom deployment, the system was installed using Docker on a Linux-based machine equipped with 8 GB of RAM and a 100 GB hard drive.

Introducing Slonig to a classroom

Three different approaches were used to introduce Slonig in the classroom.
The first, referred to as the "frontal approach," involved a five-minute verbal introduction by the teacher, during which students received a login link and could ask questions while exploring the app.
The second, the "video approach," replaced the verbal explanation with a two-minute tutorial video (Reshetov, 2024c) demonstrating how to use Slonig.
The third approach relied on peer tutoring to teach students how to use Slonig. It began with one person (person A) who already knew how to use the software both as a tutor and a tutee. Person A selected another student (person B) and walked them through steps 1–8 as outlined in Table 2. During this process, person B learned to use Slonig from the tutee's perspective. Next, the pair brought in a third student (person C) for step 9. At this point, person A continued with steps 10 and 11, while person B took on the role of tutor and repeated steps 1–8 with person C as the tutee. Meanwhile, person A acted as a guide, supporting person B in their new tutoring role. Once this three-person collaboration was complete, they split up. Person A recruited a new student and restarted the cycle as tutor. Person B transitioned to the guide role, person C became the tutor, and a new student (person D) joined as the tutee. Each cycle of completing all steps takes approximately 10 minutes. After each cycle, the number of "guides"—students who fully understand how to use Slonig—doubles. As a result, an entire class of 32 students can be trained within a single lesson, and a large school of around 1,000 students can be trained in just two lessons (see Table 1). While this rapid scale-up may seem implausible to those unfamiliar with exponential growth, it follows the same principles seen in compound interest, viral video spread, or the swift adoption of messaging apps. For readers new to this concept, these familiar examples may help illustrate how quickly impact can multiply.

Submitted to arXiv on July 10, 2025

Table 2. Step-by-step peer tutoring protocol for introducing Slonig. This table outlines a simple, repeatable procedure that tutors follow to onboard new users to the Slonig platform. The tutor selects a tutee, guides them through scanning a QR code to open the site, and helps them register by entering their name and choosing a familiar topic. The process is designed to be intuitive and requires no prior training, enabling rapid scaling of the platform's use through peer-to-peer instruction.

Step	What TUTOR should do
1	Choose **any** tutee
2	• Tell the tutee to **scan the QR** to launch the site. • Please note that the site may load slowly the first time.
3	Have the tutee type in their **full name**.
4	Ask the tutee to choose a topic they know well.
5	Ask the tutee to toggle the '**learn with a tutor**' switch.
6	Now **you (the tutor)** should scan the QR code from the tutee's screen.
7	• Teach the tutee the skill by following the instructions displayed on your screen. • Don't forget to **click** the "Next," "Yes," and "No" buttons. • The text on the **green background** is what you should say to the tutee out loud. • The **small text** contains important notes.
8	• At the end of the lesson, a QR code will appear on your screen. (You can also access this QR code after teaching just one skill by tapping the ✖- button in the top right corner, then pressing the ⏩-button.) • Ask the tutee to scan the QR code and tap the "**Reward**" button on their phone. They will receive a digital badge, and you will receive a certain amount of Slon.
9	Ask the student to choose **anyone** in the class whom they will teach to use the website. Give the student **a copy of this cheat sheet** and make sure they **read** it thoroughly. **Agree** on the Slon reward you will receive for helping.
10	Make sure the student is teaching the new person **correctly**.
11	Ask the student to reward you as previously agreed.

All three approaches were used for introducing Slonig within private schools in Montenegro. The Slonig platform was initially evaluated informally by teachers at participating schools, who considered it to be a promising tool for internal use. These pilots were not designed as formal research studies with measurable outcomes, and no data from children was collected.

Results

The frontal approach was tested in a classroom of 8 students, approximately 9 years old. While I succeeded in helping all students create accounts in the Slonig system within one lesson, there was no actual learning or understanding of how to use the platform.

The video approach was applied in a similarly sized group of older children, with an average age of 11. The results were the same—students failed to grasp how to use Slonig and didn't understand the need to work in pairs.

The third approach, based on peer tutoring, was initially tested with a small group of 5 students around 17 years old. Within 30 minutes, all students successfully learned how to use the platform. I observed appropriate feedback exchanges and correct use of the teaching algorithm. Although this group was significantly older than the previous two, it was encouraging to see clear success in teaching Slonig through peer tutoring.

Building on this success, I introduced Slonig to a group of 15 students aged 14 using the same peer tutoring method. I invited two trained students from the earlier group to assist. With three initial trainers, we managed to teach all 15 students how to use Slonig within a single lesson.

To explore the potential of using peer tutoring with younger students, I then worked with three 9-year-olds. All three successfully learned how to use the platform. While it is too early to conclude that Slonig can be effectively introduced across all age groups, these results suggest promising potential for improving the teacher experience through peer tutoring, at least in certain age ranges.

I fully acknowledge that these samples are too small to support strong conclusions. However, I believe it is important to present these preliminary results now in order to engage educators who may be interested in supporting or conducting rigorous RCTs to further evaluate the approach.

Discussion

The Slonig platform demonstrates that scalable, effective peer tutoring is achievable in everyday classrooms—even without additional teacher preparation or external resources. Our pilot implementations indicate that, when introduced through structured peer onboarding, students across various age groups can quickly learn how to use the software and begin tutoring their peers within a single lesson.

The comparison of three onboarding methods highlights a crucial point: passive introduction via video or frontal instruction is insufficient, especially for younger students. It was only the peer tutoring introduction method that consistently resulted in students mastering both the platform and the embedded tutoring algorithm. These findings echo earlier concerns raised in the literature (Anderson, 2024; Biju, 2019) that engagement and clarity are essential for peer tutoring to be successful, particularly when students are unfamiliar with pedagogical roles.

Moreover, Slonig addresses several structural limitations identified in past peer tutoring programs. Its automated pairing, built-in guidance, and real-time feedback tools reduce the burden on teachers while maintaining high-quality interactions between students. The dynamic Slon score system further ensures equity by balancing tutor and tutee roles over time—an improvement over traditional systems where some students may dominate tutoring roles while others remain passive.

While tutor training has historically been a barrier to peer tutoring success (Chopra et al., 2020; Durán Gisbert & Vázquez Rivas, 2021), Slonig's single-lesson onboarding model circumvents this limitation, enabling any student to begin tutoring within minutes. The exponential growth model observed in our trials supports the feasibility of training entire classes—or even schools—rapidly and effectively.

Nonetheless, the pilots described here were limited in scale and lacked formal outcome measurements. Further research is needed to assess long-term learning gains, behavioral engagement, and teacher perceptions across diverse educational contexts. Randomized controlled trials would help validate Slonig's impact compared to traditional teaching methods and to other peer tutoring programs.

Overall, our results suggest that with the right tools and structure, peer tutoring can become a practical, scalable alternative to one-on-one adult tutoring and a replacement for classroom instruction.

Conclusion

This study introduces Slonig as a practical solution to the long-standing challenges of peer tutoring implementation in schools. By combining structured guidance, intelligent pairing, built-in quality controls, and a simple yet powerful incentive system, Slonig transforms peer tutoring from a burdensome add-on into a scalable, classroom-ready pedagogy. The results from our pilot classrooms demonstrate that with proper onboarding, students can quickly learn to both tutor and learn from peers effectively. While further large-scale and longitudinal studies are needed to quantify learning gains and optimize implementation across diverse settings, the evidence so far suggests that peer tutoring—when supported by the right tools—can rival traditional instruction and supplement adult-led tutoring in meaningful, measurable ways.

Conflict of interest statement

The author is the developer of the Slonig app presented in this paper. However, all efforts have been made to evaluate the app objectively.

Data availability statement

Not applicable.

Ethics statement

Not applicable.

Funding information

The work was partially supported by grants from the Web3 Foundation and IPFS.

ORCID

https://orcid.org/0000-0001-5609-389X

References

Abbott, M., Greenwood, C. R., Buzhardt, J., & Tapia, Y. (2006). Using Technology-Based Teacher Support Tools to Scale up the ClassWide Peer Tutoring Program. *Reading & Writing Quarterly*, *22*(1), 47–64. https://doi.org/10.1080/10573560500203525

Alegre-Ansuategui, F. J., Moliner, L., Lorenzo, G., & Maroto, A. (2017). Peer Tutoring and Academic Achievement in Mathematics: A Meta-Analysis. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(1). https://doi.org/10.12973/ejmste/79805

Allen, P. J., De Freitas, S., Marriott, R. J., Pereira, R. M., Williams, C., Cunningham, C. J., & Fletcher, D. (2021). Evaluating the effectiveness of supplemental instruction using a multivariable analytic approach. *Learning and Instruction*, *75*, 101481. https://doi.org/10.1016/j.learninstruc.2021.101481

AlShareef, S. M., Aldayel, A. Y., Alghamdi, H. M., Alosaimi, M. B., Alharbi, M. M., Aldayel, A. A., & Alhussain, H. A. (2019). Perceptions On Reciprocal Peer Teaching Among

Medical Students As Learners And As Tutors. *Advances in Medical Education and Practice*, *Volume 10*, 817–827. https://doi.org/10.2147/AMEP.S220728

Anderson, C. (2024). *What is peer tutoring systems?* https://focuskeeper.co/glossary/what-is-peer-tutoring-systems

Andrews, M., & Fanning, N. (2015). *Mapping Peer Learning Initiatives in Public Sector Reforms in Development*. https://www.hks.harvard.edu/centers/cid/publications/faculty-working-papers/mapping-peer-learning-initiatives-public-sector-reforms-development

Biju, S. M. (2019). Benefits of Working in Pairs in Problem Solving and Algorithms—Action Research. *ATHENS JOURNAL OF EDUCATION*, *6*(3), 223–236. https://doi.org/10.30958/aje.6-3-4

Bloom, B. S. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. *Educational Researcher*, *13*(6), 4–16. https://doi.org/10.3102/0013189X013006004

Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*, *132*(3), 354–380. https://doi.org/10.1037/0033-2909.132.3.354

Chopra, N., Zhou, D. B., Fallar, R., & Chadha, N. (2020). Impact of Near-Peer Education in a Student-Run Free Ophthalmology Clinic on Medical Student Teaching Skills. *Journal of Surgical Education*, *77*(6), 1503–1510. https://doi.org/10.1016/j.jsurg.2020.05.012

Chung, S.-H., & Tan, S. C. (2022). MENTOR – Intelligent Mobile Online Peer Tutoring Application for Face-to-Face and Remote Peer Tutoring. *ASCILITE Publications*, 386–391. https://doi.org/10.14742/apubs.2019.293

Dasari, D., Hendriyanto, A., Sahara, S., Suryadi, D., Muhaimin, L. H., Chao, T., & Fitriana, L. (2024). ChatGPT in didactical tetrahedron, does it make an exception? A case study in mathematics teaching and learning. *Frontiers in Education*, *8*, 1295413. https://doi.org/10.3389/feduc.2023.1295413

Deng, X., & Yu, Z. (2023). A Meta-Analysis and Systematic Review of the Effect of Chatbot Technology Use in Sustainable Education. *Sustainability*, *15*(4), 2940. https://doi.org/10.3390/su15042940

Dietrichson, J., Bøg, M., Filges, T., & Klint Jørgensen, A.-M. (2017). Academic Interventions for Elementary and Middle School Students With Low Socioeconomic Status: A Systematic Review and Meta-Analysis. *Review of Educational Research*, *87*(2), 243–282. https://doi.org/10.3102/0034654316687036

Durán Gisbert, D., & Vázquez Rivas, A. (2021). Implementing Peer Tutoring for the Development of Empathy in Nursing Education. *Investigación y Educación En Enfermería*, *39*(2). https://doi.org/10.17533/udea.iee.v39n2e07

Ebersbach, M., Feierabend, M., & Nazari, K. B. B. (2020). Comparing the effects of generating questions, testing, and restudying on students' long-term recall in university learning. *Applied Cognitive Psychology*, *34*(3), 724–736. https://doi.org/10.1002/acp.3639

Evans, M. J., & Moore, J. S. (2013). Peer tutoring with the aid of the Internet. *British Journal of Educational Technology*, *44*(1), 144–155. https://doi.org/10.1111/j.1467-8535.2011.01280.x

Falchikov, N. (2003). *Learning Together: Peer Tutoring in Higher Education* (0 ed.). Routledge. https://doi.org/10.4324/9780203451496

Fiorella, L., & Mayer, R. E. (2013). The relative benefits of learning by teaching and teaching expectancy. *Contemporary Educational Psychology*, *38*(4), 281–288. https://doi.org/10.1016/j.cedpsych.2013.06.001

Greenwood, C. R., Arreaga-Mayer, C., Utley, C. A., Gavin, K. M., & Terry, B. J. (2001). ClassWide Peer Tutoring Learning Management System: Applications with Elementary-Level English Language Learners. *Remedial and Special Education*, *22*(1), 34–47. https://doi.org/10.1177/074193250102200105

Hardt, D., Nagler, M., & Rincke, J. (2022). Can peer mentoring improve online teaching effectiveness? An RCT during the COVID-19 pandemic. *Labour Economics*, *78*, 102220. https://doi.org/10.1016/j.labeco.2022.102220

Hidayat, R., & Saad, M. R. M. (2025). A Meta-analysis of the effect of peer tutoring in Science, Technology, Engineering and Mathematics (STEM) subjects. *International Journal of Educational Research Open*, *8*, 100446. https://doi.org/10.1016/j.ijedro.2025.100446

Kail, H. (1983). Collaborative Learning in Context: The Problem with Peer Tutoring. *College English*, *45*(6), 594. https://doi.org/10.2307/377146

Kestin, G., Miller, K., Klales, A., Milbourne, T., & Ponti, G. (2025). AI tutoring outperforms in-class active learning: An RCT introducing a novel research-based design in an authentic educational setting. *Scientific Reports*, *15*(1), 17458. https://doi.org/10.1038/s41598-025-97652-6

Knack. (2015). [Computer software]. https://www.joinknack.com/

Kraft, Matthew A., Schueler, Beth E., & Falken, Grace. (2024). *What Impacts Should We Expect from Tutoring at Scale? Exploring Meta-Analytic Generalizability*. https://doi.org/10.26300/ZYGJ-M525

Laun, M., & Wolff, F. (2025). Chatbots in education: Hype or help? A meta-analysis. *Learning and Individual Differences*, *119*, 102646. https://doi.org/10.1016/j.lindif.2025.102646

Leung, K. C. (2019). An updated meta-analysis on the effect of peer tutoring on tutors' achievement. *School Psychology International*, *40*(2), 200–214. https://doi.org/10.1177/0143034318808832

Martín, D. S., Federico, T., Maria Barron, R., Federico, M., Wuraola, M., & Eliot Jolomi, D. (2025). *From Chalkboards to Chatbots, Evaluating the Impact of Generative AI on Learning Outcomes in Nigeria*. https://documents1.worldbank.org/curated/en/099548105192529324/pdf/IDU-c09f40d8-9ff8-42dc-b315-591157499be7.pdf

Nickow, A., Oreopoulos, P., & Quan, V. (2020). *The Impressive Effects of Tutoring on PreK-12 Learning: A Systematic Review and Meta-Analysis of the Experimental Evidence* (No. w27476; p. w27476). National Bureau of Economic Research. https://doi.org/10.3386/w27476

PeerKonnect. (2017). [Computer software]. https://peerkonnect.org

Ramirez-Velarde, R., Perez-Cazares, R., Alexandrov, N., & Garcia-Rueda, J. J. (2014). Education 2.0: Student Generated Learning Materials through Collaborative Work. *Procedia Computer Science*, *29*, 1835–1845. https://doi.org/10.1016/j.procs.2014.05.168

Reshetov, D. (2024a). *Slonig backend* [Computer software]. https://github.com/slonigiraf/slonig-node-dev

Reshetov, D. (2024b). *Slonig frontend* [Computer software]. https://github.com/slonigiraf/apps-slonigiraf

Reshetov, D. (Director). (2024c). *Teachers, This App Will Change Your Life! ✨ (Slonig in Action)* [Video recording]. https://www.youtube.com/watch?v=h5eI_RSfr1s

Ritter, G., Denny, G., Albin, G., Barnett, J., & Blankenship, V. (2006). The Effectiveness of Volunteer Tutoring Programs: A Systematic Review. *Campbell Systematic Reviews*, *2*(1), 1–63. https://doi.org/10.4073/csr.2006.7

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, *15*(1), 20–27. https://doi.org/10.1016/j.tics.2010.09.003

Spivey, C. A., Davis, M. S., Rodriguez, J. D., Havrda, D., & Chisholm-Burns, M. A. (2021). Effects of peer-led study sessions on first-year student pharmacist performance in pharmacy math. *Currents in Pharmacy Teaching and Learning*, *13*(9), 1168–1173. https://doi.org/10.1016/j.cptl.2021.06.029

Steck-Bayat, K., Mourad, J., Borodulin, O., & Mahnert, N. (2019). 2275 “The Resident Buddy System”: A Better Way to Encourage Laparoscopy Simulation Training? *Journal of Minimally Invasive Gynecology*, *26*(7), S153. https://doi.org/10.1016/j.jmig.2019.09.251

Thoeni, A., & Fryer, L. K. (2025). *AI Tutors in Higher Education: Comparing Expectations to Evidence*. Open Science Framework. https://doi.org/10.31219/osf.io/24tg7_v1

Thomas, D. R., Lin, J., Gatz, E., Gurung, A., Gupta, S., Norberg, K., Fancsali, S. E., Aleven, V., Branstetter, L., Brunskill, E., & Koedinger, K. R. (2024). Improving Student Learning with Hybrid Human-AI Tutoring: A Three-Study Quasi-Experimental Investigation. *Proceedings of the 14th Learning Analytics and Knowledge Conference*, 404–415. https://doi.org/10.1145/3636555.3636896

Wang, Rose E., Ribeiro, Ana T., Robinson, Carly D., Loeb, Susanna, & Demszky, Dorottya. (2024). *Tutor CoPilot: A Human-AI Approach for Scaling Real-Time Expertise*. https://doi.org/10.26300/81NH-8262

Widoro, E., Situmorang, R., & Chaeruman, U. A. (2024). Challenges of Peer Tutoring in Different Role Organization Settings in Higher Education: Systematic Literature Review. *Pedagogika*, *155*(3), 68–87. https://doi.org/10.15823/p.2024.155.4

YTeach. (2021). [Computer software]. https://yteach.com/