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IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE APPS TO IMPROVE RECOGNITION ABILITY IN BOYS WITH MILD INTELLECTUAL DISABILITY ENROLLED IN SPECIAL EDUCATION SCHOOL

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ABSTRACT

This paper aimed to apply artificial intelligence based mobile apps to enhance recognition abilities in boys with intellectual disabilities. Artificial intelligence has the potential to address these issues. There are limited studies on improving the recognition ability of children with intellectual disability. This paper examined the implementation of artificial intelligence (AI) apps as a pedagogical intervention to improve recognition ability in boys with mild intellectual disabilities (IDs) enrolled in special education school. An experimental design was used consisting of single-subject repetitive measures in three levels, pre-test, during-test and post-test. The sample was 07 boys aged 8 to 14 years with mild IDs to enhance recognition ability by using an AI-based interventions. The intervention was 12 weeks and had 25 organized sessions with a duration of 10 minutes each having a 5-minute rest. The learning applications with AI included in the learning procedure were one-to-one sessions via learning applications, which were supported by lesson plans (Khan Academy Kids and CogniFit). A checklist consisting of a 5-point Likert scale was used to evaluate the students' performance. Friedman and Wilcoxon signed-rank tests were conducted on the quantitative data to determine the differences in performance at the three stages. The findings have reported that recognition performance is significantly improved. The results contribute to the presumption of the adaptive AI technologies in special education to empower cognitive development and foster fair learning opportunities.

Keywords: *Intellectual disabilities, Artificial Intelligence, Recognition Ability, Special education, Mobile apps.*

Introduction

Children with mild intellectual disabilities (MID) often struggle with the detection of visual, verbal, and auditory messages. These challenges may affect their ability to distinguish objects, letters, numbers, and facial expressions, which are essential for learning and communication. Recognition is a fundamental mental task that helps in focusing, memorizing, and comprehending. In this case, when the ability is low, students will find it challenging to connect new information with existing knowledge, leading to slower academic growth and reduced independence in everyday operations (Zhang, 2025).

Conventional teaching practices often rely on repetition and verbal instruction. Although these strategies provide structure, they may not fully address the diverse learning needs of children with mild intellectual disabilities (Jacob et al., 2022). The issue of boredom is that many students tend to lose interest when there is nothing visual or interactive in the lesson. It is thus becoming imperative to consider employing innovative methods of teaching that incorporate multisensory and technology-based learning strategies to enhance both attention span and recognition skills (Hussein et al., 2025).

Technology in special education has dramatically transformed the way students with disabilities learn significantly. Artificial intelligence (AI) has become a potential solution that can respond to the individual's rate and performance as a learner. Learning systems based on AI can personalize learning, provide feedback, and track progress, ensuring that students interact with content tailored to their level of knowledge. This flexibility is beneficial for children with MID, who require regular reinforcement and learning opportunities according to their needs (Mukhtarkyzy et al., 2025).

Digital technology is gaining increasing attention due to its convenient and straightforward way of facilitating the learning process for children. Educational applications, games, and virtual reality can help make learning more interactive and engaging. The technologies can also regulate the child's learning speed and provide them with a greater opportunity to play safely. They enable parents and caregivers to participate in the home-based learning process. The combination of these methods and the everyday classroom instruction can help intellectually disabled children receive an opportunity to enjoy quality and more inclusive education (Faiz & Hina, 2024).

Artificial intelligence is advancing to a more intimate level of training. The level of difficulty may be adjusted based on a child's progress using artificial intelligence applications, which can provide instant help and monitor progress in the long term. This technique not only helps teachers meet the needs of various students but also gives children with disabilities the opportunity to learn at their own pace with the help of adaptive and engaging lessons (El Morr et al., 2024).

Today's era is characterized by the widespread use of smartphones and the weekly creation of new applications for them. Such applications and programs are being developed for children's education that help them learn more and more. Through a mobile app, children can access educational support, regardless of location or time. Game-style mobile apps have already shown promising results in developing academic and everyday skills in children with disabilities. Tablets and smartphones in schools are among the most common assistive tools used to support children in developing their academic skills (Mahmoudi & Nasr, 2025).

Mobile apps based on artificial intelligence are becoming accepted as adequate resources in assisting the education of children with special needs. Mobile platforms, including smartphones and tablets, enable the flexible and accessible delivery of adaptive instruction, individual learning tasks, and assistive communication tools. Such applications can provide educational materials depending on the cognitive capability of the learner, provide real-time performance feedback to teachers and students, and also give instant feedback. To children with intellectual and developmental disabilities, AI-based applications advance attention, memory, recognition, language, and social skills because of their gamified and interactive nature. Their portability means learning is not limited to the classroom setting, resulting in less time, cost, and access to sensitive information. According to new research, AI-based interventions can enhance academic and cognitive outcomes. The interactive nature of AI-based apps helps students stay motivated while gradually improving their recognition skills (Faiz & Hina, 2024).

Recognition ability is closely associated with communication and social participation. Children who can recognize letters, shapes, and faces properly understand classroom activities and social behaviors. The acquisition of recognition skills is therefore a key aspect of both academic performance and social-emotional growth improvement. The visual, auditory, and kinesthetic learning experience, facilitated by AI applications, will help children transfer recognition skills to real-life contexts, leading to improved cognitive and behavioral outcomes (Durgungoz & St Clair, 2025).

With mild intellectual disabilities, abstract concepts can be brought to reality through repetition, adaptive images, and contextual learning, aided by AI applications. Artificial intelligence systems can modify task difficulty, detect recognition errors, and deliver immediate corrective feedback. This procedure is an adaptive mechanism that promotes active involvement and enhances the accuracy of recognition in both the short term and long term. With these intelligent systems, educators will be able to integrate human teaching with online resources to achieve better educational outcomes (Alsolami, 2025).

Mobile based interventions have a positive effect on the cognitive and academic growth of intellectually disabled children. It also encourages learners to engage in an active learning process and develop themselves through instant feedback and performance targets. Gradually, this process helps students develop a sense of achievement and confidence, which fosters their intention to engage in new learning activities (Ha, S et al, 2022). The active and visual quality of AI applications makes the students interested and lowers the psychological cost of the traditional teaching procedure. Teachers can utilize adaptive technology in the classroom to enhance human interaction, resulting in more effective and engaging learning experiences (Kim & Kimm, 2017).

Statement of the Problem

The application of artificial intelligence in education is growing very fast. Recent literature has been based on general learning outcomes, enhanced attention, or emotional recognition in autism, whereas very little attention has been given to recognition-based cognitive development in children. There is very limited research available on the impact of AI on the recognition ability of children with mild intellectual disabilities. The use of AI technologies in special education is still in its early stages, and most studies have not yet been published. It is important to understand that AI-based apps can solve recognition problems. The gap highlights the need for a localized, evidence-based study on the assessment of AI-based apps, which may positively improve recognition ability in the cognitive development of children with mild intellectual disabilities.

Significance of the Study

The research could be helpful because it bridges a significant gap in the knowledge base on the use of artificial intelligence to enhance the recognition abilities of children with mild intellectual disabilities. Recognition ability can be improved with the use of AI-based apps that help students find objects, letters, and symbols, and help them better understand. The research can provide empirical data on the effectiveness of AI applications in enhancing recognition abilities, which may help future studies of AI-based interventions in the education of children with special needs. The study may improve recognition of boys with mild intellectual disabilities through AI apps, leading to more equitable educational opportunities.

Research Objectives

The following objectives were carried out to achieve the study's purpose to

1. identify the benefits of AI-based applications in improving recognition ability of boys with MID.
2. implement AI-based mobile applications to improve the recognition ability of boys with mild IDs during class activities.
3. examine the significant differences in the improvement of recognition ability among the boys with mild intellectual disability as a result of intervention phases with the use of AI-based apps.

Research Questions

The following research questions were used in the present study:

1. What are the benefits of AI-based applications in improving recognition ability of boys with mild intellectual disabilities?
2. How can AI-based mobile applications be implemented to enhance the recognition ability of boys with mild IDs during classroom activities?

3. Were there significant differences in the improvement of recognition ability among boys with mild intellectual disability as a result of intervention phases with the use of AI-based apps?

Literature Review

Children who are intellectually disabled are characterized by both the substantial constraints on intellectual functions (relevant reasoning, learning, and problem-solving) and adaptive behavior (day-to-day social and practical skills) that commence during the developmental stage. The American Association on Intellectual and Developmental Disabilities (AAIDD) defines intellectual disability as a significant limitation in both intellectual functioning and adaptive behavior that begins before age 22 (AAIDD, 2021). As reiterated by the American Psychiatric Association (APA), the diagnosis includes conceptual, social, and practical adaptive functioning deficits, besides the early onset (APA, 2013; Boat et al., 2015).

"Mild intellectual disability" refers to the category in which intellectual and adaptive functioning are roughly 2 to 3 standard deviations below the mean, and these individuals typically reach academic skills comparable to about the fourth- to fifth-grade level with support. It is estimated that about 85% of intellectual disabilities fall into the mild category (Patel, 2020). According to Lindblad, 2017 & Fernell 2025, a mild intellectual disability typically has a prenatal or perinatal etiology, but it is rarely able to be identified as a specific etiology compared to more severe cases. This means that for many children with MID, the precise cause remains unknown, yet the functional impact in schooling and adaptive behaviour still warrants focused support. Children with MID often demonstrate slower acquisition of new skills, struggle especially with abstract or theoretical thinking, and require structured interventions to progress effectively. For example, they may learn concrete tasks but face challenges transferring learning to new contexts or solving complex problems independently (Patel, 2020). Nouwens et al. (2017) conducted a latent-class analysis showing that persons with MID display diverse profiles of individual strengths and environmental needs, which means interventions need to be tailored rather than one-size-fits-all. Because recognition tasks (such as identifying letters, symbols, faces or emotions) require quick cognitive processing, memory, attention, and generalization skills, children with MID might benefit from specially designed, scaffolded instructional methods and technological supports that scaffold recognition and retention.

Recognition Ability

Recognition ability is an essential cognitive process, which allows one to distinguish and identify previously familiar information like objects, letters, words, faces, and sounds. It is an important process of connecting perception and memory as well as learning and understanding. Recognition is the process of comparing the incoming sensory information with the mental representations that are in the store and enables the learner to relate new information with what they already know (Ahmed et al, 2021). This process has been regarded as a component of functioning of long-term memory in cognitive psychology, which is necessary to develop conceptual knowledge and efficient retrieval of knowledge. A number of learning domains are based on recognition skills. Indicatively, in the case of reading development, correct perception of letters and symbols is a precursor to subsequent recognition of the words and their understanding (Acha et al., 2023). Equally, visual pattern or face recognition skills are elements that help in social interaction and emotional cognition (Eremeev, 2019).

Children with mild intellectual disability may experience difficulties in recognition tasks because of the impairment of attention, working memory, and processing speed (Nelwan et al, 2022). Research has shown that the word and symbol recognition of such learners is slower and that they require repetitive and scaffolded exposure to memorize new information (Nilsson et al., 2021). The problem of recognition may produce the delay of reading fluency, comprehension, and adaptive communication.

Fujino et al. (2020) proved that letter recognition can be reinforced with the help of specific technology-based interventions and that early literacy can be supported in children with severe intellectual disabilities. Similarly, Dawson et al. (2002) and Wilson et al. (2010) indicated that failure to recognize faces and objects is associated with less neural activity in developmentally delayed children, highlighting the cognitive nature of the recognition capability. The enhancement of recognition, then, is not only a part of academic learning but also normal functioning and social comprehension.

Artificial Intelligence

Artificial intelligence offers even greater potential through adaptive learning experiences built upon it. AI-based applications can monitor students' progress, detect attention lapses, and adjust the activity to speed up, slow down, or change to keep students engaged. For children with intellectual disabilities, personalized teaching enables them to learn more effectively than the conventional approach, making the learning process more accessible and engaging. Recent research has demonstrated that AI-based tools can not only improve academic performance but also train fundamental cognitive skills through interactive, gamified, and motivating learning experiences (Hussein et al., 2025; UNESCO, 2023).

The best way to deliver AI-based interventions in the classroom or at home is through mobile apps. They are portable, relatively inexpensive, and applicable by teachers and families, making them suitable for educational institutions with limited resources (Breitwieser et al., 2024). Mobile applications powered by AI offer interactive, gamified, and adaptive learning tasks that can help retain children with intellectual disabilities during lessons. According to recent studies, adaptive learning platforms and AI-based instructional games have been shown to benefit children's attention, motivation, and learning performance (Wang et al., 2024; Hussein et al., 2025). This means that AI-based mobile applications can be widely used to complement traditional forms of instruction and can be applied to address one of the most common problems in special education, especially in children, which involves enhancing recognition abilities (Barua, et al. (2022).

D Despite these benefits, the effectiveness of AI-based apps in the classroom depends on teachers' attitudes and readiness to implement this technology. As demonstrated, the majority of teachers already recognize the potential of AI tools to enhance engagement and attention, but they also note the lack of training, resources, and concerns about data privacy (UNESCO, 2023). In developing countries, the barriers may be even greater, as schools may lack infrastructure or financial support. The way teachers perceive the usability, potential, and efficiency of AI applications is therefore critical to the application of AI in the classroom and to the creation of professional development programs that meet the unique needs of teachers.

The literature indicates that technology-based interventions can enhance recognition ability and learning in children with various developmental challenges. Children can be motivated and kept focused during lessons with the use of AI, game-based programs, and mobile applications. They are not only tools that aid academic skills but also assist children in building core skills, including recognition ability, which is vital to the learning process. Only a small number of studies examine children directly with intellectual disabilities, and even fewer experiment with these interventions in actual classroom environments in third-world countries. For this reason, it is timely and essential to study the application of AI-based mobile apps to enhance recognition abilities in children with MID (Zhang et al., 2024).

Artificial Intelligence-based Mobile Apps

An app, also known as a mobile application, is a particular category of software that is supposed to be executed on the mobile phone, tablet, or gadget with a touchscreen (Chung et al., 2024). The reason why these applications are popular is due to convenient and easy to use services offered. There are a lot of different mobile apps such as games, calculators, web-browsing applications and educational platforms. The majority of mobile applications are small, purpose-oriented and can be easily accessed which makes them very convenient in day-to-day life. Mobile apps can go beyond their basic functionality, and provide adaptive, interactive, and personalized learning experiences, which can be especially useful in learning and special needs. These educational apps can best be used by a special education teacher to interest his students and improve recognition ability (Beili, et al., 2024).

Here, these artificial intelligence apps are very important in augmenting the early cognitive growth. Such apps as Khan Academy Kids and ABCmouse help to develop attention and recognition abilities with the help of visual and interactive tasks, and such games as Osmo and Toca Boca stimulate solving problems and creativity. Adaptive learning platforms, such as DreamBox Learning and Duolingo, tailor lessons, which helps retain memories and learn a language. Such tools as CogniFit are aimed at enhancing the fundamental cognitive abilities which include attention, logical reasoning, and working memory. On the same note, Proloquo2Go supports nonverbal communication, allows children to communicate their thoughts and emotions, and Bee-Bot provides a child with the basic ideas of sequencing and logical thinking, through a play-based way. Together, these technologies enable children to gain dynamic, responsive, as well as inclusive, learning experiences, which in turn enables the teacher and parents to develop children in various aspects of cognition (Faiz & Hina 2024).

Importance for Teacher in Using AI Applications in the Classroom

The application of AI contributes to better personalization of lessons by teachers and monitoring the progress of each student. It also conserves time on the routine chores which enables the teachers to concentrate on meaningful and creative instruction.

Self-paced learning

AI-based applications have the potential to adapt learning content to a child's needs and capabilities. This simplifies the learning process, allowing students to understand simple concepts more quickly. According to John McCarthy, artificial intelligence is the attempt to simulate human thought and create machines that behave like humans (Muttaqin, 2025).

Increase Motivation Level

Teachers can engage children using AI applications and motivate them to learn more. Gamified elements and engaging multimedia will make students more eager to participate in the lessons. In education, AI can improve educators' work and automate and simplify administrative tasks (Muttaqin, 2025).

Development in Thinking

Interactive activities and games allow children to train their thinking and be creative with the assistance of AI applications. These activities foster problem-solving and thinking, which are required for cognitive and overall development (Zhou & Peng, 2025).

Self-Paced Learning

AI apps also customize learning resources based on each child's responses and capabilities, making the process more personalized and efficient. These applications could be used to help children learn simple concepts like numbers, letters, shapes, and colors in an interactive way, allowing them to learn at their own pace without being overburdened or bored (Urmeneta & Romero, 2024).

Fun & Interactive Learning

AI-related apps often use gamification, a combination of play and learning. This method makes children active during classes. An example is the educational robots Cozmo and Pibo, which learn cognitive skills by playing games, as they have direct interaction with children, making learning more fun and inspiring (Chung, 2025).

Availability of Learning Materials
AI offers numerous learning resources, and children can discover material not in the standard curriculum. Such exposure enriches them and expands their knowledge base. AI also facilitates students' easy access to and use of interactive educational resources (Urmeneta & Romero, 2024).

Monitoring Child Progress
Through AI-based applications, a teacher and parents can easily monitor the cognitive growth of a child. The information these tools provide helps identify each child's strengths and weaknesses to facilitate more targeted learning support (Faiz & Hina, 2024).

Use of AI Apps in the Improvement of Recognition Ability
Mobile educational applications based on AI can be instrumental in enhancing children with IDs' recognition abilities. These apps are also interactive, with colorful pictures, sounds, and animations, and even the activities are gamified, making them attractive and captivating to a child. Most of them utilize adaptive learning, adjusting the activities' difficulty based on the child's performance to avoid boredom or disinterest. Studies have demonstrated that this type of digital intervention can decrease off-task behavior, enhance engagement, and reinforce central cognitive skills that facilitate learning (Wang et al., 2024). These applications can serve as effective aids that help children with intellectual disabilities improve their recognition skills through interactive, customized practice.
AI applications in special education have created new opportunities to overcome attention difficulties in children with intellectual disabilities. Artificial intelligence-powered applications, such as digital therapeutics and adaptive learning software, offer structured, interactive, and gamified tasks to keep learners engaged and gradually improve recognition ability. Research in educational technology suggests that these tools can reduce distractions, enhance focus, and cultivate the cognitive skills essential to academic success. Although most of these interventions have been applied to children with learning deficits, little evidence exists for their application in the classroom with children with intellectual disabilities (Fazil & Faiz, 2022).
Therefore, it is essential to explore AI-based mobile apps for children; this way, we can enhance their hidden abilities. The trend to employ AI tools in the educational process is increasing. Nevertheless, very little literature has been done on the ways these tools can enhance recognition skills among children with intellectual disabilities, particularly in the classrooms of the less developed world. Available literature is centered on general education, which leaves a knowledge gap in the provision of education to students with intellectual disabilities. This research was necessary to test the feasibility of AI-based mobile applications for children in special education schools with difficulties in recognition skills, aiming to enhance their recognition abilities. The intent was to ensure that teachers could reap the benefits of these apps by implementing them in their classrooms.

Methodology
The research design used in this study was a single-subject experiment with repeated measures (Cranmer, 2017; Thyer, 2012; Jimenez, 2018) to determine the effect of AI-based mobile app in enhancing recognition ability among boys with mild intellectual disabilities. This design involved repeated measurements of the performance of each individual at various stages: before the intervention (baseline), during the intervention, and, after the intervention was completed (Fabrizi & Winston, 2016). Every child was his control, and this had the advantage of making individual progress easy to observe instead of group comparisons. This design was deemed suitable due to a small number of students and the interventions had to be provided in a very personalized way that is characteristic of special education research (Alqraini, 2017).

Population and Sample
The study population was a sample of boys with mild intellectual disabilities studying in

government special education schools in Punjab, Pakistan. Seven students aged 8 to 14 years from the Government Special Education Centre (03-Remaining Disabilities), Okara, were selected from the population based on the inclusion criteria. The following criteria were used to select them: (a) a disability certificate of mild intellectual disability, (b) teachers reports of problems with maintaining attention, and (c) parental written consent to participate. Only boys were selected for this study. The researchers reviewed several articles on the applications of artificial intelligence and identified two mobile applications to use in the study: Khan Academy Kids and CogniFit. The apps were selected due to having AI features, which included personalization, adaptive content, and feedback. They were child friendly, easy to use by teachers and students and assist in recognition ability and learning in the classroom activities involving the child with special needs.

Procedure for Implementing the Intervention Plan

The intervention took place over 12 weeks, with 25 structured classes. Each session was about 10 minutes, and after every session there was a 5-minute break to prevent exhaustion and ensure that the students were engaged. Each session was conducted one-on-one, allowing each participant to receive individual attention. The main instructional materials were AI-based applications (Khan Academy Kids and CogniFit). These apps were chosen because they could deliver adaptive, interactive, and engaging activities that meet the learning requirements of children with intellectual disabilities. The lesson plans were prepared to support all the activities, and they were formulated as per the curriculum guidelines given by the Punjab Department of Special Education.

Research Instrument for Data Collection

For this study, the researchers developed a checklist to measure the students' performance. The checklist consisted of 25 tasks that could be observed, and they were used to measure progress in recognition ability. All tasks were evaluated using a 5-point Likert scale, with responses ranging from very poor to excellent. The same checklist was used to measure improvements, with three administrations taken as baseline (pre-intervention), mid-intervention, and post-intervention. Such a repeated-measures methodological approach was necessary to ensure that variations in recognition ability levels could be tracked and compared across the various stages of the intervention. To ensure fidelity of implementation, the researchers carefully followed the session's structure, consistently applied AI-based applications, and provided equal exposure time to all participants.

Data Analysis & Interpretation

SPSS Version 27 was used to analyze the quantitative data. The scores for recognition ability obtained at three stages of the intervention (pre-test, mid-test, and post-test) were initially summarized using simple statistics (mean). This gave a basic picture of how students performed at each stage. Since the data did not meet the assumptions of normality, nonparametric tests were used. The Friedman test was applied to check whether there were any meaningful differences in recognition ability scores across the three stages. This test was suitable because it works well with repeated measures when the data are not normally distributed. When the Friedman test showed a significant difference, further analysis was carried out to identify at which stage the changes occurred. The Wilcoxon signed-rank test was then used to compare scores between each pair of stages (pre-test vs. mid-test, pre-test vs. post-test, and mid-test vs. post-test). The level of significance was set at $p < .05$, indicating that the results were considered statistically significant if the probability of error was less than 5%. The findings presented demographic data on the participants, including their ages. The result was the continuous improvement of the recognition ability scores during the three stages of the interventions. The line graphs were the most evident in demonstrating the improvement between pre, during, and post-interventions, with rising trends.

Demographic Distribution
Table 1
Classification of respondents age-wise

Age	Frequency	Percent
8	01	14.3%
9	01	14.3%
10	01	14.3%
11	01	14.3%
12	01	14.3%
13	01	14.3%
14	01	14.3%
Total	07	100.0%

Table 1 depicts the respondents' age group. The sample comprised seven students aged 8-14 years. One participant represented each age group (8, 9, 10, 11, 12, 13, and 14 years), totaling 14.3 percent of the overall sample. This indicates that respondents were evenly distributed across age groups, ensuring balanced representation of children within the target age range.

Figure 1
Line graph 1 shows student 1's performance (pre, during, and post) across 25 tasks.

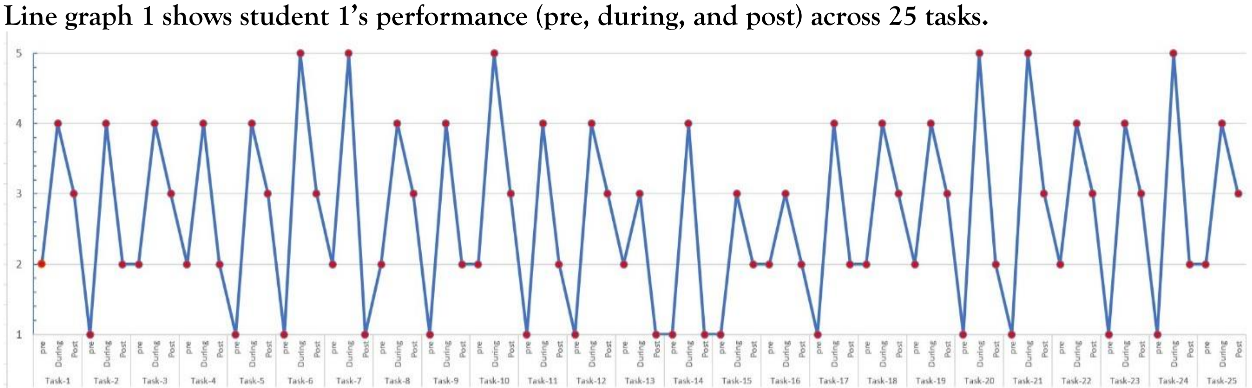

Figure 1 illustrates the performance of student 1 in 25 recognition tasks that aimed to enhance the recognition ability with the help of AI-based apps. The performance of student was measured regarding a five-point scale and at three levels. The scores used in the pre-test phase were mainly low with a range of between 1 and 3 implying that the recognition skills were weak at the beginning. The performance of the student was slowly improving during the intervention, as the student completed several tasks on the level of 4 and 5, indicating that the AI-based apps facilitated the recognition ability. During the post test, the majority of tasks were rated on level 4 or 5, which indicates an evident and consistent progress on the level of a baseline. Despite the fact that the certain variation was observed between the tasks, the general tendency demonstrates good improvement in recognition capabilities following the intervention, which indicates that the AI-based applications proved to be efficient to improve the recognition abilities of the student.

Figure 2

Line graph 2 shows student 2's performance (pre, during, and post) across 25 tasks.

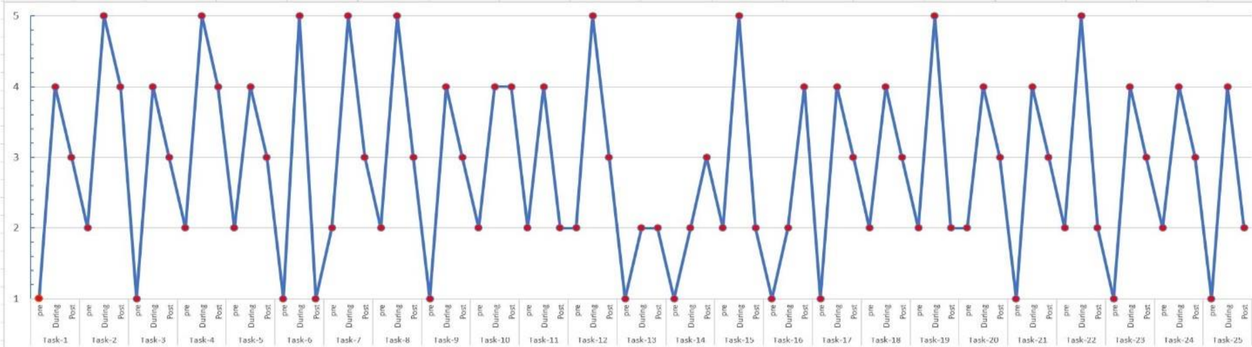

Figure 2 shows that student 2 performed 25 recognition tasks designed to enhance recognition capability using AI-based mobile applications. The student's performance was measured on a five-point scale across three phases. During the pre-test phase, negative scores predominated, with most scores ranging from 1 to 3, indicating low initial recognition ability. The student's performance also improved over time, with several assignments achieving levels 4 and 5, indicating that the AI-based applications assisted the student in improving their recognition ability. The scores were also higher in the post-test phase than at baseline, indicating continued improvement beyond the intervention period. Even though minor differences emerged across the tasks, the overall trend was an apparent increase in recognition, indicating that the AI-implemented applications were highly effective in stimulating student's recognition ability.

Figure 3

Line graph 3 shows student 3's performance (pre, during, and post) across 25 tasks.

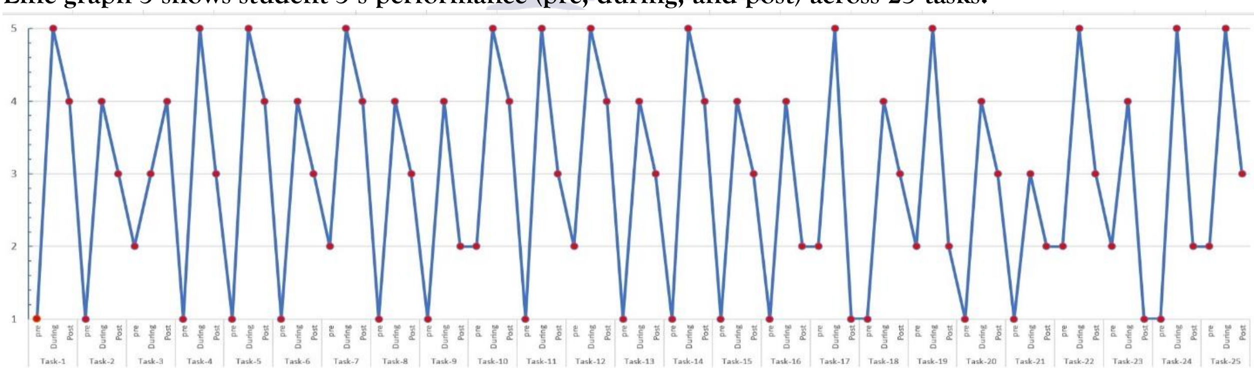

Figure 3 presents the results of student 3 in 25 recognition tasks aimed at enhancing recognition capability with the help of AI-based mobile apps. The performance of the student was measured on a five-point scale at three points, pre, during and post tests. The scores recorded in pre-test stage were relatively low ranging between 1 and 3 as a result of weak recognition skills prior to the intervention. The performance of the student also improved over the course of the intervention and some of the tasks were on level 4 and 5, which means that the AI-based apps contributed to improving recognition of responses. At the post-test stage, the scores were still higher than at the baseline, which indicated that the student still stored a lot of the improvement, obtained during the intervention. Though it had slight variations in some tasks, the tendency is evident in general with a continuous improvement, which proved that the AI-based applications helped to boost the recognition ability.

Figure 4

Line graph 4 shows student 4's performance (pre, during, and post) across 25 tasks.

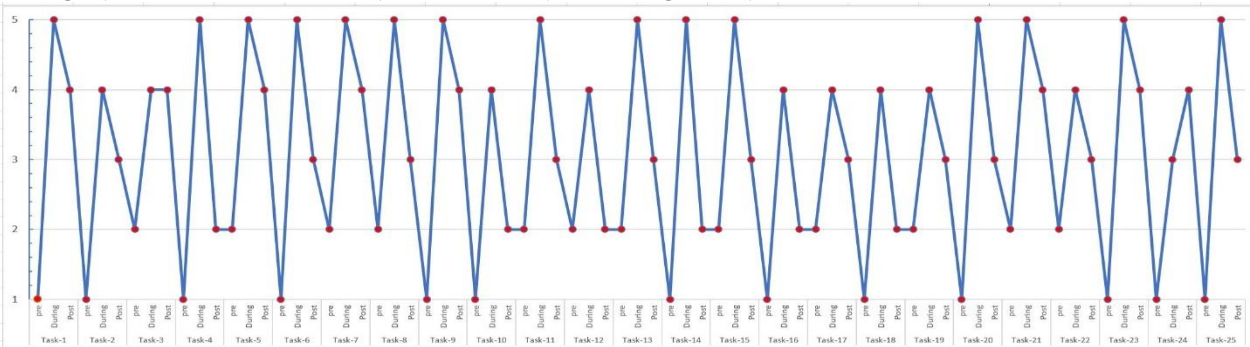

Figure 4 indicates the performance of student 4 in 25 recognition tasks to enhance recognition capacity via AI-based mobile applications. The performance of the student was measured based on a five-point-scale in three stages. During the pre-test period, the scores were predominantly low ranging between 1 and 3 indicating poor recognition abilities at the pre-intervention stage. The scores were better during the intervention, and a significant number of tasks went to levels 4 and 5, which implies that the AI-based applications assisted in enhancing the recognition. The scores were also maintained in the post-test stage being higher than at the pre-test stage and this indicates that the student retained most of the learning acquired during the activities supported by AI. Despite certain variations between tasks, the general trend was evidently consistent improvement which proves the fact that AI-based applications was successful in enhancing the recognition.

Figure 5

Line graph 5 shows student 5's performance (pre, during, and post) across 25 tasks.

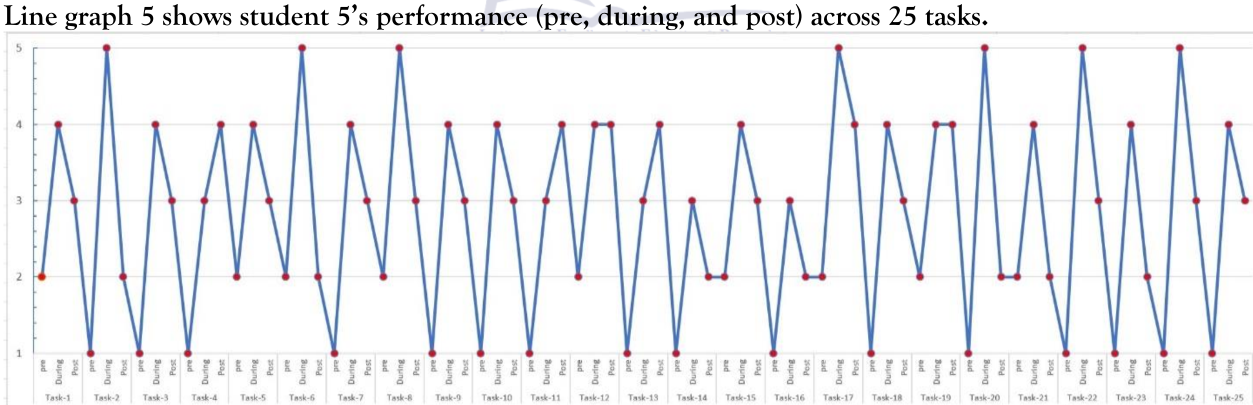

Figure 5 shows that student 5 completed 25 recognition tasks to enhance recognition capacity using AI-based mobile applications. The student's performance was measured on a five-point scale at three stages: pre-test, during-test, and post-test. The pre-test scores were generally low, ranging from 1 to 3, with weak recognition capabilities evident before the intervention. The scores were significantly higher during the intervention, with some tasks at levels 4 and 5, indicating that the AI-based applications helped the student improve recognition. The post-test scores were also high compared to the pre-test, suggesting learning retention at the end of the intervention. Though specific differences were observed across the tasks, the general trend indicates consistent improvement, demonstrating that the AI-based applications were effective in enhancing recognition ability.

Figure 6
Line graph 6 shows student 6's performance (pre, during, and post) across 25 tasks.

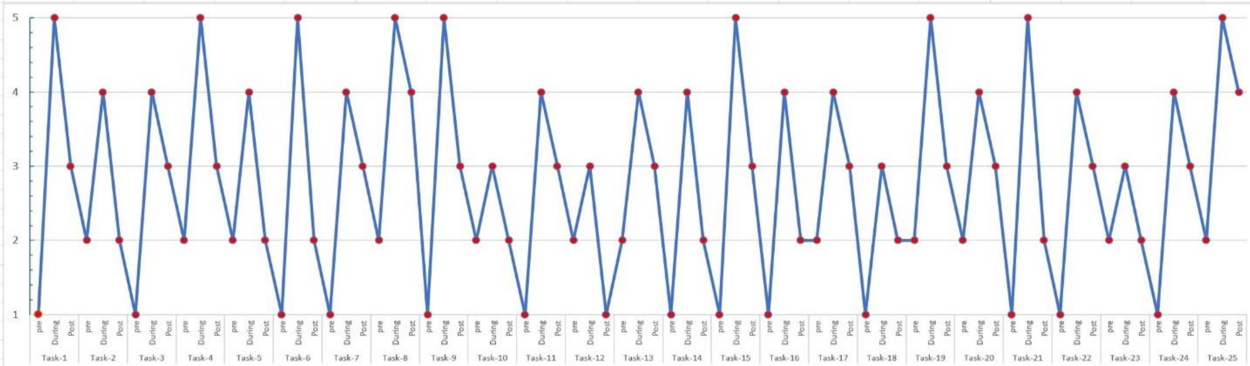

Figure 6 depicts the performance of student 6 across 25 recognition tasks to improve recognition ability using AI-based mobile applications. The performance of the student was graded based on a five-point scale in three phases (pre, during and post test). During the pre-test phase, most scores were low, ranging from 1 to 3, indicating weak recognition skills prior to the intervention. The improvement was evident during the intervention because some of the tasks were completed on level 4 and 5, which indicates that the AI-based apps assisted the student in becoming more skillful in recognition. The post-test scores were higher than the pre-test scores, showing that student improved even after the intervention. Although specific tasks showed fluctuations, the overall trend was a consistent improvement, and it is clear that AI-based applications are effective at enhancing recognition abilities.

Figure 7
Line graph 7 shows student 7's performance (pre, during, and post) across 25 tasks.

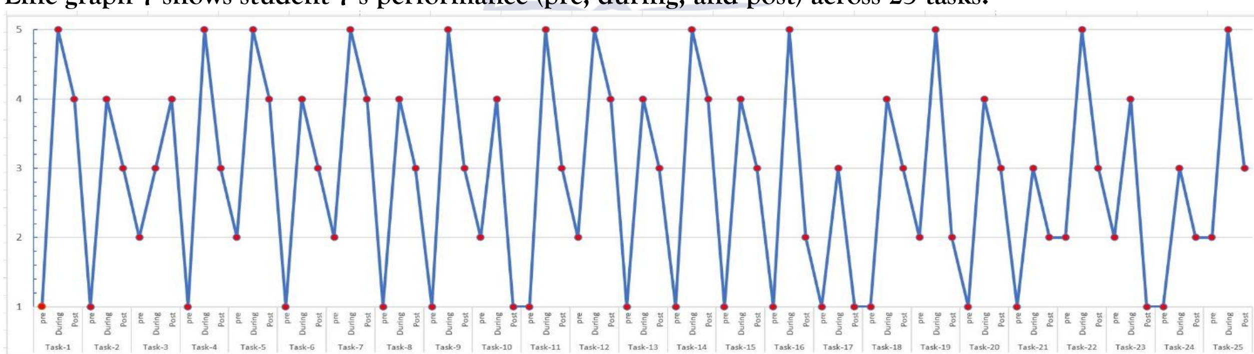

Figure 7 shows how student 7 performed on 25 recognition tasks to enhance recognition ability through AI-based mobile applications. The student's performance was evaluated on a five-point scale across three stages. The scores were relatively low in the pre-test phase, with most results ranging from 1 to 3, indicating a lack of recognition skills before using AI tools. The scores were also positive during the intervention stage as some of the tasks were on levels 4 and 5, indicating that the AI-based applications were beneficial in terms of recognition. During the post-test period, scores remained higher than during the pre-test, indicating that the enhancement persisted following the intervention. Despite the slight differences that occurred with some of the tasks, the general trend is evident and clearly indicates an upward trend which shows that the AI-based mobile applications were indeed effective in enhancing the ability in the recognition of the student.

Table 2

Friedman and Wilcoxon Test Results for Student 1's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.14	–	–	–
During-test	25	3.00	–	–	–
Post-test	25	1.86	–	–	–
Friedman Test	25		χ^2 = 45.34	2	< .001
During-Pre (Wilcoxon)	25		Z = −4.43	–	< .001
Post-During (Wilcoxon)	25		Z = −4.45	–	< .001
Post-Pre (Wilcoxon)	25		Z = −3.73	–	< .001

Table 2 shows the student 1's performance on 25 tasks that are about the ability to recognize in three stages. The rank of the pre-test mean (M = 1.14) was weak on how much they know at the baseline, and the rank of the during-test (M = 3.00) was strong as a result of instituting AI-based applications. The post-test mean rank (M = 1.86) was also lower but not below the baseline, indicating partial retention of gains. The Friedman test proved that there was a significant difference between the three phases, χ^2 (2, N = 25) = 45.34, p <.001 showing that the intervention was effective. Wilcoxon signed-rank test indicated a significant improvement between pre and during (Z = -4.432, p <.001), decline between during and post-test (Z = -4.456, p <.001) and maintained improvement between pre-test and post-test (Z = -3.734, p <.001). The findings, in general, demonstrate the presence of a significant improvement in the recognition ability due to AI-based mobile applications and that the ability was sustained even post-intervention.

Table 3

Friedman and Wilcoxon Test Results for Student 2's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.10	–	–	–
During-test	25	2.88	–	–	–
Post-test	25	2.02	–	–	–
Friedman Test	25		χ^2 = 42.60	2	< .001
During-Pre (Wilcoxon)	25		Z = −4.49	–	< .001
Post-During (Wilcoxon)	25		Z = −3.56	–	< .001
Post-Pre (Wilcoxon)	25		Z = −4.02	–	< .001

Table 3 presents student 2's performance across three phases. The pre-test mean rank (M = 1.10) was reflecting of weak performance on the baselines but the during-test mean rank (M = 2.88) was indicating a strong performance after application of AI-based apps. The mean rank of the post-test (M = 2.02) was higher than the baseline, which demonstrated partial retention of gains. The Friedman test has established the significant difference between the three phases, χ^2 (2, N = 25) = 42.60, p <.001, which means that AI intervention was effective to increase the recognition ability. The Wilcoxon test showed the significant improvement between the pre and during-test (Z = -4.496, p < .001), slight decrease between the during-test and post-test (Z = -3.567, p < .001) and the stability between the pre-test and post-test (Z = -4.021, p <.001). In general, student 2's recognition skill increased significantly throughout the intervention and was mostly retained post-intervention.

Table 4
Friedman and Wilcoxon Test Results for Student 3's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.10	–	–	–
During-test	25	2.96	–	–	–
Post-test	25	1.94	–	–	–
Friedman Test	25		χ^2 = 43.82	2	< .001
During-Pre (Wilcoxon)	25		Z = −4.52	–	< .001
Post-During (Wilcoxon)	25		Z = −4.27	–	< .001
Post-Pre (Wilcoxon)	25		Z = −4.12	–	< .001

Table 4 displays student 3's recognition performance at three stages: pre-test, during-test, and post-test. The pre-test mean rank (M = 1.10) indicated poor performance at the outset, while the during-test mean rank (M = 2.96) reflected a significant improvement in results following the use of AI-based mobile applications. The post-test average rank (M = 1.94) did not fall below the baseline, suggesting a partial continuation of the learning benefits. The Friedman test showed a significant difference among the three phases, $\chi 2$ (2, N = 25) = 43.82, $p < .001$, indicating that the intervention is effective. The Wilcoxon test displayed a significant increase between pre-test and during-test (Z = -4.521, p = 0.001), a slight decrease between during-test and post-test (Z = -4.275, p = 0.001), and a sustained improvement between pre-test and post-test (Z = -4.125, p = 0.001). Overall, student 3's recognition ability was significantly enhanced throughout the AI-based intervention and remained at or above the initial level afterward.

Table 5
Friedman and Wilcoxon Test Results for Student 4's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.02	–	–	–
During-test	25	2.94	–	–	–
Post-test	25	2.04	–	–	–
Friedman Test	25		χ^2 = 47.08	2	< .001
During-Pre (Wilcoxon)	25		Z = −4.44	–	< .001
Post-During (Wilcoxon)	25		Z = −4.21	–	< .001
Post-Pre (Wilcoxon)	25		Z = −4.37	–	< .001

Table 5 indicates the recognition ability of student 4 at three phases, which include pre-test, during-test, and post-test. The pre-test mean rank (M = 1.02) indicated poor performance at baseline, and the during-test mean rank (M = 2.94) indicated a significant improvement in performance after using AI-based mobile applications. The post-test mean rank (M = 2.04) remained higher than the baseline, indicating partial retention of learning gains. The Friedman test revealed a significant difference across all stages, χ^2 (2, N = 25) = 47.08, $p < .001$, indicating that the intervention was effective. The Wilcoxon test showed that there was a significant increase between the pre- and during-tests (Z = -4.441, $p < .001$), a slight decrease between during- and post-tests (Z = -4.210, $p < .001$), and a maintained improvement between pre- and post-tests (Z = -4.371, $p < .001$). In general, student 4 showed a significant improvement in recognition skills that was higher than baseline at the post-intervention stage.

Table 6

Friedman and Wilcoxon Test Results for Student 5's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.04	–	–	–
During-test	25	2.84	–	–	–
Post-test	25	2.02	–	–	–
Friedman Test	25		χ^2 = 42.45	2	< .001
During-Pre (Wilcoxon)	25		Z = –4.45	–	< .001
Post-During (Wilcoxon)	25		Z = –3.59	–	< .001
Post-Pre (Wilcoxon)	25		Z = –4.28	–	< .001

Table 6 indicates the performance of student 5 in pre-test, during-test, and post-test. The rank of pre-test mean (M = 1.04) revealed a weak recognition ability initially and the rank of during-test (M = 2.84) indicated a significant improvement of AI-based mobile applications introduction. The post-test mean rank (M = 2.12) was also bigger than the baseline, and it indicated that the gains were mostly retained. The Friedman test showed that there was a significant difference between the three stages, χ^2 (2, N = 25) = 42.75, p < .001, which proved the effectiveness of the intervention. The Wilcoxon test indicated that there was a significant difference between pre-test and during-test (Z = -4.453, p < .001), minor differences between during- and post-tests (Z = -3.591, p < .001), and maintained improvement between pre-test and post-tests (Z = -4.283, p < .001). On the whole, the recognition ability of student 5 increased significantly in the course of the intervention and was higher than the original one after the intervention.

Table 7

Friedman and Wilcoxon Test Results for Student 6's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.12	–	–	–
During-test	25	3.00	–	–	–
Post-test	25	1.88	–	–	–
Friedman Test	25		χ^2 = 46.58	2	< .001
During-Pre (Wilcoxon)	25		Z = –4.42	–	< .001
Post-During (Wilcoxon)	25		Z = –4.48	–	< .001
Post-Pre (Wilcoxon)	25		Z = –3.92	–	< .001

Table 7 presents Student 6's recognition ability across three stages-pre-test, during-test, and post-test. The pre-test mean rank (M = 1.12) showed weak initial performance, while the during-test mean rank (M = 3.00) indicated a sharp improvement after exposure to AI-based mobile applications. The post-test mean rank (M = 1.88) maintained its position above the baseline, indicating the retention of some learning gains. The Friedman test confirmed a significant difference across all phases, χ^2(2, N = 25) = 46.58, p < .001, proving the effectiveness of the intervention. The Wilcoxon test showed a significant improvement between pre- and during-tests (Z = -4.429, p < .001), a small decline between during- and post-tests (Z = -4.481, p < .001), and continued improvement between pre- and post-tests (Z = -3.922, p < .001). Overall, Student 6's recognition ability improved considerably during the intervention and remained better than before.

Table 8
Friedman and Wilcoxon Test Results for Student 7's Performance Across Intervention Phases

Test / Comparison	N (tasks)	Mean	χ^2 / Z	df	p (2-tailed)
Pre-test	25	1.12	–	–	–
During-test	25	2.96	–	–	–
Post-test	25	1.92	–	–	–
Friedman Test	25		χ^2 = 43.43	2	< .001
During-Pre (Wilcoxon)	25		Z = –4.45	–	< .001
Post-During (Wilcoxon)	25		Z = –4.27	–	< .001
Post-Pre (Wilcoxon)	25		Z = –4.06	–	< .001

Table 8 shows student 7's recognition ability across the pre-test, during-test, and post-test stages. The pre-test mean rank (M = 1.12) indicated weak recognition performance at baseline, while the during-test mean rank (M = 2.96) showed strong improvement following the AI-based intervention. The post-test mean rank (M = 1.92) remained higher than the initial level, showing partial retention of learning. The Friedman test confirmed significant differences among all phases, $\chi^2(2, N = 25) = 43.43$, $p < .001$, verifying the effectiveness of the intervention. The Wilcoxon test showed significant improvement between pre- and during-tests (Z = –4.458, p < .001), a small decline between during- and post-tests (Z = –4.276, p < .001), and sustained gains between pre- and post-tests (Z = –4.076, p < .001). Overall, student 7 demonstrated strong progress in recognition ability that persisted beyond the intervention period.

Findings

The study found that all seven boys with MID showed a clear improvement in their recognition abilities after using AI-based mobile applications. At the pre-test stage, the students had low mean ranks (M = 1.02–1.14), indicating weak recognition skills. During the intervention, mean ranks rose sharply (M = 2.84–3.00), indicating a significant improvement in recognition performance. The post-test mean ranks (M = 1.86–2.12) continued to surpass baseline levels, indicating a partial retention of learning gains. The Friedman tests confirmed significant differences across all three phases (p < .001), while Wilcoxon signed-rank tests showed consistent improvement between pre- and during-tests and sustained progress between pre- and post-tests. The results prove that AI-based mobile applications significantly enhanced recognition ability, and the improvement persisted beyond the intervention period. Student 4 achieved a Friedman chi-square value of 47.08 (p < .001), the highest among all students, and showed consistently strong performance with a pre-test mean rank of 1.02, a during-test mean rank of 2.94, and a post-test mean rank of 2.04. This reflects both the largest overall improvement and strong post-test retention. The Wilcoxon signed-rank results further confirmed significant progress between the pre-test and during-test (Z = –4.441, p < .001), as well as sustained improvement between the pre-test and post-test (Z = –4.371, p < .001). Overall, student 4 performed the best among all seven participants.

Conclusion

This study concluded that the use of AI-based mobile apps significantly improved the recognition ability of boys with MID. The results showed that all seven students performed better during the intervention compared to the pre-test phase, confirming the positive impact of AI-based learning tools on cognitive development. Although a slight decline was observed after the intervention ended, the post-test results remained higher than the baseline, indicating that the improvement was partly retained. Among all participants, student 4 showed the highest level of progress and retention, demonstrating the strongest effect of the intervention. This study also concluded that AI-based mobile applications are effective, engaging, and practical tools for enhancing recognition ability and supporting continuous cognitive growth in special education classrooms.

Recommendations

This paper suggests that AI-based mobile applications get implemented in the special education classroom as a regular instructional aid in enhancing the recognition skills of students with mild intellectual disabilities. These electronic devices can establish interactive and personalized learning opportunities that encourage active engagement and critical thinking. Professional training and continuous assistance should also be offered to teachers so that they could effectively implement AI-based educational technologies. As teachers learn to implement these technologies in the most effective way, they will be able to more effectively differentiate lessons and ways to monitor student progress. Constant tracking and evaluation of the students' progress are also necessary to determine the effectiveness of AI interventions and to implement the required changes in the teaching strategies. It is also suggested that educational developers and policymakers should work together in order to create localized AI content, which fits the national curriculum, local languages, and culture. This customization would render the AI-based learning more accessible and special education-specific in Pakistan. Lastly, future studies must focus on the long-term effects of AI-based interventions on bigger and more diverse samples. These measures will contribute to the fact that AI-assisted learning becomes a lasting and fair component of the special education practices.

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