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Verification Strategies and Independence: Cash Reader Use Among Students with Visual Impairment

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A B S T R A C T

Students with visual impairment face persistent difficulties identifying rupiah banknote denominations because their distinguishing features primarily rely on vision, tactile codes deteriorate through circulation, and personal folding strategies are ineffective when receiving change from strangers. This study examined the Cash Reader application as assistive technology for transaction activities and its contribution to learning independence. A qualitative descriptive design involved five totally blind students in grades X and XI at SLB Negeri A Citeureup Cimahi, representing all students who met the inclusion criteria and were selected purposively. Data were collected through in-depth, semi-structured interviews addressing learning capability, application use, and constraints, then analyzed using Miles, Huberman, and Saldaña's interactive model. Validity was supported through verbatim quotations with participant codes, explicit boundaries for findings not confirmed by every participant, and an auditable trail linking raw statements, categories, and conclusions. Findings showed that participants used the application situationally during real transactions through a controlled, non-continuous pattern and learned to operate it through peer networks rather than formal instruction. Its use supported self-regulated learning through self-regulation, metacognition, and problem solving, while strengthening confidence in everyday transactions. However, critical engagement with the application's output varied among participants. Constraints included limited detection accuracy, dependence risk, and sensitivity to lighting conditions. Importantly, inaccuracies encouraged participants to develop personal verification strategies. Schools should therefore explicitly teach verification within daily living skills instruction, preserve foundational banknote-recognition abilities, and position assistive applications as complementary tools rather than complete substitutes for independent denomination-identification skills under diverse environmental and everyday transactional circumstances.

INTRODUCTION

The way disability is understood has undergone a fundamental shift over the past two decades (Zajadacz, 2015). The medical model, which framed disability as an individual condition requiring correction, has given way to social and functional models that locate barriers in the mismatch between an individual's capabilities and the demands of their environment (Tarsidi, 2012; Verbrugge & Jette, 1994). The consequence of this shift is practical: the success of special education services is no longer measured by how far limitations can be reduced, but by how far individuals are able to carry out their social and economic roles independently (Schmidt, 2022). In the context of independent living skills,

the ability to manage financial transactions is one of the crucial competencies that determine the economic participation of blind individuals in society.

Within this framework, adaptive behaviour becomes a key construct. Adaptive behaviour encompasses the conceptual, social, and practical skills that individuals learn and use in everyday life (Schalock et al., 2021). Among these three domains, practical skills bear the most direct relationship to independence because they concern activities that must be performed daily without assistance. The ability to handle money occupies a strategic position within this domain. The skill extends beyond recognising denominations to conducting transactions, understanding exchange value, and judging whether a price is reasonable. Failure to master it has layered consequences, ranging from dependence on others for the most basic needs to vulnerability to error and exploitation in transactions.

For individuals with visual impairment, this is precisely the skill that proves hardest to acquire. Banknote marking systems are designed on the assumption of sighted users, so that the principal distinguishing features between denominations, namely dominant colour, numeral size, and printed symbols, all rely on the visual channel (Fulvian et al., 2025). The loss of sight therefore does not merely reduce the sharpness of information; it severs the primary pathway for recognising monetary value. Hakobyan et al. (2013) note that visual access barriers constrain independence, safety, and quality of life in everyday functional activities. The effects are evident in practice: a transaction that for sighted people unfolds automatically within seconds becomes a situation demanding repeated verification, taking considerably longer, and ultimately often requiring the involvement of another person.

Efforts to address these barriers have rested on two approaches. The first involves physical modification of banknotes, namely size differences between denominations and the addition of tactile markings, as implemented on the rupiah through raised-dot blind codes (Hafiar et al., 2020). The second involves personal strategies, such as folding notes in distinct patterns according to denomination or separating them into different wallet compartments. Both leave fundamental problems unresolved. Tactile markings fade through circulation and become barely legible on worn or creased notes (Hafiar et al., 2020; Hartono & Cahaya, 2018), while folding strategies function only as long as users know the denomination from the outset, and therefore offer no help when receiving change from an unfamiliar person. In public transactions that demand speed, both approaches fail alike. This situation places individuals with visual impairment in a position of dependence on the honesty of others, with the attendant loss of financial privacy and exposure to costly errors.

The development of mobile assistive technology offers an alternative route around these limitations. Hakobyan et al. (2013) map how advances in information technology have widened the scope for mobile devices to support the independence of users with visual impairment, while Griffin-Shirley et al. (2017) report high levels of acceptance, with 95.4% of respondents rating specialised applications useful and 91.1% rating them accessible. Martiniello et al. (2022) reinforce this trend, finding that mainstream devices increasingly displace traditional aids, particularly for object identification tasks. On the instructional design side, Al-Azawei et al. (2016) underline the importance of providing multiple modes of representation so that material remains accessible to learners with diverse needs. Taken together, these studies establish that mobile assistive technology is accepted by users with visual impairment and increasingly integrated into their everyday routines.

The Cash Reader application is one concrete implementation of such technology. It detects the visual features of banknotes through a smartphone camera and converts them into audio output, making denominations accessible aurally (Csapó et al., 2015). Its strengths lie in the speed of feedback and its availability on commonly owned devices, although its accuracy remains affected by lighting conditions, camera quality, and the user's skill in operating it.

A preliminary study at SLBN A Citeureup found that the application was already being used by students with visual impairment in grades X and XI to identify denominations independently. Notably, knowledge of how to use it was acquired through peer networks rather than through formal classroom instruction. This points to a practice of technology use that unfolds independently and contextually, yet has never been documented or analysed systematically.

Three gaps follow from this body of work. First, existing studies stop at the level of adoption, perceived usefulness, and general device preference, and are dominated by survey designs that report aggregate figures without describing what users actually do with an application in the course of a transaction. Second, the currency-recognition function has received markedly less attention than navigation and object identification, even though money handling is the practical skill most directly tied to economic participation. Third, and most consequentially, no study has examined what users do when the technology fails: the strategies they construct when an application misreads a note, and what those strategies mean for their learning independence. Existing research therefore explains how far assistive technology is used, but not how it is learned, negotiated, and corrected in practice. It is this last gap that the present study addresses.

Addressing this gap is urgent on two counts. Practically, smartphone ownership among students with visual impairment has outpaced the capacity of schools to guide its educational use, so that a technology already embedded in students' daily transactions remains outside the curriculum and outside teachers' field of view. Without an empirical description of that use, schools have no basis on which to decide whether it should be facilitated, corrected, or supplemented. Pedagogically, an assistive application that is imperfectly accurate confronts its user with a choice between accepting its output and testing it, and that choice is precisely where learning independence is either built or eroded. Documenting how students negotiate it therefore matters for the design of daily living skills instruction that treats assistive technology as an object of learning rather than merely as a solution to a technical problem.

The novelty of this study lies in positioning a currency recognition application not merely as a compensatory aid for visual limitation, but as a medium that triggers the formation of self-regulated learning. This perspective shifts the focus of inquiry from how accurately the technology performs to how users construct strategies when that technology proves less than fully reliable. Unlike prior research measuring adoption rates and perceived usefulness in aggregate through surveys, this study traces usage practices that grow informally outside formal instruction, and treats the verification strategies users devise for themselves as an object of analysis.

Proceeding from this gap, the study aims to describe the use of the Cash Reader application in the transaction activities of students with visual impairment, to examine its contribution to self-regulation, metacognition, problem solving, and self-confidence, to trace how knowledge of its use is acquired, and to identify the constraints that accompany it. These four foci are directed towards establishing a basis for instructional strategies that integrate assistive technology with the strengthening of learning independence, so that the use of technology does not stop at solving technical problems but develops into a means of building sustainable independence.

METHODS

This study employs a qualitative approach with a descriptive design. The design was selected because the research aims to develop an in-depth understanding of how the Cash Reader application supports the independence of students with visual impairment, particularly in the context of everyday use and users' subjective experience. A qualitative approach allows the researcher to explore the meanings, perceptions, and dynamics of assistive technology use that cannot be captured through quantitative measurement. Creswell and Poth (2018) note that qualitative research is appropriate

when the researcher seeks to understand the meanings participants construct around a phenomenon within its natural setting. Consequently, the findings of this study are contextual to the setting examined and are not intended for statistical generalisation to the wider population of students with visual impairment.

The study was conducted at SLB Negeri A Citeureup Cimahi, a special school that has served since 1998 as a Resource Center for inclusive education in West Java and has integrated assistive technology into its educational services. The respondents numbered five students with visual impairment in grades X and XI, hereafter referred to by the codes P1 through P5. This figure represents the entire population of students at the school who met the inclusion criteria at the time of data collection, so that the five respondents constitute a complete rather than a partial sample of the eligible group. Participants were selected through purposive sampling, in which selection is deliberately directed towards individuals judged to be most information-rich in relation to the phenomenon under study (Creswell & Poth, 2018; Maxwell, 2009). Four inclusion criteria were applied: (1) enrolment in grade X or XI at the research site; (2) total blindness, so that the usage patterns identified would reflect the complete absence of visual access rather than the use of residual vision; (3) prior and active use of the Cash Reader application in everyday transactions, established through the preliminary study; and (4) willingness to take part and to recount personal experience openly, confirmed through informed consent. Students who owned a smartphone but had never used the application, and students with residual vision, were excluded on the ground that their accounts would not speak to the phenomenon under study.

Data were collected through in-depth interviews using a semi-structured interview guide, designed to preserve flexibility of inquiry while remaining focused on the study's concerns. The semi-structured format was chosen because it allows the researcher to pursue participants' accounts in depth without departing from the prepared framework of questions (Alshenqeeti, 2014; Creswell & Poth, 2018). The interview guide covered three domains. The first concerned students' learning capabilities, including independence in operating the application, control over its use according to need, how they evaluated detection results, strategies adopted when errors occurred, the source of their knowledge about the application, and its effect on their self-confidence. The second concerned the conduct of use, covering the timing, manner, and frequency of application use. The third concerned the constraints encountered, whether arising from the application's accuracy or from the conditions of the environment in which it was used. Inquiry was also directed towards participants' accounts of concrete experiences using the application in real transaction situations.

The research procedure began with a preparatory stage covering instrument development and participant selection. This was followed by interviews with all five participants, conducted individually so that each could recount their experience without being influenced by their peers' responses. Once the data had been gathered, data condensation was carried out to sort relevant information, followed by data display in the form of descriptive narrative. The final stage involved drawing conclusions on the basis of the patterns that emerged.

Data were analysed using the interactive model of Miles, Huberman, and Saldaña (2020), which proceeds cyclically through data condensation, data display, and the drawing and verification of conclusions. Data condensation involved sorting statements relevant to the study's focus and then grouping them into the categories of learning independence, self-regulation, metacognition, problem solving, contextual learning, and self-confidence. Trustworthiness was maintained through the presentation of verbatim quotations accompanied by participant codes for every finding, allowing readers to trace the empirical basis of each conclusion drawn, and an auditable record was kept linking raw statements to the categories and conclusions derived from them. It should be noted that each aspect of the findings rests on the accounts of some participants and was not confirmed by all five,

so that the findings are to be understood as a portrait of emerging practice rather than a pattern holding uniformly across all participants. The analysis focused on identifying the benefits of the Cash Reader application for participants' independence, together with the factors supporting and hindering its use.

RESULTS AND DISCUSSION

Research Setting

SLB Negeri A Citeureup Cimahi has a well-established institutional foundation in providing educational services for students with visual impairment. The institution was founded in 1984 as a branch of SLB Negeri A Pajajaran Bandung. Its institutional status was subsequently formalised through Decree No. 0885/O/1986 of the Minister of Education and Culture of the Republic of Indonesia, dated 22 December 1986, which established its change of status to SLB Negeri A Citeureup Cimahi. This decree provides the legal basis for the delivery of special education to students with visual impairment in Cimahi and the surrounding region.

In line with shifting demands for special education services, the function and role of SLB Negeri A Citeureup Cimahi underwent significant transformation from 1998 onwards. The institution is no longer confined to delivering formal education but has developed into a Resource Center serving as a hub of support for the implementation of inclusive education across West Java. This transformation was subsequently reinforced through Decree No. 421.9/6843.SK-PLB/2005 of the Head of the West Java Provincial Education Office, dated 26 September 2005. The school thus functions not only as an educational institution but also as a provider of services, learning resources, and professional support in the field of special education.

These institutional conditions indicate a readiness to integrate innovative instructional approaches, including the use of technology in education. In this context, the use of technology at the school is oriented not only towards improving academic attainment but also towards developing functional skills related to Activities of Daily Living (ADL).

Within this ecosystem of services, the Cash Reader application is used as an aid for recognising banknote denominations, a skill that forms an essential component of ADL. The school's institutional position as a Resource Center means that the use of this application is not a standalone intervention but part of a wider practice of technology use already established within the school.

Students' Learning Capabilities

Table 1. Students' Learning Capabilities by Participant Code

No	Aspect	Finding	Interview Quotation
1	Learning independence	Students can use the application independently without help from others	"this application helps users find out the denomination independently without having to depend on other people" [P1]
2	Self-regulation	Students control their use of the application according to everyday need	"usually used when I want to make a transaction such as buying something or receiving money" [P2]
3	Metacognition	Students evaluate results by rescanning and comparing outputs	"I scan repeatedly and decide based on the result that comes up most often" [P3]
4	Problem solving	Students have a strategy when the application misdetects	"if it says Rp2,000 more often, then I conclude it is Rp2,000" [P4]
5	Contextual learning	Students learn from their social environment rather than formal instruction	"I found out about the application from friends, such as technology groups" [P5]
6	Self-confidence	Using the application increases confidence and independence	"I feel more independent in managing money and do not always rely on other people" [P1]

Source: Interview data processed by the authors (2025)

The findings in Table 1 show that use of the Cash Reader application contributes to both cognitive and affective dimensions of participants' experience. In terms of learning independence, P1 reported that the application helped him identify denominations without depending on others. This account marks the emergence of an autonomous pattern of learning, in which access to information is no longer mediated through another person.

Indications of controlled use emerge from accounts of when the application is employed. P2 stated that it is used when about to make a transaction or receive money, while P4 emphasised that it is not used at all times but only when needed. Both accounts point to use tied to particular needs, although the available data are insufficient to establish whether this reflects deliberate self-control or simply follows situations that call for denomination recognition. Such selective use may be read as an early indication of self-regulation as understood within the framework of self-regulated learning (Zimmerman, 2002).

Metacognition is most visible in P3, who scans repeatedly and then decides on the basis of the result appearing most frequently. This practice indicates active monitoring and evaluation of the application's output, consistent with the performance-monitoring and self-reflection phases of regulated learning (Zimmerman, 2002). The participant does not accept the technology's output as final but tests it first.

This strategy extends into problem-solving capability. P4 explained that if the application more often says Rp2,000, then that is the denomination concluded. This approach resembles frequency-based reasoning deployed to reduce uncertainty, and reflects the use of strategy in ill-structured situations as described by Jonassen (2011). Notably, the strategy was devised by the participant without formal instruction.

A similar pattern appears in how participants came to know the application. P5 learned of it through friendship networks such as technology groups rather than through classroom instruction. This finding shows that mastery of assistive technology can develop through informal social channels, and helps explain why usage practices vary between participants.

In terms of self-confidence, P1 reported feeling more independent in managing money and not always relying on others. This account indicates a strengthening of self-efficacy, understood as belief in one's capability to organise and execute the courses of action required to manage particular situations (Bandura, 1997). The application's effect thus extends beyond the technical capacity to identify denominations to participants' confidence when facing real transactions.

Conduct of Application Use

Table 2. Conduct of Application Use

No	Aspect	Finding	Interview Quotation
1	Timing	Used in specific situations such as transactions	"used when buying something or receiving money" [P2]
2	Manner of use	Pointing the camera at the note for detection	"you just point it at the money and it reads out the denomination" [P5]
3	Frequency	Not used continuously, only when needed	"not all the time, only when necessary" [P4]

Source: Interview data processed by the authors (2025)

Use of the Cash Reader application at SLBN A Citeureup Cimahi is situational, arising primarily when students are in real contexts such as making a transaction or receiving money. Use begins with downloading and installing the application from the Play Store on a smartphone, after which the user grants the permissions required, such as camera and audio access, for the application

to function properly. Once ready, students operate it by pointing the device camera at the banknote or coin to be identified, whereupon the system automatically delivers the denomination as audio output.

In practice, using the application requires adjustments to distance, camera angle, and lighting conditions for more accurate detection. Simplicity of operation accelerates mastery, as P5 described: the device is simply pointed at the note and the denomination is read aloud. Such ease indicates a good level of accessibility and aligns with the principle of providing multiple modes of representation so that material and information remain accessible to users with sensory barriers (Al-Azawei et al., 2016).

Frequency of use, meanwhile, reveals a consistent pattern of control. P4 emphasised that the application is not used at all times but only when required. This pattern reinforces the findings on self-regulation and reflects the capacity of regulated learners to adapt strategies to situational demands (Broadbent & Poon, 2015). With repeated use, participants became more skilled, so that identifying denominations proceeded more quickly and merged into everyday activity. The conduct of application use may therefore be judged effective, since it addresses participants' real needs without developing into excessive reliance.

Constraints in Application Use

Table 3. Constraints in Application Use

No	Aspect	Finding	Interview Quotation
1	Detection error	The application sometimes misreads the denomination	"sometimes it says the wrong denomination" [P3]
2	Dependency	Potential dependency on the application	"I use the application more often than checking manually" [P2]
3	Environment	Lighting affects detection results	"if it is dark it sometimes cannot be read" [P5]

Source: Interview data processed by the authors (2025)

Alongside these benefits, use of the Cash Reader application encounters a number of constraints. Limited accuracy is the first, as P3 reported that the application sometimes states the wrong denomination. It is precisely this limitation that prompts the strategy of repeated scanning, so that a technical shortcoming on one side functions as a trigger for the development of metacognitive capability on the other.

The second concerns potential dependency. P2 admitted using the application more often than checking manually. This account merits attention because it shows that critical engagement with the application's output is not evenly distributed among participants. For P3 and P4, doubt about detection results gave rise to verification strategies, whereas for P2 the application's convenience displaced the habit of checking independently. This variation shows that motivation and self-regulation help determine how far individuals lean on external support in their learning (Schunk & DiBenedetto, 2020).

The third arises from the environment of use. P5 reported that in dark conditions the denomination sometimes cannot be read. The dependence of the application's performance on lighting quality shows that the effectiveness of assistive technology is determined not solely by the sophistication of the system but also by its fit with the contexts of everyday use. These three constraints indicate that the application's benefits hold within particular conditions, so that its use needs to be balanced by strengthening foundational skills if the independence formed is not to rest entirely on the device.

Discussion

The findings are best read through Zimmerman's (2002) cyclical model of self-regulated learning, in which learning proceeds through forethought, performance monitoring, and self-reflection. Each phase has an observable counterpart in the participants' accounts. Forethought appears in the decision to reach for the application only when a transaction is imminent (P2, P4); performance monitoring in the repeated scanning of a single note (P3); and self-reflection in the judgement that the reading returned most frequently is the correct one (P4). What is notable is that none of these phases was taught. The cycle assembled itself around a technical limitation, which suggests that self-regulated learning in this setting was occasioned by the technology rather than by instruction. This is a mechanism that survey-based studies of assistive technology adoption cannot detect, since they measure whether an application is used rather than what its failures oblige users to do.

This reading both confirms and qualifies earlier work. Griffin-Shirley et al. (2017) and Martiniello et al. (2022) establish that mainstream smartphones are widely accepted among users with visual impairment and increasingly displace traditional aids, and the fluent, unremarkable use observed here is consistent with that trend. Alimović (2024), surveying both users and professionals, likewise found that a clear majority of individuals with visual impairment recognise the benefits of assistive technology while simultaneously reporting difficulties with it, and Senjam et al. (2021) show through usability testing that the accessibility features of smartphone applications are often only partially mastered by those who depend on them. Both findings match the present accounts, in which the application was valued and imperfectly trusted at the same time. The qualification concerns what acceptance means. High usefulness ratings in those studies are treated as evidence that a technology works; the accounts gathered here show that an application can be judged useful precisely while being known to be unreliable, and that its value for learning may depend on that unreliability remaining visible to the user. Fulvian et al. (2025) demonstrate, in engineering terms, that automated rupiah recognition remains an unsolved classification problem. Read alongside the present findings, that residual error rate is not only a technical deficit to be minimised but a pedagogical variable with effects on how users learn.

The uneven distribution of critical engagement carries the sharpest theoretical implication. P3 and P4 converted doubt into a verification procedure, whereas P2 allowed the application's convenience to displace manual checking. Schunk and DiBenedetto (2020) argue that motivational beliefs govern how far learners recruit external support as a substitute for, rather than a scaffold to, their own strategies, and the divergence observed here fits that account closely: the same application, in the same school, produced strategy construction in some participants and strategy replacement in others. Bandura's (1997) construct of self-efficacy helps explain the difference. Participants who had already succeeded in resolving a misreading had grounds for believing themselves capable of judging the application's output, and that belief sustained further verification, whereas a participant without such experience had no comparable basis for questioning it. Independence, on this reading, is not conferred by access to assistive technology; it is produced by the interaction between the technology's reliability and the user's motivational resources.

The informal route by which the application was learned situates these findings within the broader shift in how disability and educational provision are understood. Schalock et al. (2021) place practical skills at the centre of adaptive behaviour, and Schmidt (2022) argues that provision should be judged by the scope it creates for participation rather than by the reduction of impairment. Money handling learned through peer networks satisfies both criteria in outcome while bypassing the school entirely in process. The same displacement of formal instruction by informal acquisition has been documented elsewhere: Sankhi and Sandnes (2022), interviewing five blind teenagers about their daily

smartphone use, found that none had received formal training in the screen readers they relied on, so that basic operational knowledge remained patchy and expectations of the technology were frequently mistaken. Read against that study, the peer-network route observed here is not an anomaly of one Indonesian school but a recurring feature of how blind adolescents come to assistive technology, and it carries the same risk: what is learned informally is learned unevenly. That gap between where the learning happened and where it was intended to happen is an institutional finding as much as an individual one: a school with the standing of a Resource Center and an established practice of assistive technology use was nonetheless not the site at which this particular competence was acquired.

The academic contribution of this study is accordingly threefold. Conceptually, it reframes a currency-recognition application from a compensatory device into a trigger of self-regulated learning, and identifies the mechanism through which that reframing operates, namely imperfect accuracy made visible to the user. Empirically, it supplies the qualitative account of currency-recognition practice that the predominantly survey-based literature has lacked, documenting the verification strategies users devise for themselves rather than the aggregate rates at which applications are adopted. Pedagogically, it locates a concrete point of intervention for special education: not the procurement of more accurate technology, but the deliberate teaching of verification as a skill, so that the independence emerging informally around assistive applications is strengthened by design rather than left to depend on which students happen to distrust the output.

CONCLUSION

This study set out to describe how the Cash Reader application is used in the transaction activities of students with visual impairment, to examine its contribution to their learning capability, to trace how knowledge of its use is acquired, and to identify the constraints attending it. Taken together, the findings support a single synthesis: the application's value for these students lies less in the accuracy of the information it supplies than in the position it places them in as learners. Because it is used selectively in real transactions, and because its readings cannot simply be trusted, it requires of its users precisely the sequence of planning, monitoring, and evaluation that defines self-regulated learning, and it does so without any instruction having been given. What emerges is therefore not a compensatory device that removes a barrier, but a medium through which independence is constructed, on the condition that the user engages critically with what the device reports. Where that critical engagement is absent, the same application produces reliance instead. Independence, on the evidence of this study, is an achievement of the user's response to an imperfect technology rather than a property of the technology itself; and because the competence involved has so far been acquired informally, through peer networks rather than the classroom, the pedagogical implication is that verification deserves to be taught as a skill in its own right within daily living skills provision, alongside the foundational denomination-recognition abilities on which it rests.

Several limitations qualify these conclusions. The study rests on the accounts of five participants at a single school, all of them totally blind, and on interview data rather than observation of transactions as they occurred; its findings are accordingly contextual and are not intended for statistical generalisation, and not every aspect of the findings was confirmed by all participants. Reliance on self-report also means that the verification strategies described are those participants were able to articulate, which may not exhaust those they in fact employ. Three directions for further research follow. First, studies involving a more diverse range of participants, including students with residual vision and students in other schools and regions, would establish how far the patterns identified here hold beyond this setting. Second, direct observation of transactions, combined with interviews, would allow the reported strategies to be checked against practice. Third, longitudinal

designs would show whether the independence observed consolidates over time or dissipates as the technology changes. For schools, the practical recommendation is to bring the use of currency-recognition applications into a planned daily living skills programme in which verification strategies are taught explicitly and foundational skills are maintained, so that assistive technology strengthens learning independence rather than quietly substituting for it.

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