Designing for Children

- With focus on 'Play + Learn'

Designing Technology for Special Children

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Abstract: Tata Interactive Systems (TIS) is one of the world's largest e-learning companies and has developed several innovative and cutting edge solutions for the corporate, education and government sectors over the last 19 years. In line with its focus on education, as a part of its corporate social responsibility, our company has been addressing the cause of Learning Disability (LD) at a grassroots level since 2002 by supporting the LD Clinic at LTMG, Sion Hospital, Mumbai. This is one of the largest government hospitals in India and one of the few certified institutions of its kind dedicated to detecting and treating learning disorders in children. Every year close to a 1000 children are certified with LD at the Sion Hospital LD Clinic.

Apart from sustaining the clinic through financial and management support, as well as helping build awareness in the community through the Tata Learning Disability Forum, TIS has also been involved in creating support material and software for the detection and remediation of children with special needs across the remedial cycle for customers worldwide.

This paper first outlines the problem faced by children with LD, as well as touches upon the methodology for clinical diagnosis and management of these children. It then focuses on how technology, taking cues from the clinical approaches, can help in the detection and remediation of LD. There are special considerations in the design of these software interventions at each stage for multiple target users – the child, the doctor, the teacher and the parent. The paper explores the critical role that design plays in addressing special requirements in support of these children.

Key words: Learning Disability, Special Needs, Dyslexia, Dyscalculia, Dysgraphia, Tata Learning Disability Forum.

1. Introduction

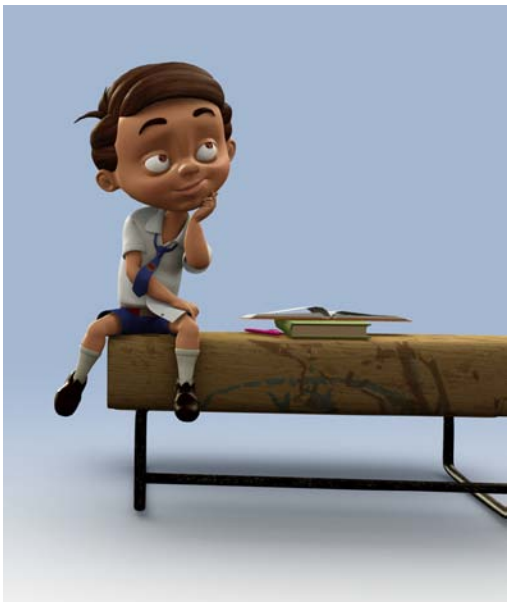


Figure.1 Character from TIS's film "Special Deeds for Special Needs"

"Stupid", "Slow", "Clumsy"

Words that have been used cruelly for children with low attainment levels, when it was felt that there was no way they could ever learn effectively.

Learning Disability (LD) is a lifelong disorder that affects the manner in which individuals with average or above average intelligence select, retain, and express information. It reflects in a difficulty in encoding and decoding information as it travels between the senses and the brain, and is expressed through difficulties in reading, writing, and mathematics. These disorders are called Dyslexia, Dysgraphia, and Dyscalculia, respectively.

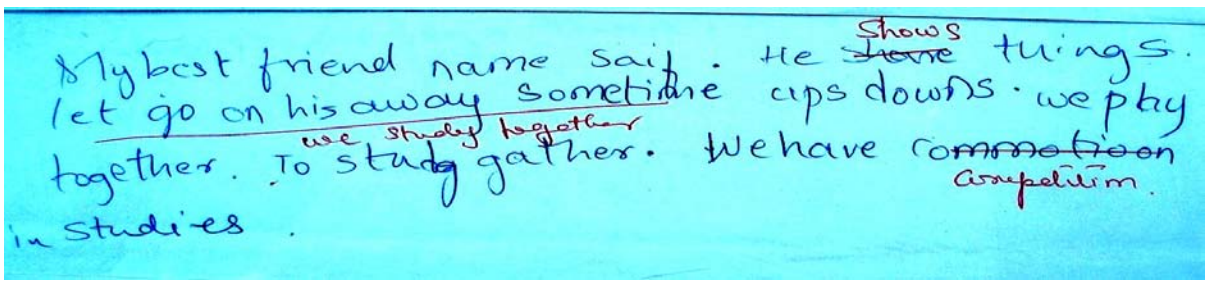


Figure 2. Writing of a 10 year old boy with LD

Dyslexia: The word Dyslexia is derived from the Greek word "dys" meaning difficult and "lexia" meaning words or vocabulary. Commonly interpreted as difficulty in reading, dyslexia denotes a language disorder affecting reading, spelling, speaking and listening.

There are some symptoms that are quite apparent with children with Dyslexia.

Symptoms:

- Delayed spoken word
- Problems with left right orientation
- Difficulty in decoding and encoding words (identification and spelling)
- Poor sequencing of words and letters when read or written
- Confuse similar sounding letters – b and d – bog and dog
- Tend to guess the word from the first letter – e.g. farm for front
- Difficulty in remembering sounds of words
- Difficulty in remembering months of the year, days of the week, tables etc
- Difficulty with handwriting
- Difficulty with mathematics

Dysgraphia: In Greek, *graphia* means writing. The term refers to an unexpected difficulty in learning to write.

Symptoms

- Difficulty in expressing thoughts in writing
- Write jumbled sentences, though speak correctly
- Poor muscle control therefore difficulty in forming letters
- Write alphabet that is inappropriate in size – very large very small, illegible
- Exert pressure on page while writing – tear the page sometimes
- Confusion on whether they are left or right handed
- Tend to mirror write letters, words and numbers

- Omit or add letters and words
- Child with good phonic skills might spell words according to their sound
    - Monkey as Munky
    - Bridge as Brig
    - Enough as Enuf
- Has difficulty blending sounds of double consonants
    - Eg Gl in Glass or Bl in blast

Dyscalculia: In Greek *calculia* means mathematics. The term refers to a disorder affecting mathematical reasoning and calculations.

Symptoms

- Tend to use fingers to count
- Poor digit memory – forward & backward
- Does not understand place value (units, tens)
- May reverse numbers (e.g. 63 for 36)
- Difficulty in memorizing multiplication tables
- Difficulty learning to tell time
- Mix up symbols + - x etc
- Have difficulty in mental math
- Perform poorly in math at the appropriate level

If detected early, support can be given to children with LD in a normal classroom, and special techniques could be used for teaching them. However, the problem gets compounded if the disability is detected at a later stage, when the child reaches secondary school. In such a scenario, more focused interventions and concessions are required to enable the child to keep pace with the rest of the class.

Children with LD have a lot to offer society. They possess considerable visual, spatial, problem-solving, and lateral thinking abilities, which would be of value to future employers. Unfortunately, their creativity, skills, and talent may so often lie dormant within a framework of frustration and helplessness—a framework that may be attributed to a lack of adequate support in the traditional educational environment in which they study.

2. Characteristics of students with learning problems

It is critical to understand the cognitive, affective and behavioral characteristics of children with LD, in order to be able to be able to design interventions for their support and treatment.

2.1 Cognitive Characteristics

Children with LD display some typical characteristics:

2.1.1 Low Academic Achievement:

Low academic achievement occurs in areas such as language, reading, mathematics, spelling, written expression, and is a primary characteristic of students with learning problems. Typically this is contradictory to the fact that these children have above average, and in some cases high IQs.

2.1.2 Poor Memory:

Many students have difficulty remembering information presented visually or auditorially. Teachers frequently report that these students forget spelling words, math facts, vocabulary words and directions.

2.1.3 Attention Problems and Hyperactivity:

To succeed in school, a student must recognize and focus thought on relevant classroom tasks as well as be able to shift attention to new tasks. Students with LD often have attention problems and are unable to separate various stimuli and are infact attracted to irrelevant stimuli. Many suffer from Attention Deficit Disorder and Attention Deficit Hyperactive Disorder (ADD and ADHD).

2.1.4 Perceptual Disorders:

Perceptual problems (such as the inability to recognize, discriminate and interpret sensation), especially visual and auditory disabilities are common in children with LD. Visual-perceptual processes are important are important to reading and mathematics

achievement at younger ages, and later relate to spelling, writing and conceptual difficulties.

2.2 Affective Characteristics

2.2.1 Poor social skills

Children with learning disorders often are unable to understand social cues and lack competence in skills such as greeting someone, accepting criticism, receiving compliments, saying no and giving positive feedback. Because of their inability to interact appropriately with teachers and peers, they frequently have low social status among their peers.

2.2.2 Poor Self Concept

Frustrated by their lack of achievement academically as well as socially, many students with LD suffer from negative feelings of self worth. They need a higher level of encouragement and positive re-enforcement than other children for them to keep focused on learning.

Figure.3 Drawing of a 9 year old girl with LD

2.2.3 Poor Motivation

Children with LD are often not motivated to learn, given the fact that they repeatedly suffer from poor academic attainment. Many develop a state of helplessness and lose their

intrinsic motivation to prove their ability and competence. Therefore extrinsic motivators should be used by educators or software such as rewards and encouraging feedback.

2.2.4 Debilitating Mood States

Research proves that students with LD have higher levels of anxiety, worry, oversensitivity, loneliness and depression than students without disabilities (Bender & Wall, 1994; Margalit & Shulman, 1986, Sabornie, 1994)

2.3 Behavioral Characteristics

2.3.1 Adaptive Behavior Deficits

Students with LD often display behavior deficits and low adaptability, that interfere with academic achievement and social relationships. Adaptive behavior or adaptivity "is a proactive process through which individuals organize their lives in purposeful, flexible and advantageous ways to meet the demands of multiple environments" (Weller, Watteyne, Herbert, & Crelly, 1994, p 282).

2.3.2 Disruptive Behavior

As a result of social skills deficits and poor academic achievement, students with LD often display aggressive behavior towards others. Often this is manifested with fighting, name calling, swearing and sarcasm. Another trait that teachers need to content with is absenteeism. There is always a need to constantly make plans to help absent students catch up on learning and work.

2.3.3 Withdrawal

Some students withdraw completely as a result of previous failures and are unable to interact positively with peers or adults. Because of loneliness, this may manifest in depression and in extreme cases attempted suicide, it is therefore critical to develop interventions and preventive strategies to deal with these conditions.

3. Clinical Evaluation and Management Procedure

The first step towards treating a child with LD is detection and the earlier and more accurate a diagnosis is, the easier it is to remedy and support the child.

3.1 Evaluation

Identification of this disorder is a multidisciplinary approach involving pediatrician or a neurologist, a clinical psychologist, an educator, a psychiatrist, an occupational therapist, and a speech therapist.

The clinical evaluation involves:

- Medical assessment, including history with an emphasis on events at birth, developmental milestones, educational performance and socio cultural background of the family. A detailed physical and neurological examination, as well as a vision and hearing test – to rule out any other potential reasons for the child not being able to learn
- Analysis of school performance including school reports, history of failures
- Assessment of general cognitive functioning or IQ tests. Children with LD typically have above average IQs. If it were below average, they would be classified as "slow learners"
- Assessment of achievement Level – as measured on specially designed educational tests.
- Assessment of associated behavioral and social problem if any.

3.2 Management

Early intervention and remedial education are essential components of management that help a child overcome learning problems and prevent school failures.
General management principles involve:

- Counseling for the child, parents, school personnel
- Interpretation of diagnosis and its implications
- Outline of an Individualized Education Plan (IEP)
- Remedial education
- Minimization of distracting stimuli
- Increasing teacher availability
- Assuring structured focused interventions, giving predictable routines
- Providing immense encouragement and positive re-enforcement
- Offering extra time during assessments and examinations
- Helping the child develop interest in extra-curricular activities such as drawing, sports, drama etc. These not only allow them to express themselves and interact with other children, but also help them build their self worth by succeeding in some areas beyond academics

Figure.4 Screenshot from TIS's award winning film "Special Deeds for Special Needs". Good Management involves closer Teacher monitoring

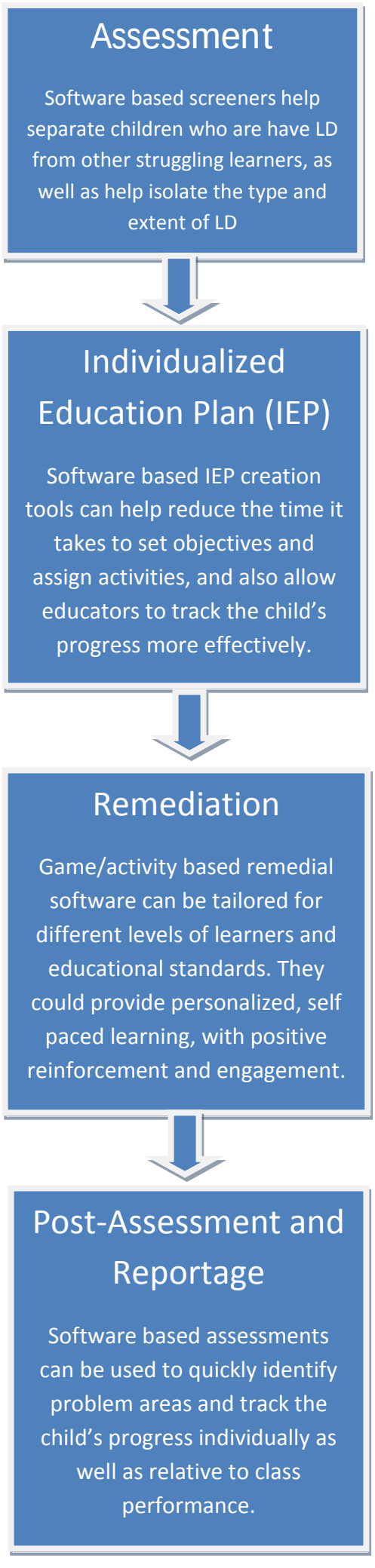
4. Software Interventions

Considering that one in six individuals suffers from some form of LD, compounded with the lack of awareness on the subject that exists in most Indian schools, there is a pressing need for educators to employ standardized, effective methods to help these children realize their educational potential.

While nothing can replace face-to-face guidance and training, the use of specially designed technological interventions can certainly help make the process more engaging for the child, effective and efficient for the educator, doctor and parent.

4.1 How software helps

A software based intervention could help in accurate detection, make remediation fun and engaging for children, enable tracking of scores and progress. The following diagram outlines how software interventions help at different stages in the LD remedial cycle:


Assessment
Software based screeners help separate children who are have LD from other struggling learners, as well as help isolate the type and extent of LD
Individualized Education Plan (IEP)
Software based IEP creation tools can help reduce the time it takes to set objectives and assign activities, and also allow educators to track the child's progress more effectively.
Remediation
Game/activity based remedial software can be tailored for different levels of learners and educational standards. They could provide personalized, self paced learning, with positive reinforcement and engagement.
Post-Assessment and Reportage
Software based assessments can be used to quickly identify problem areas and track the child's progress individually as well as relative to class performance.

Apart from playing an instrumental role in the assessment and remedial cycle, technology can help in the following ways:

- E-learning can be used to train teachers on how to identify children at risk, and provide them standardized teaching strategies and classroom management techniques to support children with learning problems.
- Databases can help doctors, psychologists and special educators to store students' history, records, test scores as well as provide statistical data such as average age of detection, male vs female ratio, demographic data on which states, nationalities the condition is more prevalent.
- Websites are being used to create awareness and build communities and support groups bringing together different stakeholders including children, parents, doctors and educators.
- Assistive devices such as calculators, touch monitors, digital pens etc. help children and adults with LD keep up with daily tasks even in some cases if remediation is not possible

4.2 Design Considerations

Design of assessment and remedial software for LD is an iterative process that involves a multidisciplinary approach, intensive research as well as rigorous testing, owing to the fact that the manifestation and degree of the problem varies in different children.

However there are certain design factors that can be considered common across all products:

1. Teacher control: Since close monitoring of student's progress is required during remediation there is a need for a section for teachers to help them in tracking student's progress, setting difficulty levels, controlling the pace of activities.

2. User control: Since learners do have a difficulty in reading, controls are given to either the student or the teacher to set text and background color, size of text and font.

3. Typically due to the fact that these students easily get distracted, the screens are kept very simple and clutter-free to help them focus on the task at hand. Fonts used should be bold and preferably sans serif.

4. Icons should be supported with simple visual elements and should have audio support for children with reading difficulties. They should be placed at a distance from the activity area, as these children sometimes have poor motor controls and can accidentally click on them.

5. Design of activities should be repetitive and progress to more difficult levels gradually. However the difficulty level could increase faster or slower based on the student's responses. This helps in personalizing the activity for different levels of learners.

6. Since these children do not have a motivation to learn, extrinsic motivators such as personalized positive feedback and reward animations can help build engagement.

7. Activities should focus on typical mistakes made by children with LD (sequencing, letter reversals, blending of consonants, telling the time, left right orientation, etc).

8. Non threatening, funny cartoon characters could be used as a mascot or guide for providing instruction and reinforcement. Typically these children have a fear of failure and a humorous guide can allow them to make mistakes without fear of retribution.

9. Examples and scenarios could show characters engaged in extra-curricular activities such as sports, gardening and theatre so that children do not realize that they are learning.

10. There should be summarizers at regular intervals to help re-enforce what has been learnt and help build metacognitive abilities that are typically weak in these children.

4.3 Examples

The following are examples of products we have created for children with LD which help illustrate these design considerations.

4.3.1Assessment

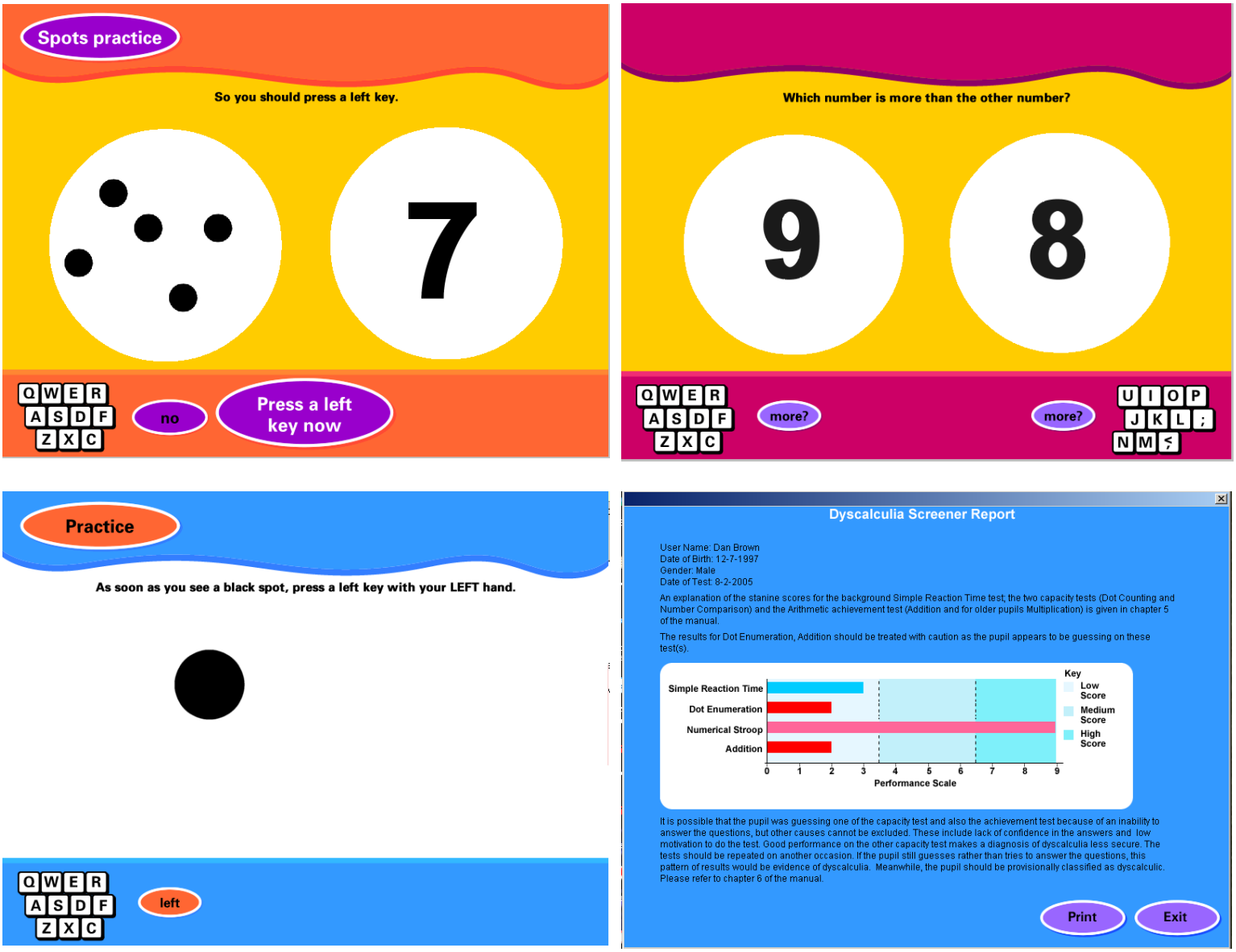
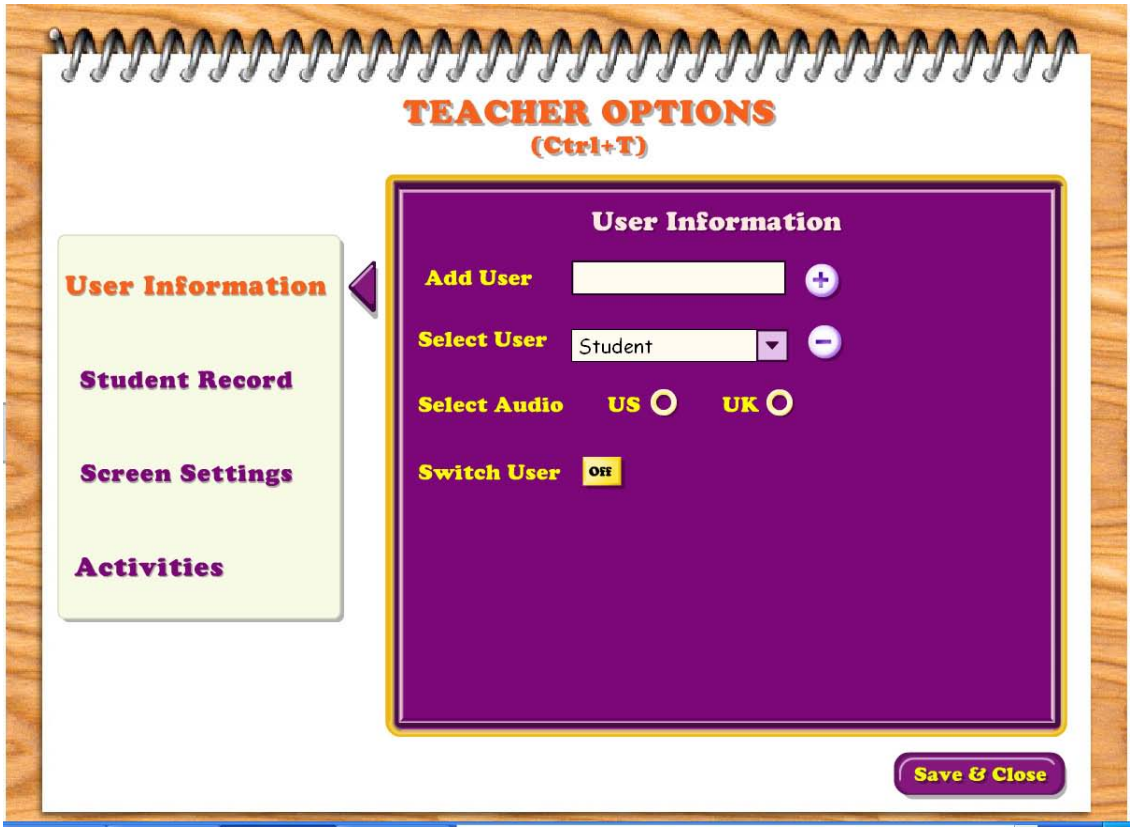
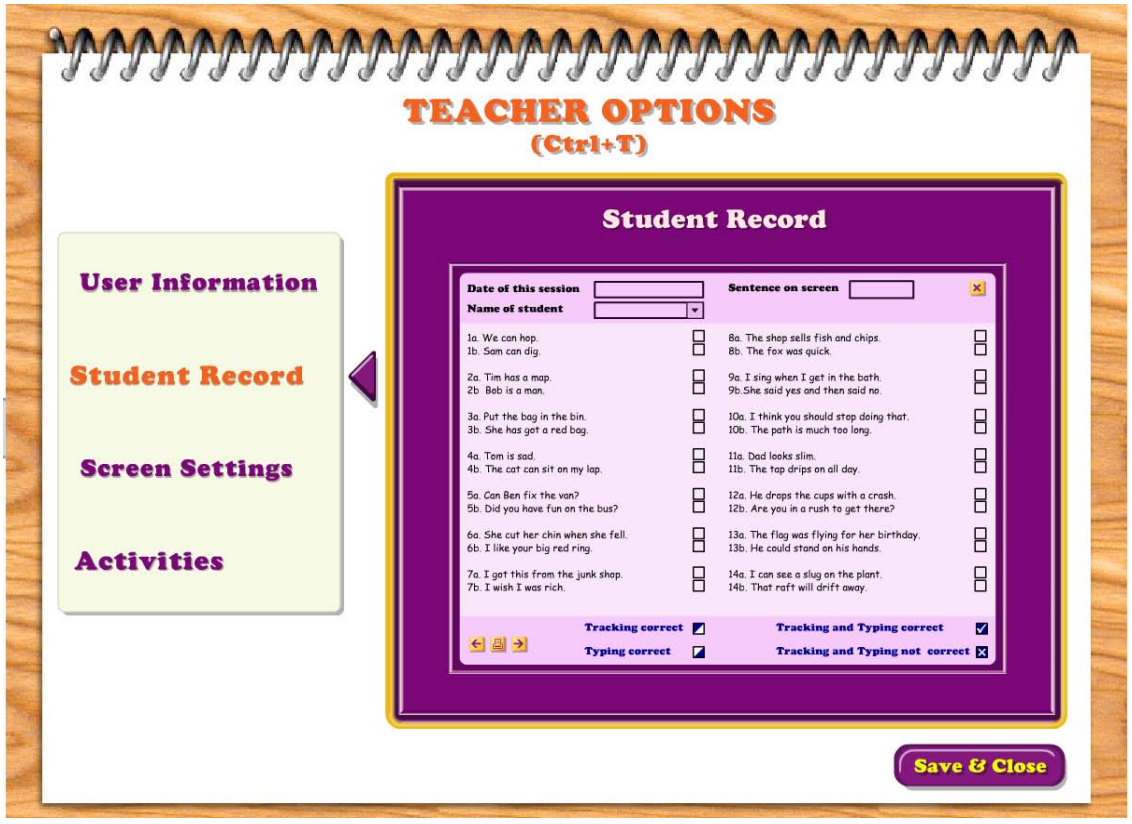


Figure.5 Screenshots from *nferNelson's Dyscalculia Screener* showing different tests that measure the accuracy and speed of response of students with problems in mathematics. The tests are followed by a report which clearly indicates whether the child has Dyscalculia, as well as helps diagnose the problem areas.

4.3.2 Teacher Control





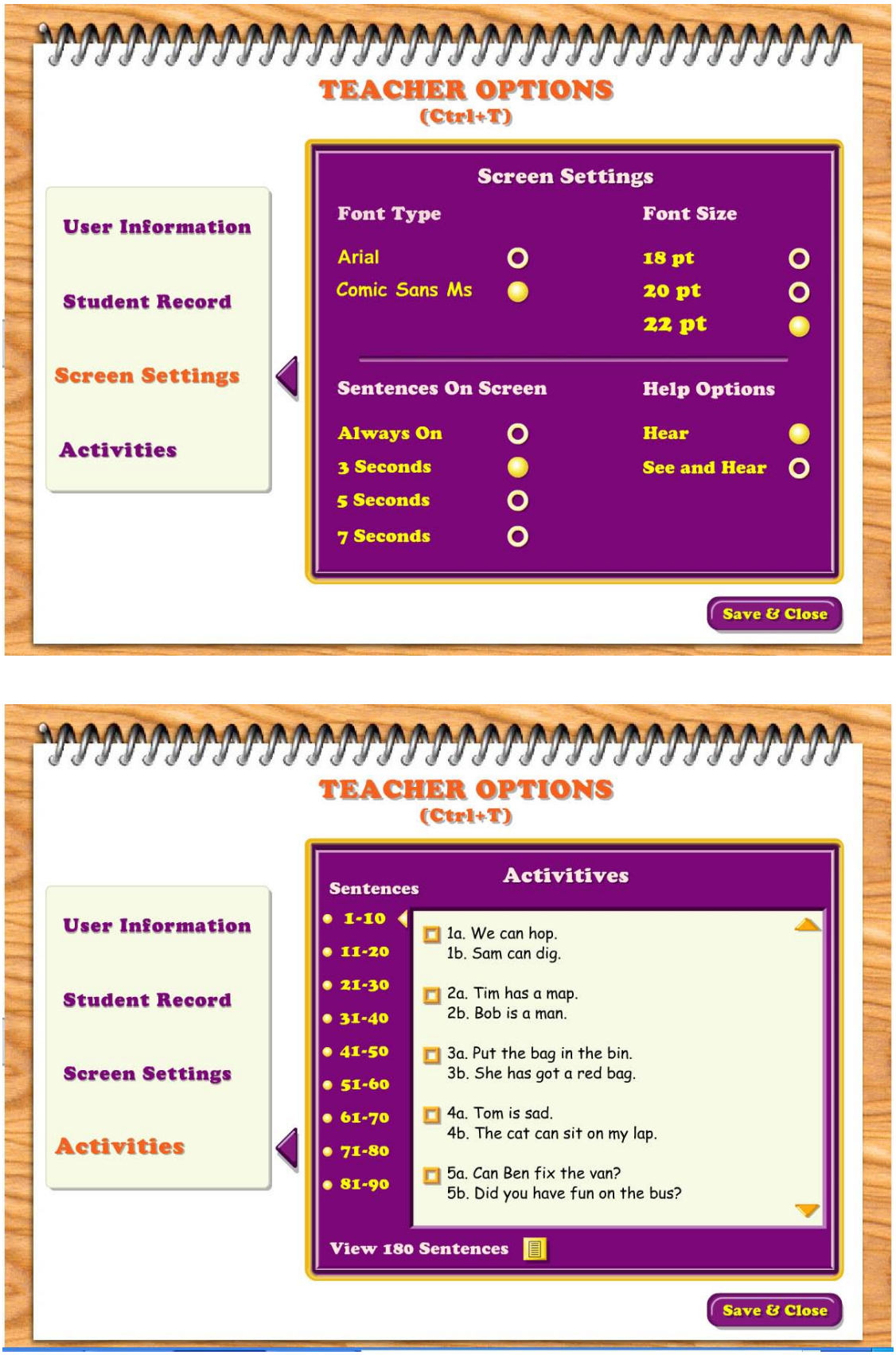


Figure.6 Screenshots from *Word Track a remedial product for Dyslexia created for SEMERC, Granada Learning* which show teacher controls including student details, choice of audio, student completion status, screen settings, and choice of sentence difficulty levels.

Remediation

Figure.7 *A screenshot from "Number Track", a remedial product for Dyscalculia created for SEMERC, Granada Learning*. This demonstrates a sequencing activity in which a non-threatening character (e.g. Dinosaur in this case) is used for giving positive or negative feedback.

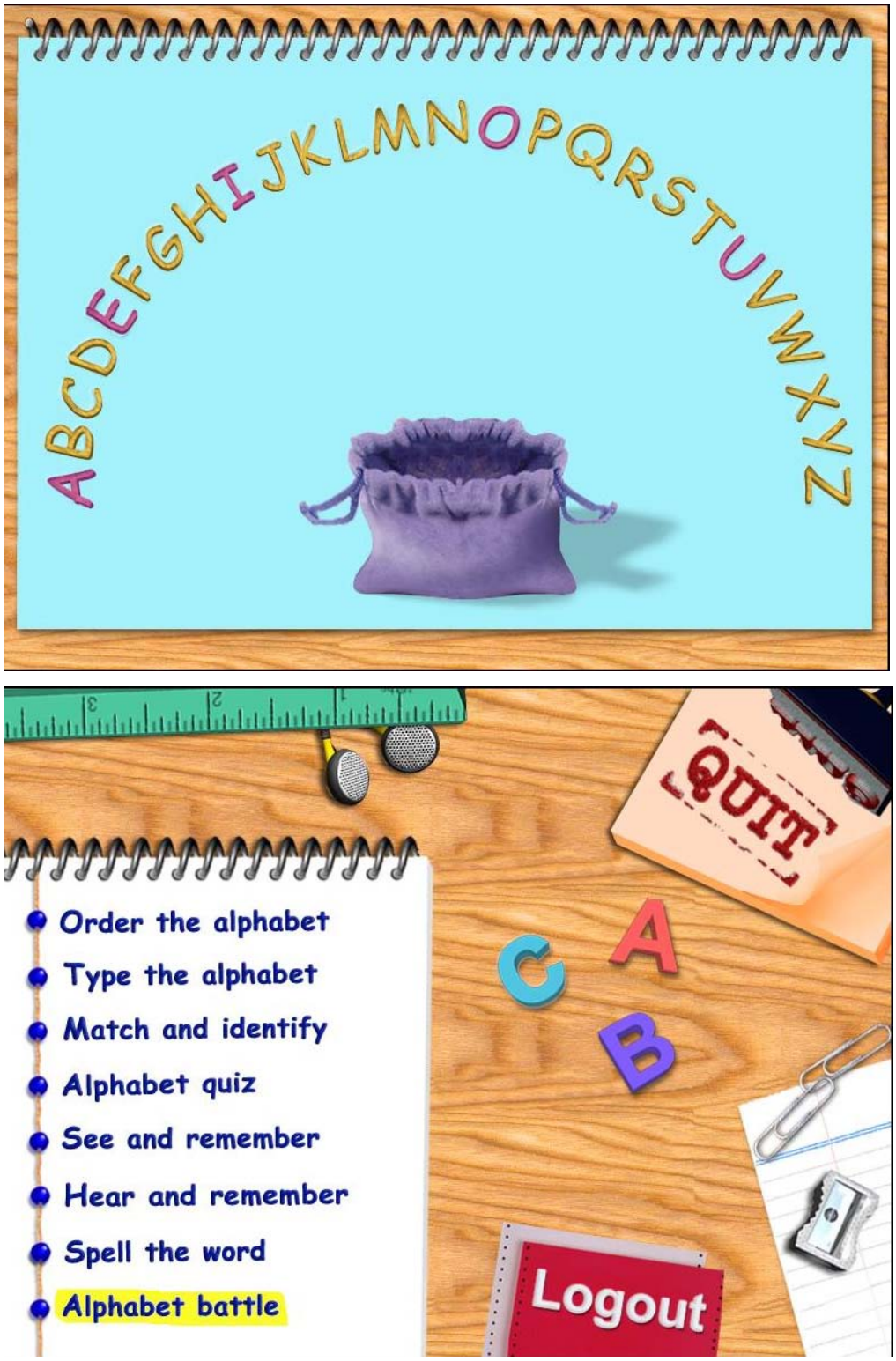


Figure.8 *A screenshot from "Alphabet Track", a remedial product for dyslexia created for SEMERC, Granada Learning*. This includes a set of eight activities teaching the sequence of alphabets on an alphabet arc. The activities involve dragging and dropping letters which help develop motor skills in children.

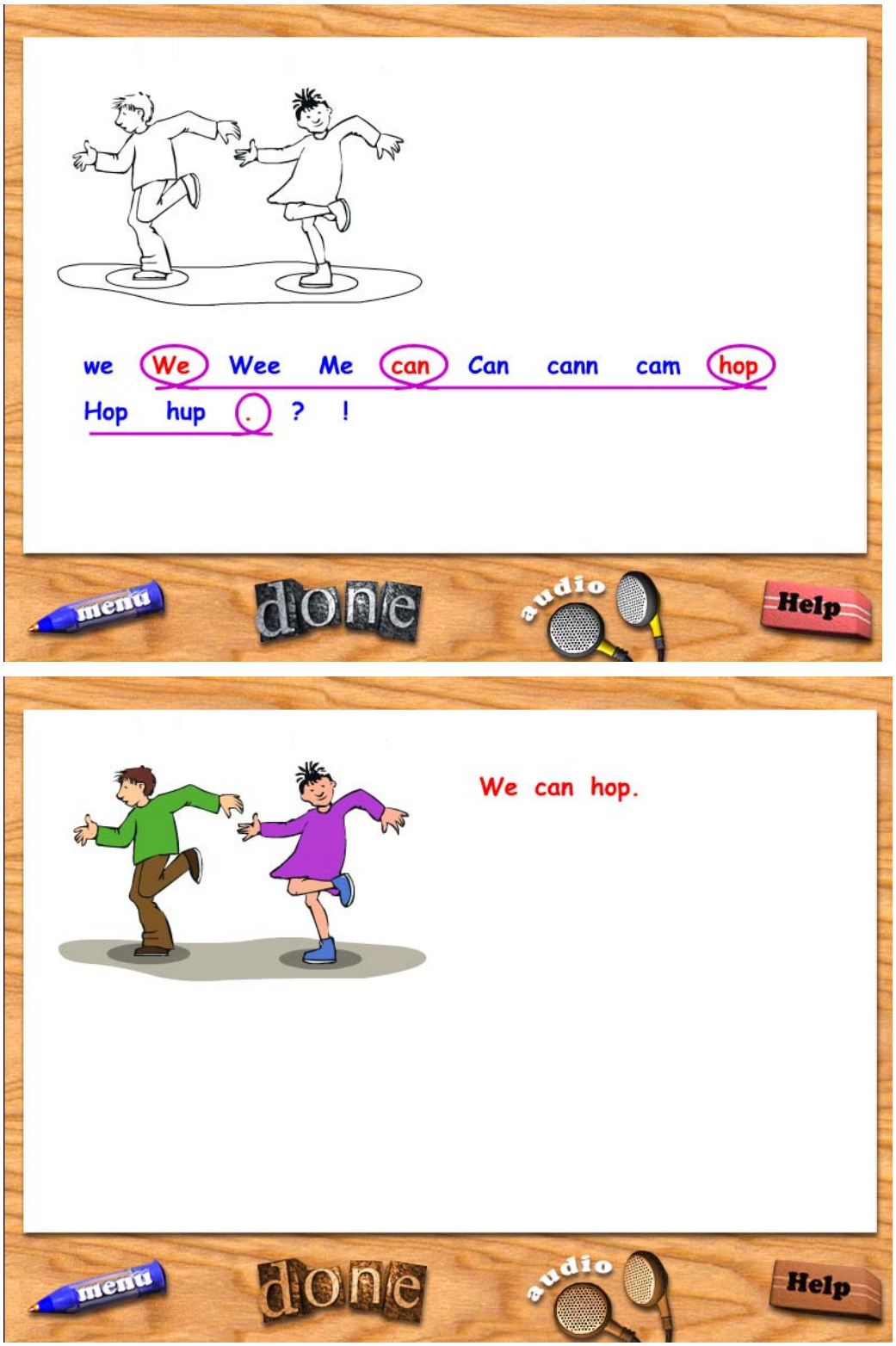


Figure.9 These are screenshots *from Word Track, a remedial product for Dyslexia created for SEMERC, Granada Learning.* The screens are simply designed, less clutter. Allow children to hear and view a sentence, and then pick the correct words with punctuation from a set of distracters. The distracters are based on typical mistakes made by children with LD. Correct responses are followed by a simple, colored animated version of the picture as a reward.

Teacher Training

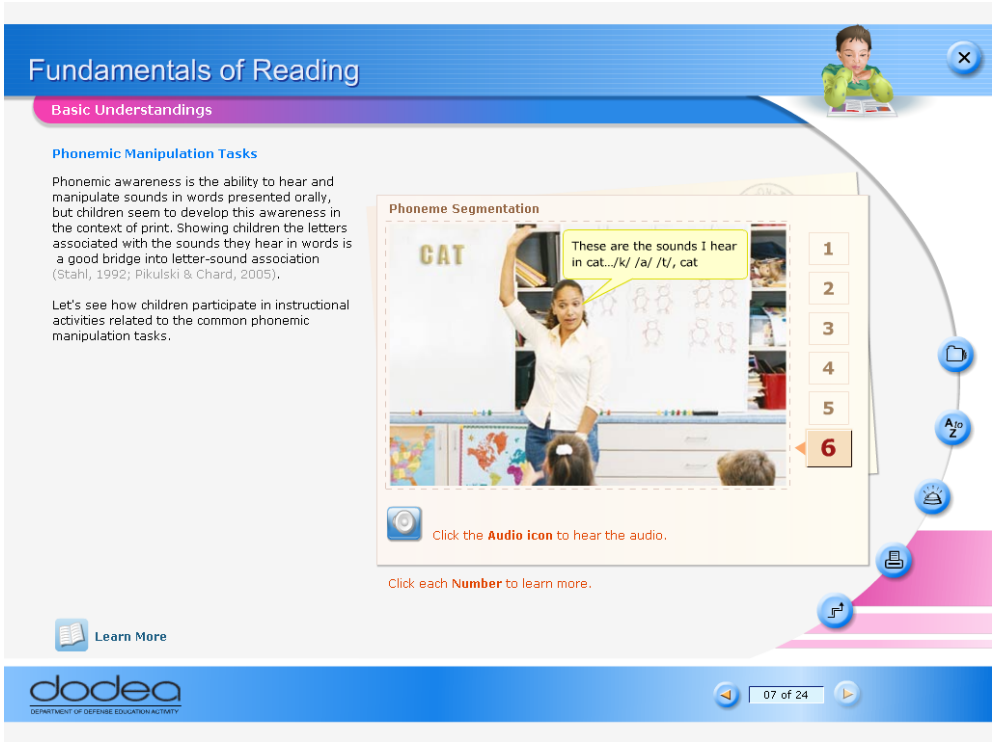
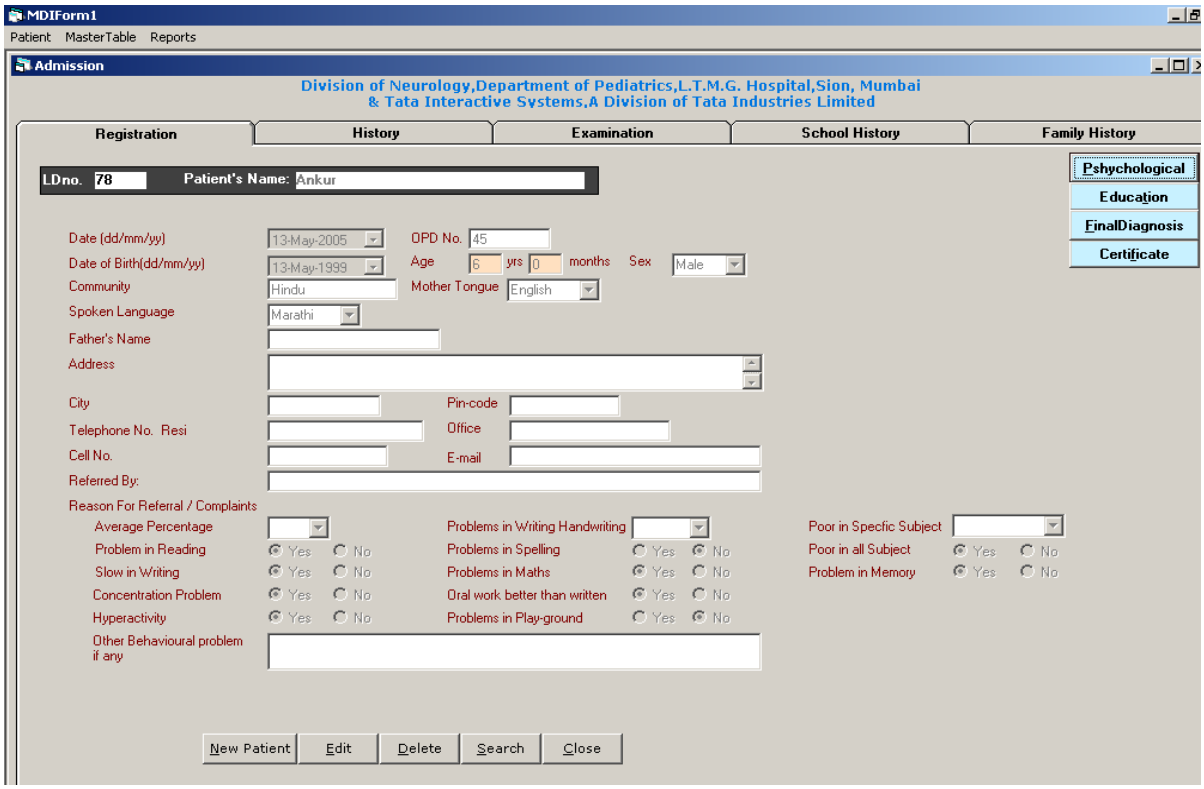


Figure.9 This is a screenshot of a reading difficulties program we have created for the Department of Defense, USA, which focuses on providing web based training for primary school teachers on the identification and remediation of children at risk for reading difficulties and LD.

Database for doctors and psychologists



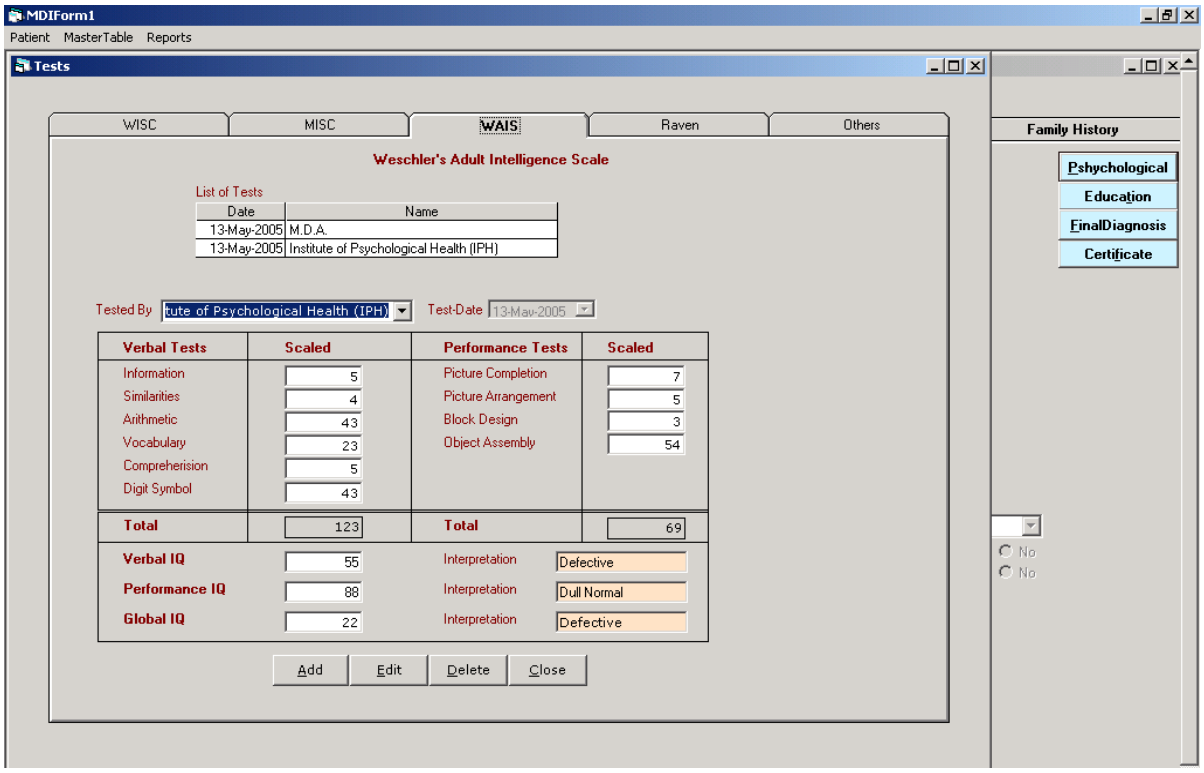


Figure.10 these screenshots are from a database TIS has created for LTMG Sion Hospital which helps in storing and analyzing student records.

6. Conclusions

Within every classroom exists a young farmer, a nurse, a builder, a doctor, an actor and a scientist yet to grow and blossom. These are the ones who will shape the future, it is therefore our responsibility to help them put the pieces together and realize their true potential. Software based approaches will help to make it faster and easier to detect and remedy special children; however they can only work in conjunction with the collaborative support, understanding and encouragement from parents, teachers and doctors.

Figure.11 Screenshot from TIS's LD awareness film "Special Deeds for Special Needs". Children with LD need the support of doctors, teachers and most importantly their parents.

Awards won for Special Needs products created by Tata Interactive Systems

- BETT, UK, 2004 best product in the Special Needs Category - nferNelson Dyscalculia Screener for Granada Learning, UK
- Notable Computer Software Award, USA, 2006, for the Track Series (Alphabet Track, Word Track, Sentence Track, Phoneme track) developed for SEMERC, Granada Learning, UK
- FICCI BAF Award in the Social Awareness Category 2009 for Tata Learning Disability Forum LD Awareness film "Special Deeds for Special Needs"
- NCERT AICEAVF Award 2009 in the Animation and Puppetry Category 2009 for Tata Learning Disability Forum LD Awareness film "Special Deeds for Special Needs"

- Mumbai International Children's Film Festival Award, 2009, Second Prize in the Animation Shorts Category for Tata Learning Disability Forum LD Awareness film "Special Deeds for Special Needs"

Awards won by Tata Interactive Systems for supporting Learning Disability as a Corporate Social Responsibility Initiative

- Readers Digest Pegasus CSR Gold Award 2009
- Readers Digest Pegasus CSR Gold Award 2007

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- Department of Defense in Educational Activities, USA
- Learning Disability Clinic, Sion Hospital, Mumbai, India
- Tata Learning Disability Forum, TIS, Mumbai, India

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