

ITALIAN LITERACY TUTOR

tools and technologies for individuals with cognitive disabilities

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Abstract

The Italian Literacy Tutor (ILT) is a project designed to implement a program of individualized, computer-aided reading instruction with the potential to dramatically improve reading achievement and learning from text in Italian, especially considering L2 teaching/learning frameworks or working with children with reading disabilities. The Italian Literacy Tutor is the Italian counterpart of the "Colorado Literacy Tutor" (CLT), a project developed at CSLR (Center for Spoken Language Research, Colorado University Boulder) for English. The ILT will mainly integrate two sets of literacy tools, the first one based on speech and animation technology, and the second based on language comprehension technology.

1. Introduction

Research has shown that learning is optimized when students are actively engaged in interesting and challenging learning tasks with individual tutors or in small groups of students. In these environments, teachers can design and customize learning tasks to the interests and needs of each student, observe and analyze each student's behavior, and provide individualized feedback and guidance. Individualized instruction is so effective because the teacher can apply all of her experience and knowledge to the learning process while keeping the student engaged, focused and motivated.

The ILT project will entirely follow CLT's guidelines [1]. A primary assumption underlying our work is that it is possible to enable such optimized learning experiences by inventing intelligent animated agents that behave like sensitive and effective teachers in specific learning tasks. Inventing such agents requires research to improve auditory and visual recognition and synthesis technologies so the animated agents can recognize and interpret students' behaviors and respond to these behaviors like master teachers, and research to

understand and model the behaviors of effective teachers. The seminal work of Reeves and Nass [2] suggests that, if such embodied animated agents are designed well through appropriate research, learners will interact with these agents just as they would with real teachers.

Our work on learning and comprehension in interactive books is motivated by the theory of text comprehension developed by Walter Kintsch and his colleagues [3-4]. This cognitive theory is guiding the design of interactive books, the structure and content of the stories we are developing, and the manner in which animated characters interact with students to stimulate both the acquisition of new knowledge and the application of this knowledge to new problems and domains. The idea is that that one learns good comprehension strategies and writing skills by using them multiple times in multiple ways with support, guidance and appropriate feedback.

The relationship between interactive books and the Kintsch's constructive theory of text comprehension is synergistic: while the theory will guides the design, content and use of interactive books, the books provides will provide an ideal platform for new research on comprehension training and a vehicle for widespread deployment and evaluation of a comprehension training program

This project aims to train students to comprehend what they read by analyzing students' written or spoken summaries of stories and providing feedback through Expert System for Summary Evaluation (ESSE) [5] or Latent Semantic Analysis (LSA) [6] techniques. In the typical comprehension training paradigm, students read expositions or stories, and then provide typed summaries. The summaries are analyzed using ESSE or LSA, and students are provided with feedback about their summaries. The ESSE tool is based both on statistical and explicit linguistic knowledge rules while LSA tool is entirely based on statistical knowledge.

Interactive books will provide a powerful platform for research on text comprehension. An obvious advantage will be the ability to automate the ESSE-based or LSA-based comprehension training process - the text can be presented for reading, students can type summaries directly into a window within the book, student summaries can be analyzed in real time, and feedback can be presented to students in near real time. Beyond this obvious benefit, interactive books will enable us to conduct research to extend comprehension training from the current paradigm of students reading text, typing a summary, and receiving visual feedback of their summary, to natural dialogue interaction with intelligent animated agents. The conversational agent can ask questions to help students discover and integrate knowledge that was not included in their summaries. Moreover, Interactive Books extend the scope and power of ESSE-based or LSA-based comprehension training to students who cannot yet read or type. For these students, animated agents can narrate the stories. The animated teacher or coach can then instruct the student to summarize the story in his or her own words. The student's speech is then transcribed automatically by a speech recognition system such as SONIC [7-8], and analyzed using ESSE or LSA techniques. The animated character can then converse with the student to provide feedback about the summary and guide the student - by asking questions to which good answers require key information that was not included in the summary, by again narrating the text that contains the key information, and so forth.

The development of stories for presenting knowledge in interactive books is guided also by various researches that have shown that students will acquire knowledge from books more effectively if the knowledge is integrated effectively into the plots of interesting stories with interesting characters. If students identify with the characters and become engaged in the stories, and if acquiring new knowledge is integral to story, then students will acquire this knowledge to some extent.

The design of well-organized stories, in which new information is integrated into the plot, combined with good questions presented by animated agents that require students to think about what they have read, provides a powerful foundation for comprehension training.

2. Research Challenges

Human Communication technologies have matured to the point where it is now possible to conceptualize, develop and investigate computer systems that interact with people much like people interact with each other. We envision a new generation of human communication systems in which intelligent animated agents engage users in natural face-to-face conversational interaction. By integrating computer vision into spoken dialogue systems, the animated agent will interpret the user's auditory and visual behaviors to more accurately infer their user's intentions and emotional state. The animated agent will orient to the user, engage in eye contact at

appropriate times, and produce accurate visible speech, facial expressions and hand and body gestures. The character will mimic the actions of real persons and behave intelligently, gracefully and appropriately in the context of specific task domains.

Inventing systems that enable face-to-face communication with intelligent animated agents requires a deep understanding of the auditory and visual behaviors that individuals produce and respond to while communicating with each other. Face-to-face conversation is a virtual ballet of auditory and visual behaviors, with the speaker and behavior simultaneously producing and reacting to each other's sounds and movements. While talking, the speaker produces speech annotated by smiles, head nods and other gestures, while the listener provides simultaneous auditory and visual feedback to the speaker (e.g., "I agree," "I'm puzzled," "I want to speak."). The listener may signal the speaker that she desires to speak; the speaker continues to talk, but acknowledges the nonverbal communication by raising his hand and smiling in a "wait just a moment" gesture. Face-to-face conversation is often characterized by such simultaneous auditory and visual exchanges, in which the sounds of our voices, the visible movements of our articulators, direction of gaze, facial expressions and head and body movements present linguistic information, paralinguistic information, emotions and backchannel cues, all at the same time.

Building systems that engage users in natural face-to-face conversational interaction is a challenging task. The system must simultaneously interpret and produce auditory and visual signals. The system must simultaneously interpret the user's auditory and visible speech, eye movements, facial expressions and gestures, since these cues combine to signal the speaker's intent - e.g., a head nod can clarify reference, while a shift of gaze can indicate that a response is expected. In addition, auditory and visual cues provide paralinguistic information that annotates and enriches the linguistic message, indicating new and important information, imparting emotion to the message (e.g., anger, surprise) and indicating whether the speaker is being serious, sarcastic, etc.

In addition to interpreting the auditory and visual cues provided by the student, the animated agent must also produce accurate, natural, and expressive auditory and visible speech with facial expressions and gestures appropriate to the physical nature of language production, the context of the dialogue, and the goals of the task. Most important, the animated interface must combine perception and production to interact conversationally in real time - while the animated agent is speaking, the system must interpret the user's auditory and visual behaviors to detect agreement, confusion, desire to interrupt, etc., and while the user is speaking, the system must both interpret the user's speech and simultaneously provide auditory and/or visual feedback via the animated character.

Developing such systems requires advances in speech recognition, natural language generation and synthesis, facial animation, recognition of facial expressions and gestures, dialogue interaction and imparting personalities to computer agents. As well, realizing these scenarios requires a deeper understanding of the nature of human communication and human computer interaction. To address these issues, we must record, analyze and study the behaviors of master teachers and their students during learning sessions, and then interpret and model these same perceptual and production behaviors in interactive books, and evaluate their effectiveness.

2. Overview

As its Colorado counterpart [1], the ILT project will be focused on two sets of tools. The first set includes interactive books and reading tutors that are designed to work together within a comprehensive reading program. Interactive books will help children learn to recognize words, read fluently and understand what they read. They provide an environment for learning from pre-readers (who can have stories narrated to them by animated characters, and then engage in dialogues with the characters to assess and train comprehension) to advanced readers who can read stories and then receive comprehension training. Interactive books will help indicate what foundational reading skills are lacking or weak, and “point to” individual reading tutors that will assess and teach these skills. Over fifty reading tutors are being designed to teach foundational skills.

The second set of technology to be incorporated into the Italian Literacy Tutor is that relative to the “summarization” task. Comprehension training will be achieved by letting children write summaries of texts in their own words. Expert System for Summary Evaluation (ESSE) [5] or Latent Semantic Analysis (LSA) [6] techniques automatically will compare their writing with the text they are summarizing and provides feedback about the content and adequacy of their summaries. ESSE or LSA are also being used in a tutor specifically designed to help students learn and practice reading comprehension strategies that are assessed in standardized, competency-based tests.

2.1 Scalable and Sustainable Technologies for Reading Instruction and Assessment

We plan to implement and assess a program of individualized, computer-aided reading instruction with the potential to dramatically improve reading achievement and learning from text in Italy and to be inexpensively scaled to school systems. The goal is to create a population of students who read with fluency and comprehension well beyond current national norms and who are skilled at acquiring new knowledge through reading.

We will develop two sets of literacy tools, one based on speech and animation technology, and one based on language comprehension technology. An example of the first kind, the Vocabulary Tutor, focuses on developing

reading vocabulary. It will include a 3D animated talking head synchronized with recorded or synthesized speech, paired with illustrations and printed words that can be entered by the teacher or by the child. Children will look at the images, label the items they see, listen to the words, see their spelling, pronounce them, hear how to pronounce them, and receive feedback. An example of the second kind is Summary Street®. This tool is based on a statistical theory of meaning, Latent Semantic Analysis. Comprehension training is achieved by letting children write summaries of chapters in their own words. Summary Street automatically compares their writing with the text they are summarizing and provides feedback about the content and adequacy of their summaries. Both these tools should be classroom tested, and still a lot of work is required to make them into stand-alone applications for Italian that could be used by teachers without direct supervision.

We shall start our work by putting these tools into classrooms and further assessing their usability and efficacy in a collaborative design process with teachers.

This project will extend this foundation of technology and application development to comprehension training within a comprehensive program of reading instruction and learning, and will evaluate the program in a diverse set of schools in Italy. In addition, we shall explore further pedagogical uses of these technologies. In particular, a system that integrates speech recognition technology with the analysis of meaning may open up some exciting new possibilities for instruction, for both regular and special populations of disabled students. Comprehension assessment will be possible not only for written text, but also for spoken texts. The technologies we will develop will be used not only for instruction in reading skills but also for the assessment of reading comprehension and learning.

2.2 ISTC Reading Project

The ISTC Reading Project will be a component of the Italian Literacy Tutor, and it will represent collaboration between universities and public schools that aim to improve student achievement through development of educational software that helps students learn to read and comprehend text.

A key objective of the ISTC Reading Project will be that of improving human communication technologies through basic research, leading to the invention of perceptive animated agents - lifelike computer characters that speak, emote and gesture, and engage learners in natural face-to-face conversations in learning tasks, much like effective and sensitive teachers. By embedding perceptive animated agents in immersive, multimedia learning environments, we hope to improve student achievement by teaching foundation reading skills (e.g., phonological awareness, sounding out words), fluent reading and comprehension. Inventing perceptive animated agents involves integrating research advances in areas of speech recognition, natural language understanding, computer vision and computer animation. If we are successful, future

learning tools will incorporate animated agents that behave much like sensitive and effective teachers in specific application domains.

3. Building Blocks

We envision a new generation of intelligent and embodied animated agents that engage users in natural face-to-face conversational interaction in learning and language training tasks. An intelligent agent is one that mimics the actions of real persons and behaves intelligently in the context of a specific application or task domain. An embodied agent is one that resembles a real person. The goal of our work is to invent intelligent animated agents, such as LUCIA [9] illustrated in Figure 1, that engage children in face-to-face conversational interaction to help them learn to speak, understand, read and write language. In our software applications we are creating, the animated agents will interact with Italian and English speaking children with speech and/or reading difficulties.



Figure 1. LUCIA talking head [10].

Perceptive intelligent animated agents “live” in **Interactive Books** and **Tutors**. Together, Books and Tutors will be designed to provide a comprehensive reading program. Interactive Books will help children learn to recognize words, read fluently and understand what they read. They provide an environment for learning from pre-readers (who can have stories narrated to them by animated characters, and then engage in dialogues with the characters to assess and train comprehension) to advanced readers who can read stories and then receive comprehension training. Interactive books will help indicate what foundational reading skills are lacking or weak, and engage learners in an individualized sequence of exercises that will assess and teach these skills. Our Tutors will integrate fully with our Interactive Books. Children will learn and practice foundational skills in completely individualized ways using these tutors. A full assessment of the educational efficacy of the interactive books and tutors will be developed. An on-line assessment of a child's reading abilities will be also available that can place students into the appropriate instructional levels of tutors and books as well as assess their progress. Teachers, students, and parents all help in a

participatory design process, to ensure that our Books and Tutors will meet the needs of the people who will use them. Researchers will continue to collect auditory and visual data for our speech corpus development, so that all our programs will accurately recognize and interpret the speech of children of all ages.

3.1 Tutors

Children need foundational speech, language, and reading skills, to help them achieve academic and social success and to gain self-esteem. Our programs will help children accomplish this with programs that integrate powerful, individualized, tutorial activities (Tutors) with engaging Interactive Books. While all children can benefit from our programs, the programs are critically useful for children with special needs, in the following four populations: 1) students with reading disabilities, 2) foreign-speaking students with limited Italian/English language proficiency, 3) students with autism spectrum disorder, and 4) students with hearing impairments.

Students in these populations must overcome significant barriers to learning, and are at great risk of ever realizing their potential within the public school system. We can help these students overcome their barriers to learning and achievement by providing them and their teachers with computer-based learning tools that enable significant learning gains while reducing teacher load. At all phases of development, teachers and students will help design, evaluate, and modify activities. Teachers will appreciate greatly that the programs can provide powerful individualized instruction for some of their students, freeing the teacher's time to help other children one on one or in small groups.

Our Intelligent Tutors will integrate fully with our Interactive Books. Children learn and practice foundational skills in completely individualized ways in Tutors. Book programs evaluate application of these skills, and assign review activities. Both Tutors and Books work with the help of an intelligent, supportive animated coach, who gives focused hints adapted to the child's rate of progress. Both Books and Tutors teach and support vocabulary learning.

Tutors will follow a default sequence from phonological awareness and decoding and encoding of simple consonant-vowel-consonant (CVC) words to more complex orthographic patterns into multisyllable words [10]. Tutors will be divided into:

- **Basic Domains**
 - Phonological Awareness (word, syllable, rhyme, phonemes). With all, practice identifying, matching, blending, segmenting, and manipulating these units of spoken language).
 - Alphabet and Letter-Sound Knowledge
 - Reading of Regular Words, from CVC to complex words.
 - Spelling of Regular Words
 - Reading Sight Words
 - Spelling Sight Words

- Vocabulary
- Comprehension strategies, if the children are not successful with the comprehension support and practice within the Books. Word reading, vocabulary, fluency, and comprehension are taught and practiced in Books, which also assess needs and assign Tutors based on those needs.

- **Optional Expanded Domains**
 - Articulatory Awareness (of how speech sounds are produced in the body)
 - Morphology
 - Syntax
 - Fluency, or prosodic expression
 - Visual Persistence
 - Composition

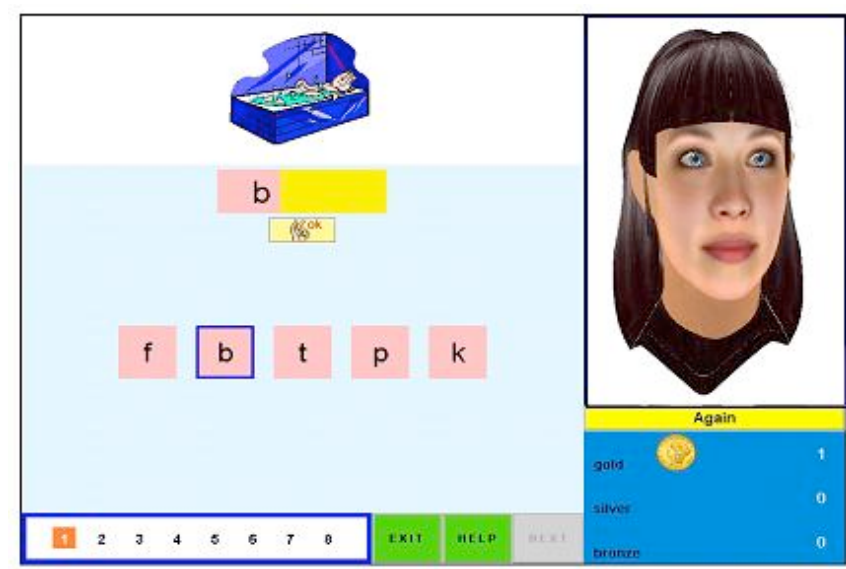


Figure 2: “Beginning Sound” Tutor

Tutors, such as the example illustrated in Figure 2, will choose input words for lessons from this sequence to match students' needs, and authoring tools allow teachers to insert particular words of their own into any Tutor. The programs will have default settings of time per domain, balanced between skills work in Tutors and application, fluency, and comprehension in Books. The balance of instruction leans more towards foundational skills work at kindergarten and first grade levels and moves to more and more reading in context as students progress.

A teacher menu will allow teachers to accept default settings, to modify those settings to match their instruction that day, or to select different selections of pre-programmed sequences or times of instruction per domain. Teachers and students will help in the design and modification of activities. We will scale up the new foundational skills Tutors through various design activities with teachers and reading specialists. Teachers are looking forward to how the programs will extend their teaching resources, so they can work with more students one-on-one, knowing that others are receiving effective, individualized instruction from the computer programs.

3.1 Interactive Books

Our goal in designing interactive books will be that of providing a powerful and immersive environment for learning new knowledge and acquiring new skills. In this environment, students will interact with intelligent

animated agents using natural communication skills. Advanced human communication technologies - including speech recognition, natural language processing, speech generation, character animation, computer vision and dialogue modeling - enable students to engage in natural face-to-face spoken dialogue interaction with intelligent, perceptive animated characters that will behave much like sensitive, caring and effective teachers and mentors. This software will be freely available to educators and university researchers worldwide.

Interactive books will be designed to serve several functions. These are:

- **Learning tools** designed to help children learn to read fluently and effortlessly, to develop effective strategies to comprehend what they read, and to apply knowledge gained from reading to real world situations.
- **Authoring tools** for designing effective and immersive learning experiences. These experiences include dialogue interaction with animated characters in a wide variety of contexts (e.g., comprehension training, sounding out words), having students reading aloud with real time feedback on the pronunciation of each word (provided by an automatic speech recognition system) narration of stories by animated characters, and the ability to create or revise change their own animated stories.

- **Test beds**

- Researching and developing perceptive animated interfaces - systems that engage users in natural face-to-face conversational interaction with intelligent animated characters;
- Researching, developing and evaluating core technologies in learning tasks; including speech recognition, speech generation, natural language processing,

computer vision, computer animation, and dialogue modeling and management;

- Conducting education research in reading instruction, second language learning, knowledge acquisition in content areas, comprehension training, etc.

Interactive books, such as that illustrated in Figure 3, will incorporate leading edge speech, language, computer vision and character animation technologies to provide engaging and immersive learning experiences.

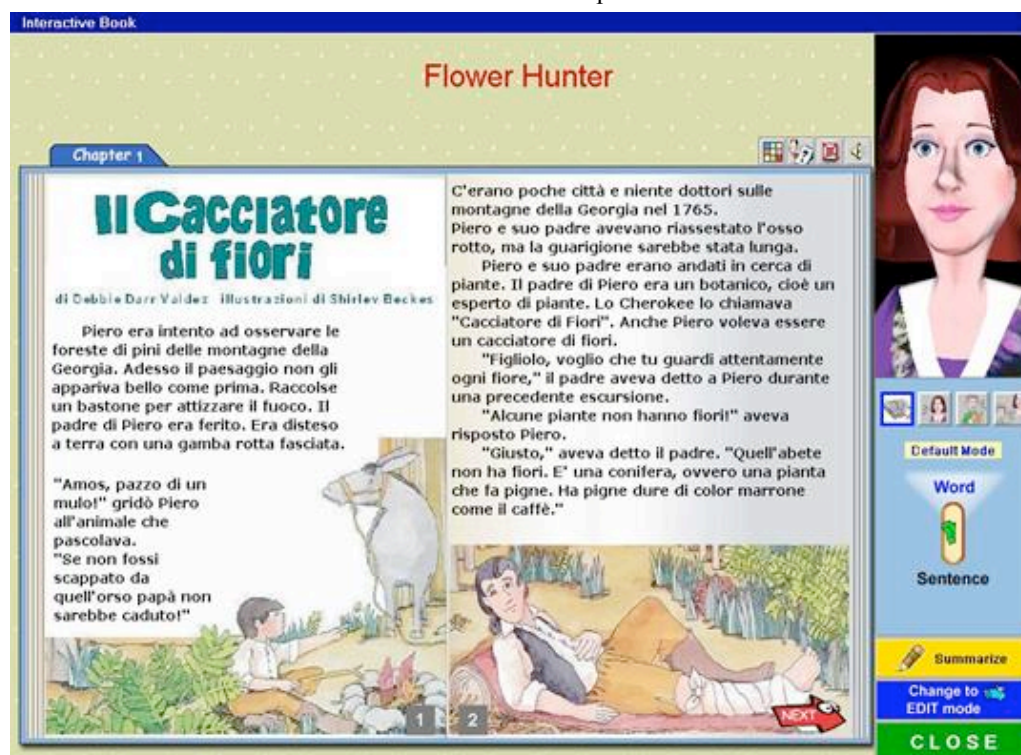


Figure 3: An example of an Interactive Book.

In what follows, the main features of interactive books in terms of the learning experiences they enable and the technologies that enable them are described.

3.1.1 Animated Speech

Three dimensional animated computer characters produce natural or synthetic speech, a wide variety of facial expressions and emotions, and natural body movements.

To overcome limitations of text-to-speech synthesis, applications can use naturally recorded speech, aligned and synchronized automatically with the visibly accurate production of Italian or English speech of the animated characters.

The characters' heads can be rotated and made semi or fully transparent, so children can watch how sounds are made to improve their own speech clarity and to detect errors. If a child has, for instance, left out the "l" in spelling "sled," the coach can direct him to watch the tongue movement right after the /s/ in "sled" to discover the missing sound. Children can also compare

video capture of their own mouths, in speaking a sound or a word, to the articulation of the coach's mouth. This encourages active and clear speech in the exercises, to improve both the clarity of the child's speech and the underlying precision of his phonological representations for words. They can narrate the book or engage the user in conversational interaction. For example, the animated character LUCIA can narrate an entire story while individual words, sentences or paragraphs are optionally highlighted. Or, LUCIA can narrate portions of the text, while individual characters displayed in illustrations "come alive" to speak their parts. In addition to telling stories, LUCIA can pronounce individual words (or syllables in words) that are selected by the student, or provide hints to help the student decode the word. Finally, LUCIA or other animated characters can engage the student in dialogues to train and test comprehension.

In addition to producing accurate visible speech with associated facial expressions and gestures, animated characters can provide visual feedback to students

during learning and conversational interaction. For example, the character can nod while the student is speaking or look puzzled if the system does not recognize what the student is saying. The character can also provide visual feedback and reinforcement, in the form of a head nod, smile, “thumbs up” or other gestures when the student provides correct answers. We will argue below that visual components of conversational interaction are critically important to effective communication and learning.

3.1.2 Speech Recognition

There are many ways in which speech recognition is used in interactive books. Speech recognition enables students to read aloud while receiving real time feedback about their word recognition and pronunciation accuracy. In this application, the recognizer determines if words are pronounced accurately and provides immediate visual feedback about correct and incorrect pronunciations. Speech recognition is also used during spoken dialogue interaction with animated characters. The animated agent may ask the student to provide specific answers to questions (“What did Mary eat for breakfast”), or elicit more complex utterances that require inferences (“Why did Mary get angry?”). Or, the animated agent may ask the student to produce a spoken summary of what she just read. In each of these cases - reading aloud, providing specific answers to questions, producing open-ended responses; and summarizing stories -different speech recognition systems are used to process the speech.

3.1.3 Natural Language Processing

Utterances that are transcribed by the speech recognition system or typed by the student are processed to interpret semantic content. When students converse with animated agents in spoken (or typed) dialogues, robust semantic parsing techniques are used to assign word strings to semantic frames and interpret the users’ intended meaning. When students produce spoken or typed summaries of stories, Expert System for Summary Evaluation (ESSE) [5] or Latent Semantic Analysis (LSA) [6] techniques will be used to analyze the summaries and provide feedback about their quality and conciseness.

3.1.4 Computer Vision

Computer vision plays a key role in interactive books, enabling the system to locate and identify the student, track the student’s movements and interpret his or her visual behaviors. An accurate face tracking system will be incorporated into interactive books. It will be possible for the animated agent to orient to the student, and move its head or eyes to follow the student’s movements. Once the location of the student’s face is determined, face recognition algorithms can be used to identify individuals, to recognize visible speech, and to interpret facial expressions and gestures. We note that interactive books are an ideal test bed for research on the integration of auditory and visual information to improve human computer interaction. For example,

auditory and visual information can be combined to improve speaker identification, recognition and understanding of speech, and to more accurately interpret the cognitive and emotional state of the student.

3.1.5 Face-toFace Conversations

Face-to-face conversational interaction with animated characters occurs through real-time integration of speech recognition, natural language understanding, speech generation, facial animation, computer vision and dialogue modeling technologies.

3.2 Authoring Tools

Interactive books will be accompanied by a set of powerful authoring tools for designing interactive books, or more generally, learning applications. These tools will enable authors to create stories that will be displayed in electronic form as books with text, illustrations, and animation.

Authors will be able to design animated productions of the text, in which different characters narrate their parts, much like characters in an animated movie. A library of facial expressions, gestures and animation sequences are available to animate characters, giving designers great flexibility and control of how characters behave during interactions with the user. Authors can also construct structured or unconstrained (mixed-initiative) dialogues between animated agents and students to test comprehension or to encourage students to think deeply about the events within a story.

Thus, Interactive Books provide a powerful test bed for research and development of applications that can be used to understand the principles and implementation of good learning tools and communication systems.

4. The Balance of Instruction

Programs will balance reading for meaning with instruction of foundation-level skills. The balance of instruction will shift as students progress, from more skills work for early readers to more book-reading as children improve. Beginning readers will read Books with decodable and with predictable language, and practice comprehending stories that are read to them by coaches.

Programs will follow a default sequence of spelling-sound patterns (orthography), based on simplicity and consistency of regular words and on frequency of sight words. Programs will move children up and back along these sequences, depending on performance. For instance, children will practice words with consonant blends (e.g. “spot”) only after demonstrating success with simpler words without blends (e.g., “pot”). Item sets in Tutors will begin with an “easy” item, proceed to instructional items, and finish with an easier item.

The program also will have “default” percentages of time to be spent in skill domains, depending on the student's needs. The program will a default time allotment of 30 minutes, or the teacher or student will be able to select the time they want to spend with the

programs, regularly or for a particular day. According to the default settings, students will complete a domain's activity, when they will have finished 2 item sets or finished the time limit, whichever comes first. Students may choose among activities in a domain, and may choose reward activities, including Books. In general, the time in Interactive Books is the most flexible, taking up any time remaining after Tutors.

The teacher menu will allow teachers to select the default sequence, choose among different pre-programmed sequences, or to override a sequence for the teacher's own set of words or choice of orthographic structure to work on that day. Teachers will be able to choose more or less strict per cent correct criteria, and they can vary the number of files at criteria needed to advance. Teachers can also modify percentages or amounts of time for students to spend in skill domains and in Books.

5. Assessment

The objectives of the Assessment are to provide formative and summative evaluation feedback about the interactive books and reading tutors and to develop on-line assessments that can place students into the appropriate instructional levels of tutors and books as well as assess their progress. Formative evaluation includes feedback that will promote, improve and enhance the development and dissemination of the books and tutors. Summative evaluation involves assessment of the educational efficacy of the books and tutors, i.e. whether or not they improve students' reading more than other types of intervention.

Parents and teachers will be surveyed about students' reading and computer habits. This information should help us determine the themes, characters and activities that students enjoy at different age levels. It should also give us a sense of students' access to computers and their computer literacy at different grade levels. This information will help us determine the type and range of software instruction that should preface and accompany students' use of tutors and books.

Once the interactive books and tutors have been fully integrated into targeted schools, feedback from parents, students and teachers will be obtained through surveys and interviews. Their perceptions will be analyzed for trends that indicate the usability and sustainability of the books and tutors.

On-line assessment will be developed by the use of computerized assessments, both to place students into the appropriate levels of interactive books and tutors, and later to assess their progress in foundational reading skills.

The summative evaluation of the books and tutors will ask the question: Is the use of interactive books and reading tutors more efficacious than the use of an alternative computer-based reading intervention or the traditional intervention?

The question will be answered by comparing the reading performance of students in the ILT Book and

Tutor group with students in two matched groups, one receiving the traditional intervention and another receiving traditional instruction. Lastly, the number of hours of special education services received by students in the ILT Books and Tutors group will be compared with that of students in the other groups. This final analysis will help us address the more practical aspect of the cost-effectiveness of the interactive books and tutors, a perceived value-added aspect of the ILT Books and Tutors program.

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