SPELLWELL CASE STUDY

GAME-BASED E-LEARNING TO IMPROVE ENGLISH SPELLING OF VISUALLY DISABLED YOUTH, APRIL 2006

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1.0 ABSTRACT

1.1 Objective

The SpellWell case study analyses the need and methodology of co-creating with end-users, universally accessible e-learning products that are engaging and effective, for both visually disabled and sighted audience.

1.2 The Need for a Spelling Learning Tool

Learning spellings is a multi-sensory experience - writing words provides a tactile recall and reading provides a visual recall. Understanding of spelling rules with drill and practice helps in remembering and writing correct spellings. Most blind young adults, especially in Indian context, are poor spellers of English language because they are auditory learners who rely on volunteer readers, cassettes or screen-readers for learning and on scribes while taking examinations. Also, contrary to belief not many visually disabled people know Braille.

Thus, they have little tactile or visual experience with English words making them poor spellers who face unique problems like misspelling homophones (e.g. sight, site, cite), which sound the same. Poor spelling leads to poor communication, which impedes pursuit of higher education and career growth.

With India emerging as a global back-office hub new opportunities have opened up where sense of sight is not imperative and where large numbers can get employment, like medical transcription, telemarketing and data-entry. However, visually disabled young adults lack requisite skills like good English communication to tap these opportunities. An ICT based solution for improving English spelling makes learning 'fun', universally accessible, have more reach and still be cost competitive

1.3 Product Development Challenges and Solutions

Little pedagogical research is available on developing e-learning for visually disabled learners. The key challenge in developing SpellWell was to make the learning experience effective and engaging even with the monitor switched off and the mouse unplugged, as that is how visually disabled learners interface with computers.

SpellWell provides a tactile experience for remembering spelling through repeated typing of a word till it is spelled correctly. However, this drill & practice is embedded in a game to eliminate monotony. SpellWell provides mistake-based feedback comprising of correct

spelling, associated spelling rule, examples with contextual usage and mnemonics to help recall. Relevant wordlists like business words or commonly misspelled words ensure high learner motivation.

We experimented with various pedagogical approaches like embedding words in a story followed by game-based exercises but this approach could tackle only a few words over long seat time; then we created a prototype with a character-based approach, a coach teaching spellings, but found that understanding virtual characters was a problem for visually disabled learners who were new to computers. After much user testing we created an interactive quiz show based on a 'game-show metaphor' that the learners could understand easily.

"Soundscapes" and audio cues provide equivalent of visual navigation elements. Human voice instead text-to-speech provides drama that enhances engagement. The UI has large fonts and high contrasting colours to facilitate low vision users. Learners' performance is tracked and reported. The product is built modularly and more wordlists can be added. SpellWell will be integrated with our online learning community, EnableAll.org for access to enhancements and to support peer-based learning.

2.0 INTRODUCTION

The project, SpellWell, is based on a Research Study conducted by our company, Enabling Dimensions, in January 2002 in New Delhi, India. We found that like anyone else, people with visual disabilities too want to improve quality of their lives and becoming financially independent is the key to improving quality of life. Earlier, in agrarian and industrial economies, since nature of work was highly physical, lack of a sense proved to be a major impediment. However, in today's knowledge oriented economy, mental faculty matters most and technology becomes a great enabler helping people with disabilities overcome lack or deficiency of senses.

Knowledge-oriented economy has opened new employment avenues for people with visual disabilities. With India emerging as global back-office hub opportunities have emerged in sectors like telemarketing, medical transcription and call center operations. However, most visually disabled young adults, who can tap these opportunities lack the skills to perform well in these jobs. Hence, the key challenge is to provide job-oriented skills relevant to prevailing economic milieu.

Talks with potential employers revealed that key skill baskets that enhance a person's employability today are – Basic IT skills, English language and communication skills, soft skills, logic & reasoning skills and specific to people with disabilities, independent living skills. This is not an exhaustive set but having these skills significantly increases a candidate's probability of getting a job.

Traditional institutes offering training in these skills are mostly not equipped to cater to the special needs of students with disabilities as their premises and course material are inaccessible, teachers are not trained to service special needs of students, commuting to reach the training institute is a problem for the students, tuition fees is high and they have limited reach.

As opposed to this, ICT-based education can be made universally accessible, it overcomes the trouble of commuting, it is more democratic because in a virtual classroom it is the students prerogative to reveal or not reveal his or her disability, e-learning has wide reach, multimedia content can make learning fun and provide

alternate learning paths and students can choose the one they learn best from, if managed well it can be very cost-efficient and e-learning allows own pace, own time

learning as also allows the learners to repeat a lesson any number of times, which is a very useful feature for a person with visual disabilities who may need several iterations to learn something new.

3.0 THE NEED FOR A SPELLING LEARNING TOOL

The research study was followed by an email survey among the visually disabled where 70% of the respondents reiterated the demand for English language course and 68% indicated that computer based or web based training would be the preferred mode of training, provided such training is engaging, interactive and accessible.

During the Research Study we dwelled deeper into the need to improve English language and communication skill and found that visually disabled students are poor spellers of English for the following reasons:

1. Unlike sighted audience who are visual learners capable of making orthographical associations, visually disabled students are primarily auditory learners because their learning is mostly through auditory means like audiocassettes or other human readers reading aloud to them. Therefore, they rely more on phonetic occurrence of words than their orthographical representation and more often than not spell words wrong. For example, homophones like sight/site/cite or arms/alms sound alike and hence are often misspelled.
2. Being auditory learners, visually disabled students get few opportunities to build orthographical association of word forms with their contextually correct spellings. Thus, orthography, a key element in the retention of spelling forms in the memory does not lend itself for use to this community.
3. Visually disabled students are dependent on transcribers to do their writing for them and this limits their exposure and practice.
4. Contrary to popular belief, a substantial number of members of the visually disabled community do not know Braille. This eliminates the tactile mode of lexicon association.
5. Even those who know Braille are not good at spelling because Braille uses shortcut notations and users fail to learn the actual spellings of these words.

Poor English spelling implies poor communication skills and becomes a big hindrance in career growth and in pursuit of higher education for the visually disabled. Good linguistics skills, both comprehension and creation, improve job prospects specifically in fields like medical and legal transcription, stenography, content writing and data entry. Competitive exams like CAT, B.Ed entrance exam, UGC-NET, TOEFL, GRE or GMAT, which need to be cleared for pursuing higher education also require a good grasp of English spelling and language.

Talks with Singapore Association of the Visually Handicapped, Malaysian Association of the Blind and National Federation of the Blind, Baltimore, USA further reiterated that poor spellings among the visually disabled community is an acute problem and a solution to tackle this problem is much needed.

Before discussing the pedagogy and development methodology of SpellWell, lets briefly scan how spellings have been taught or learnt over the years.

4.0 EVOLUTION OF TEACHING & LEARNING OF SPELLINGS

4.1 [1]Spellings in the 19th century

Numerous spelling books were produced. These books generally presented word lists to be memorized followed by short paragraphs to give the pupils practice in reading. These paragraphs were totally unrelated to the spelling lesson and had more to do with the behaviour of people than to do with behaviour of graphemes (letters).

[2]John Mayer Rice (born 1857) carried out the first scientific study in America on learning spellings in a classroom. The educational practices which Rice observed in his various field studies were characterized primarily by rote (mechanical) drill, aimed towards what Rice called lower results, i.e. memory of facts and processes. Spelling particularly was simply drill, with little rationale for the selection of words. Rules or patterns were rarely taught. Based on research Rice derived a set of recommendations for spelling instruction:

1. Use a variety of teaching methods
2. Devote no more than 15 minutes per day to the topic
3. Grade spelling words by orthographic differences and use
4. Give precedence to common words
5. Omit instruction for words that are easily spelled from their sounds
6. Separate regular and irregular words
7. Stress rules for adding suffixes
8. Begin drill as early as possible on difficult, small words

4.2 [1]Spellings in early 20th century

The situation did not improve in America. Children were given lists of words whose spelling was to be memorized by whatever system they found most productive. Whether the system used was largely visual or involved hand learning (acquiring a neuromuscular sense of the way it feels to write particular words) or oral repetition of the letters, it was essentially rote memorization of each word, followed by tests (dictation) and relearning of misspelled words by writing them over and over until they were supposedly fixed in memory. Evidence began to accumulate that children who could read could not

[1] From the book "Spelling: Structure and Strategies" by Hanna, Hodges & Hanna
[2] From the book "Cognitive Processes in Spelling" edited by Uta Frith, pages 19-23

necessarily spell. What was not recognized when emphasis was placed on reading vis-à-vis spelling was that the encoding and decoding processes are quite different. Spelling is the encoding of speech or thought into writing; reading is the decoding of writing into meaningful expression.

4.2.1 Encoding and Decoding

The use of all writing systems necessitates the learners' acquiring two closely related processes 1) the mastery of graphic symbols needed to set forth speech in writing (encoding or spelling), and 2) the ability to translate written or printed graphemes (letters) into the oral forms they represent (decoding or reading). But in English orthography because of lack a precise one-to-one correspondence between phoneme (sounds) and grapheme (letter), the encoding and decoding processes are sometimes disparate and confusing. Many phonemes can be spelled in several ways, for example, the phoneme /s/ may be spelled as **c (city); s (sit); sc (scene); ss (toss)** thus confusing the encoder. Similarly, the decoder must determine which of the several possible speech sounds is represented by a grapheme in the word he or she is seeking to decipher. For example, **o** in **go** or **o** in **women** has completely different pronunciation.

4.3 Spellings in 1930s

In the 1930s, two ideas stand out 1) choosing for the basic study list those words that were most frequently used and therefore most likely to be needed by pupils in their writing and 2) presenting the words for a week's work in an attractive and meaningful package. Instead of being presented only in an unadorned list to be memorized, most of the words were introduced in interesting stories with appealing illustrations and page make-up. In each lesson, the story was followed by a list of words to be mastered and by a set of exercises based both on the spelling of words and on the content of the story. Comprehensive spelling tests were usually given every six weeks. Another feature was *My Own Words*, a plan for providing for individual spelling needs. Pupils were encouraged to keep a notebook in which to record for study any words they needed to learn to spell or words they had misspelled.

4.4 Spellings in 1940s

Although the spelling tests of the 1930s provided some relief from the previous dull exercise of memorizing lists of words, ten years later, the story idea was continued, with expanded stories. Educators developed a six-step plan for studying a word by visual learning and hand learning combined, a plan that still has merit, especially when it comes to words that have maverick phoneme-grapheme correspondence – like **choir.**

My Own Words feature was retained, as well as the six weeks' tests that assured a systematic and spaced review of material previously taught.

4.5 Spellings in 1950s

Suspicion of the effectiveness of the introductory paragraph was generated as teachers found that the actual business of learning to spell was being sacrificed to lengthy discussions of the subject matter of the stories. Linguists like Leonard Bloomfield reiterated that English follows the alphabetic principle of writing in which phonemes (sounds) are represented by graphemes (letters), and that a spelling programme ought to begin by teaching phoneme-grapheme correspondences and guide pupils to use them in spelling written words.

4.6 Project 1991

In a study conducted by Stanford University in 1991, 17,000 American English words were analysed using computers and the analysis revealed:

4.6.1 American-English orthography is an alphabetically based orthography.

Alphabetic Principle

The alphabetic principle requires that each phoneme in a language shall have its own unique graphic counterpart (grapheme). In the language in which there is nearly a one-to-one correspondence between a sound and its letter representation (/f/ = f; /k/ = k) the task of learning to spell is quite simple. In Hawaiian, for example, there are 13 phonemes and 12 letters, thus the alphabetic principle is almost adhered to. However, in English there are 40 plus phonemes but only 26 letters (or graphemes).

While fewer graphemes representing more phonemes reflect the brilliance of an alphabetic orthography as it allows economical use of graphic characters, it also implies more effort to master rules governing the grapheme representation of the phonemes.

4.6.2 There is a pattern and system in the way words have been created and continue to be created. This morphological factor helps to account for many of the seemingly demonic spellings and knowledge of morphology contributes importantly to the pupil's development of a power to spell.

4.6.3 The number of "spelling demons" is relatively small (about 3% of the core vocabulary fell into this category)

5.0 TEACHING SPELLINGS TO THE VISUALLY DISABLED

Like any human learning in general, spelling ability is acquired through the senses. Therefore, learning to spell is a multi-sensory, multi-motor process involving speech, audition, vision and haptics (touch and kinesthetic) and different learners employ them in varying degrees, in varying ways and in different combinations.

In their book *Spelling: Structure and Strategies* the authors *Hanna, Hodges & Hanna*, note that while learning spellings the learners, "develop a 'cognitive map' of spelling, a map that in its construction involves the use of sense impressions stored in the brain: memories of sounds and 'feel' of the words as they are written".

To reiterate the problem faced by the visually disabled audience, when it comes to spellings, since they are auditory learners who have seldom written down words (most of them do not know Braille and even those who do know Braille, learn the short form of many words and not the full, correct spellings) they are poor spellers.

In learning spellings, for a visually disabled person understanding the spelling rule, meaning of the word and its correct contextual usage is as important as it is for their non-disabled peers. However, haptic association assumes paramount importance i.e. act of writing words to get a visual feel of the word is replaced by Braille or typing to get a kinesthetic retention. This learning strategy forms the basis of SpellWell.

6.0 CO-CREATING SPELLWELL WITH END-USERS

Little pedagogical research is available on developing e-learning for visually disabled learners. The key challenge in developing SpellWell was to make the learning experience effective and engaging even with the monitor switched off and the mouse unplugged, as that is how visually disabled learners interface with computers.

We created several prototypes and tested them vigourously with end-users to see which elements worked and which didn't. The final version has been co-created with end-users with pedagogical insights, user-interface, navigation, selection of word lists and level of complexity of language all based on feedback provided by end users during testing.

6.1 Prototype-1: Story-based approach

We analysed e-mails written by visually disabled users in email discussion groups like 'Access India' (http://www.freelists.org/archives/accessindia/) to understand what kind of spelling mistakes are most usually made. We learnt that besides the usual spelling mistakes made like doubling of consonants, or adding suffixes and prefixes, visually disabled were poor spellers of homophones.

Accordingly, we created two wordlists – Commonly Misspelled Words and Homophones - words the target learners often use and often misspell. We took a group of 10 such words and knit a story using these words, such that there contextual meaning was clear from usage in the story. The story was followed by exercises, where the learner was given a clue and had to type the correct word and the correct spelling.

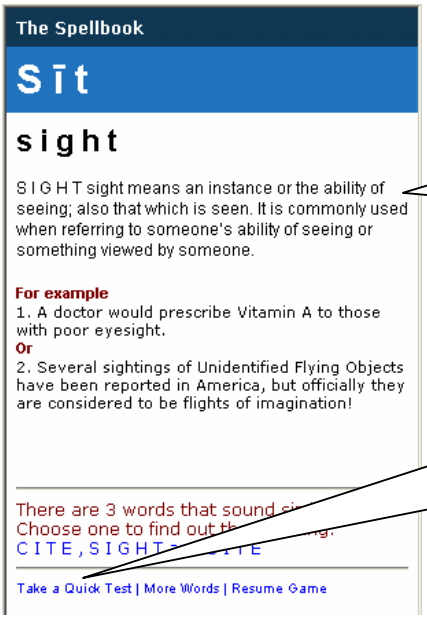
The learner got 3 attempts after which a new word would come and the word not spelt correctly would move into a "Try Again" list. The learner could also refer to a "Reference Book" where the correct spelling, meaning of the word, contextual usage and mnemonic, if any, were given. The learners could also take an optional Quick Test in the Reference Book to check if they had got the meaning and spelling right.

Figure-1: Screen-Shots of SpellWell Prototype-1

Contextual meaning of words is embedded in the story to show contextual usage of the words

A clue is given and the learner has to type the correct spelling of the word. Learner gets instant feedback.

A Reference Book is available



Reference Book gives the correct spelling of the word; its meaning and examples of contextual usage of the word

Besides the main game, learners can also take a Quick Test to ensure they have learnt meaning and spelling of a word

To test the effectiveness and engagement of the prototype we created a list of hypothesis we had made for each ability or skill the learner was supposed to learn and analysed these parameters during testing.

Figure-2: User-Testing Parameters

Skills/ abilities	Abilities/skills to be achieved/tested	Hypothesis	Priority
Knowledge	Ability to type the correct spelling	Drills and practice of spelling each word will reinforce the spelling in the mind of the learner	1
Knowledge	Ability to know the semantic difference in meaning between words	Knowing the meaning of a word will help learner remember the spelling of a word	1
Knowledge		Customised feedback on why the spelling is wrong or right will help the learner *significantly* in not repeating mistakes.	1
Knowledge	Ability to know the difference in usage of homophones via context		
Comprehension	Ability to differentiate between right and wrong spellings	Learners will be able to differentiate between right and wrong spellings when they know the correct rules and usage	1
	Ability to recognize a rule at work	Ability to recognize rules at work while spelling	
Application	Ability to apply morphological rules to root words or derived words to type the correct spelling (e.g. which words take –tion or –sion ending when it becomes a noun)	Knowing the morphological and derivational rules for a word will enable learners to apply this to spell derivations of that word.	1

Skills/ abilities	Abilities/skills to be achieved/tested	Hypothesis	Priority
Application	Ability to apply learned rules to similar words or words that follow the same rules (e.g. which nouns take –es or –s as plural ending)	Knowing the morphological and derivational rules for a word will enable learners to apply this to spell similar words	2

6.1.1 Key User Feedback on Prototype-1

- Embedding words in a story followed by game-based exercises helps in learning spelling but this approach tackles only a few words over long seat time
- Feedback comprising of correct spelling, associated spelling rule, meaning, contextual usage example and at places mnemonic to help recall, is too long and learner loses interest and concentration
- Backend engine has to do a better mistake analysis and provide appropriate feedback
- For advance learners, tackling simple words and listening to long feedback makes the product boring

6.2 Prototype-2: Character-based approach

Based on the user feedback and testing results of Prototype-1 we created Prototype-2, which was based on role-playing. The learner is a new member of the "Spelling Team". A coach takes the learner through different short exercises, which require correct spelling to be typed, thus embedding repeated typing of words to be learnt into different short games and the coach providing feedback. This approach allowed more words to be tackled in a shorter time span and a set of different games made the overall experience engaging.

The feedback was made crisp and as far as possible it was linked to mistake made. Example, if the learner had made a rule-based error ('frIEnd' spelled as 'frEInd') the associated "I-E" spelling rule was told. After first attempt, based on nature of mistake, feedback was given which comprised of one component of the total feedback like spelling rule or contextual usage example or meaning of the word. After second attempt, another component of the feedback was given and only after third wrong attempt the correct spelling were told and the word moved to Try Again list, comprising of words that reappear later in other games till the learner spells them right. This approach chunked the feedback and made the product move faster, thus enhancing the engagement aspect, especially for advance learners, who knew simple spellings and wanted to move to complex spellings faster.

Since we wanted to test specific hypothesis only flash-based "sound-scapes" were created for user testing, no visual UI was developed.

6.2.1 Key User Feedback on Prototype-2

- Understanding virtual characters and virtual spaces, based only on sound was a problem for visually disabled learners who were new to computers
- Chunked feedback was very well received
- Advance learners felt that besides homophones and commonly misspelled words other theme-based words would increase the relevance of the product for advance learners. Example, words from politics or business communication or entertainment and other themes

6.3 Prototype-3/Final Version – Interactive Quiz

The third prototype we created was an "interactive quiz show" based on a 'game-show metaphor' that the learners could understand easily as they had participated or heard such quizzes in their schools or colleges or on radio and television. This prototype performed well during user testing and the final version of SpellWell is based on this approach.

The quiz is divided into Episodes. Each episode covers 5 homophone sets, 5 misspelled words and 3 words based on a theme that the learner has chosen from a given list of themes. In the backend database words are divided into Pedagogical Units, based on spelling rules. Level of complexity is also defined and based on learner performance the engine throws simple or complex words. Scoring is based on complexity of word and number of attempts taken. Learner performance is tracked and compressive progress reports are provided.

7.0 KEY PEDAGOGICAL AND ENGAGEMENT ASPECTS

1. **Repeated typing:** A quizmaster voice-over provides clues and learners have to type the right spelling. Each wrong attempt gives feedback based on mistake. After third wrong-attempt the learner is told the right spelling and has to type in a mode where all other keys in the keyboard are locked. This is to ensure that learner types the correct spelling and gets a haptic recall of the word. The word also moves to a Try Again list and reappears later for repeated typing till the learner learns the spelling.

2. **Feedback:** comprises of the key elements that are useful in learning spelling,
    a. Spelling Rule
    b. Meaning
    c. Correct spelling
    d. Contextual Usage
    e. Mnemonic for 'demon' spelling that don't follow a rule or are words borrowed from other languages

3. **Mistake analysis:** The system analyses the word typed and the error made. If it is a rule-based error then the learner is told the rule, if it is wrong contextual usage of a homophone, learner is explained the meaning of the word and given example of contextual usage.

4. **Chunked Feedback:** helps in making the product more engaging as the learner can move through the product at a faster pace, tackling more spellings in a shorter time span. If advance learners spell a word correct, they are given a short congratulatory feedback and move to the next word. This is so that they don't get bored listening to feedback on words they already know how to spell.

5. **Relevant Wordlists:** Words selected are those that the learners frequently use either during their studies or in their job, thus ensuring higher learner motivation.

6. **Learner Tracking:** the backend engine works like a LMS and tracks the learner performance and provides Reports. **Scoring** has been introduced to add a competitive element

7. **Human voiceover** instead of synthesized voice of text-to-speech has been used to ensure engagement through drama in voice. Thus, learners don't require expensive screen-readers to use SpellWell. Human voice also ensures easy comprehension as compared to text-to-speech voice, which usually uses foreign accent that is difficult to comprehend for Indian students. **'Sound-scapes' and music** further enhances the engagement aspect.

8. SpellWell is **XML**-based and the modularity means more wordlists can be added later

9. SpellWell will be integrated with our **online learning community**, www.EnableAll.org for access to enhancements and to support peer-based learning.

8.0 ACCESSIBILITY FEATURES

- SpellWell has an audio-based interface and is fully accessible to visually disabled learners
- The UI has large fonts and high contrasting colours to facilitate low vision users
- An alternate keyboard-based navigation is available that obviates the use of mouse, as blind students do not use the mouse

Figure-3: Screen-shots of SpellWell Final Version

Based on a game-show metaphor, SpellWell is an interactive quiz that uses human voice instead of text-to-speech for engagement

Keyboard navigation through access-keys instead of mouse-based navigation

Wordlists relevant to the needs of the learner, to ensure learner motivation - homophones, commonly misspelled words and theme-based words

Words follow a pedagogical structure – spelling rule and its exceptions

Learner is read out a clue and needs to type in the correct spelling.

Letters typed by the learner are read out aloud

Mistake-based Feedback:

- Correct spelling
- Meaning of the word
- Contextual usage example
- For tricky words, mnemonics are given to help recall

Where relevant the associated Spelling rule is explained

Learner performance is tracked and reported

Scoring for motivation

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