Degree Project (Stage I)

A Tool For Adults To Learn The

Devanagari Alphabet

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Approval Sheet

The Interaction Design Project II entitled 'A tool for adults to learn the Devanagari Alphabet' by Mr. Milind Kaduskar, Roll No. 07633006 is approved in partial fulfilment of the requirement for the Masters of Design degree in Interaction Design

Signature:

Project Guide:_____

Chairperson:_____

Internal Examiner:_____

External Examiner:_____

Abstract:

The aim of this project is to develop a personal tool which helps an adult to learn the Devanagari Script. The tool uses writing as the focus for learning the script. As the project advanced, the focus was narrowed down to helping illiterate adults of India to learn the Devanagari alphabet. The system still uses writing as its focus but can be expanded so that it caters to reading and speaking as well.

After studying the process undergone by illiterates in learning Devanagari script, the findings were listed out as problems. Based on these problems, goals were defined for the system which were then attempted to achieve through various design ideas. The ideas which satisfied the most important goals in the most satisfactory manner were explored further. A sequence for the alphabet to be introduced to the user was decided and a hierarchical structure was designed. Based on these pillars, the final system was developed.

Acknowledgements:

I'd like to extend my sincere gratefulness to my guide, Prof Anirudha Joshi for his patience and guidance. I also thank the institute for providing me with this precious opportunity. I'd like to thank Punam Medh for her invaluable expert guidance. Moreover, I'd like to thank Aboo, Sarita, Shilpa, Sharon, my nine students and everyone else at Oasis India for letting me work with them. It was a rare opportunity that I will always cherish.

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Last but not the least, I am forever indebted to my family and friends for their unfailing support, encouragement and timely help.

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Introduction:

Only 61% of the adults in India are literate (UNESCO, including the Education for All 2000 Assessment.). So, a solid 39% of the adults (15 years or above) in India are illiterate. Illiteracy defines almost every aspect of their life because it affects almost every aspect of their life. They get cheated at every step, every day, they face insults and mockery, they undergo a lot of adversities because they are illiterate. Most of they would love to study and become illiterate if life presents them with the opportunity to do so. But it seldom happens and they remain trapped in their vicious cycle of poverty and illiteracy.

Learning for an adult is very different than that for a child. It becomes much more difficult to learn for an adult. Not only are there cognitive issues, the adult faces psychological issues and real life issues such as lack of time, resources and inclination. As a child one is used to new experiences and hence is inclined to accept and adapt to new methods. Hence, the activities such as learning to write are easier for a child than for an adult who cannot adapt that easily to these new methods.

There are people who work in this area to try and help the adults of India become literate. Many NGOs such as Pratham, Oasis, etc have been working for adult literacy. Also, there have been projects by TCS and IIM Ahmedabad which have tried technological or innovative approaches at adult learning.

This project aims at generating a solution that will help the illiterate adults of India. The project focuses at understanding the issues that are involved with adults and with illiterates, and developing a system that will cater to their needs. It tries to generate a system help the illiterate adults learn the alphabet of Devanagari. Once they have set the first foot into the world of literacy, the next step should be a lot easier. The basis of this project is using writing for getting familiar with the language. One of the objectives is to find better and innovative ways in which the process of learning to write could be made more interesting and involving. It explores ways in which writing can be used to strengthen the base of the language in the mind.

Theoretical Study:

In order to understand how the mind works when processing language data and also to study the issues related to teaching adults, certain theoretical reasearch was carried out during the project. Mainly, the following topics were looked into:

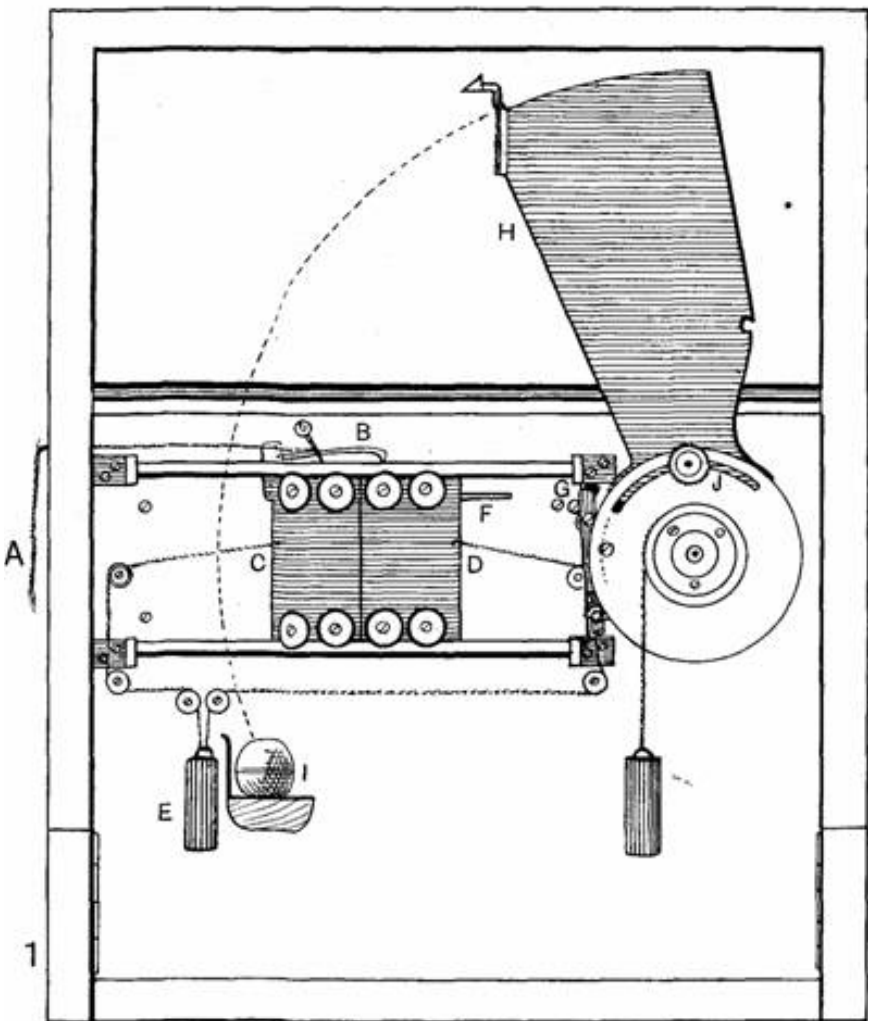
- Tachistoscopy

  This method was researched as a possible methodology for helping the adults learn faster. Although it was later rejected, it helped understand the working of the short term memory better.

- Lexical memory

  This topic was studied because it explained how the brain organizes and manages information. This knowledge helped gain more insight into the working of the mind as far as scripts and languages are concerned.

- Adult learning principles
- Learning to read
- ARCS model



Pulling A releases B which opens shutters C and D due to weight E. F attached to D hits G which allows H to fall in place. The user sees the image in the short duration between the opening of C and D and falling of H. (Image Courtesy:Bartlett, F.C. (1916). 'An experimental study of some problems of perceiving and imagining', British Journal of Psychology 8: 266)

Tachistoscopy:

Tachistoscopy is an experimental method which involves exposing the subject with visual stimulants for a very brief amount of time. It has been used previously on several occasions for research purposes relating to memory.

Tachistoscope:

It is a device that presents a visual field to an observer for a carefully controlled time interval [3].

It flashes an image for a very short interval to the observer, so that it gets registered only in his short term memory. It is used by researchers to study human memory[9] and also has been associated with research in letterforms [1]

This method was among the initial considerations as an option for strengthening the memory for letterforms of the users.

Previous applications of Tachistoscopy:

- Training of fighter pilots in WWII.
- Eye testing
- Memory testing
- Advertisement industry

Lexical memory:

Lexical means of or pertaining to a word. The Lexical memory is our ability to remember words or morphemes - the vocabulary of a language[2]

The lexical memory is stable over time. New words come in and old words may exit but these are merely ripples on the outer edges while the core remains unchanged.[2] Also, the retrieval from the memory is through a specific mechanism. If a person is given a word as a stimulus, his response will be in the same syntactic category and the word he gives will be in some way related to the stimulus. [2]

The lexical memory is arranged using semantic components of the word. For example, 'female' is the semantic component of the word 'sister'. Hence, saying 'female sister' is redundant but saying 'maiden sister' is not since unlike sex, marital status is not a semantic component of the word sister. The more semantic components given two words share, the more similar in meaning they will be judged to be. And hence, closer will they be in the lexical memory. This understanding helps in tracing how the memory accesses the huge database of words[2]. Further study into the semantic component formation of a word yields deeper understanding of the lexical memory.

Adult Learning Principles:

Learning for adults cannot be by the conventional pedagogical approach. Tracy L. LaLonde, in her article[7], states that as opposed to pedagogy, andragogy is an approach where the learner and the teacher collaborate to bring about learning for the adult. This method yields much more successful results as compared to pedagogy where the teacher is the instructor and the adult is supposed to follow instructions blindly. This fails because as an adult, the student cannot suspend his rationale and hence, feels compelled to question and disobey orders given without consultation or explanation.

In her paper[7], she states that andragogy encompasses five assumptions:

- Learning is self directed:

This means that the adult is in the co-pilot's seat. Adult learners take responsibility for themselves and so, every stage of the learning process, right from planning to execution and evaluation has to involve the learner's opinions and judgement. This does not mean that the teacher does not take responsibility at all, but it means that both the teacher and the student collaborate.

- Learner has experience:

This is a big difference as compared to children. As an adult, the learner already has a lot of experience and has developed the habit of learning from experiences.

So, if this is made use of and the learner's experience is used to teach then the process is bound to lead to success. The teacher must build upon the learner's experiences.

- Adults learn when they perceive a need:

As adults, the learner will not learn just because he is asked to do so. The teacher cannot order the learner to pay attention. The learner will be interested only if he/she feels the need to learn what is being taught. Only if they realize that this is necessary for them, they will learn. The teacher must help learner understand why this skill is important.

- Adults want reality:

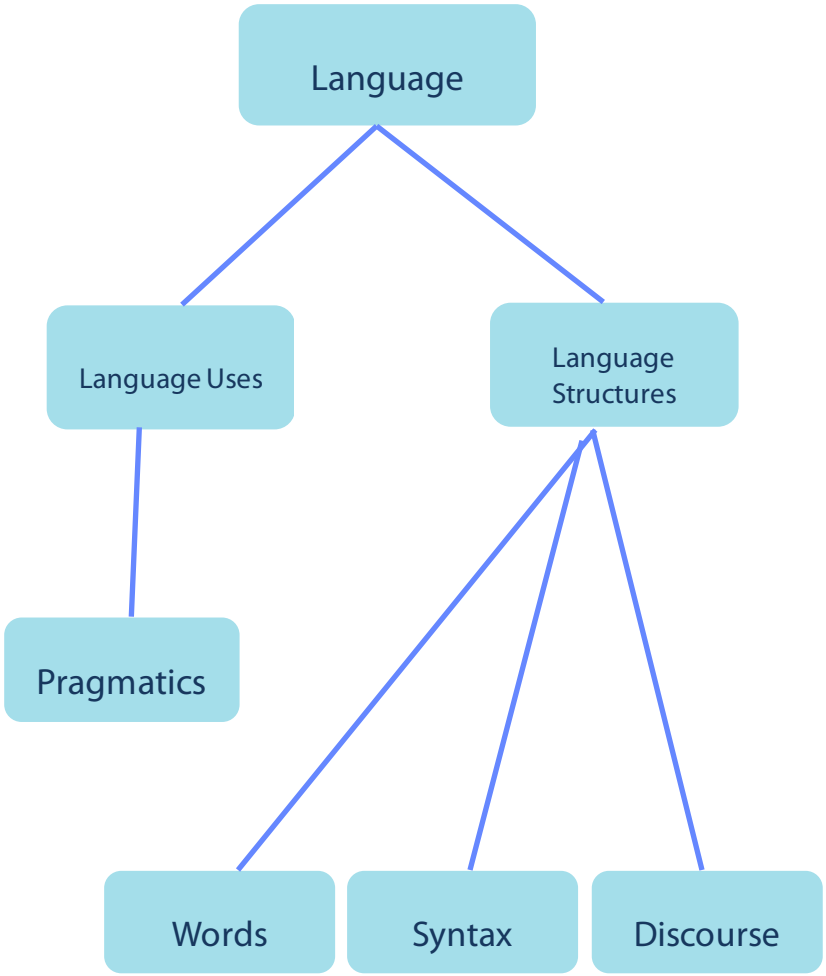
Adults will like to learn only when they see application just around the corner. They will be motivated to learn when they see the relevance to their lives and are able to apply what is being learnt as quickly as possible. As put in the article, "They like to 'do' rather than to be simply told what to do."

- Motivation is internal:

The motivation for the adult should come from within, such as self esteem, the desire for recognition or natural curiosity. External motivation factors, though helpful, do not make as big a difference.

The article also states that the learners need one of the six "perceptual modalities" to grasp the content. These modalities and examples of each are described as:

- Visual: Videos, graphs, slides, demonstrations, learning through use of the eyes.
- Print: Text, paper-and-pencil exercises, absorbing the written word.
- Aural: Lectures, audiotapes, learning through use of the ears.
- Interactive: Group discussion, Q&A sessions, learning through the exchange of ideas.
- Tactile: Hands-on activities, learning through handling objects or putting things together.
- Kinesthetic: Role plays, physical games and activities, using psychomotor skills and movement. than intrinsic motivation factors[7].



Language pragmatics and structures

Learning to read:

Bruning, Schraw and Ronning in their book[8] describe in detail, the fundamentals behind the human mind's process of learning to read. Language is basically made up of Language uses (the pragmatics) and the Language structures, which is the words, the syntax that strings those words together and the discourse which is formed when words and syntax get together[8].

Pragmatics:
Language not only serves as a channel for interaction, it also is a medium for us to communicate our feelings and values. It is a technique by which we have been able to discuss future and preserve our past. Most of what we know is communicated through language[8]. Thus, language is pragmatic in that it affects every aspect of our life and fulfills vital human needs.

Phones: All sounds that a human being can make including clicks, chirps, babbling, to our familiar vowels and consonants

Phonemes: The small subset of Phones that are perceived by speakers and listeners of that language as meaningful.
Phonetic awareness: The awareness that phonemes are the individual meaningful units and the ability to manipulate them.

Morphemes: The sounds or combination of sounds that are the minimal units of meaning in a language (joy-ful-ly)

Words:
Words are the building blocks of a language[4]. Phones are the raw materials of a language. Phones combine to make up phonemes and morphemes. The combination of morphemes and phonemes makes up symbols which we call as words. Semantics, the study of words and vocabulary, has been the area of greatest interest for scholars[8]. Combining words according to a particular set of rules gives us coherent sentences. These rules are syntax.

Syntax:
The next level after words in understanding the languages syntax, the organization of words into higher units such as phrases, clauses and sentences. Its onset is even earlier than morphology, which is the capability to identify morphemes in the words[8].

Discourse:
There are two kinds of discourses. A discourse which is in the form of "Stories" that is, structured by a temporal sequence of events is called a narrative. On the other hand, the discourse made up by a combination of sentences that reflects the organization of abstract thought about a topic or a body of information is called an Exposition[8].

ARCS model for motivation[10]:
John Keller[10] has developed a model which categorizes and explains the basic fundamentals that are necessary to motivate an adult learner to study. This model is called the ARCS model. It has two parts. The first part states the categories of the model which have been created after a long and thorough research[10]. The other part is the design process which helps in implementation of the model.

ARCS Categories:

Attention:
Perceptual arousal
Inquiry arousal
Variability

Relevance:
Goal orientation
Motive matching
Familiarity

Confidence:
Learning requirements
Success opportunities
Personal control

Satisfaction:
Intrinsic reinforcement
Extrinsic rewards
Equity

ARCS Design Process[10]:

The ARCS design process as described by John Keller is as follows:

- Knowing and identifying the elements of human motivation
- Analyzing audience characteristics to determine motivational requirements
- Identifying characteristics of instructional materials and processes that stimulate motivation
- Selecting appropriate motivational tactics
- Applying and evaluating appropriate tactics

Using these steps of design process, the ARCS model can be applied to inspire an adult learner to be motivated.

The Process:

The project started off with the objective of generating a system which will help adults learn to write a new language. With this objective in mind, there were these basic kinds of user groups to study:

- Adults who travel frequently for longer durations (also includes adults who immigrate)
- Adults who like to learn new languages
- Adult illiterates

So, a preliminary user study was conducted among the users of the first two groups. Also some theoretical research was carried out to understand how the human mind processes and stores language or vocabularies. After these initial studies, the focus was revised. The target audience was decided as adult illiterates and the language was decided as Devanagari. Of course these were preliminary decisions subject to change.

In the next stage, further user studies were carried out with illiterate adults to understand their problems and issues. Analysis of the data collected lead to a classification of data into problems, leading to goals.

The focus was fine tuned to a system that will help adult illiterates to learn the Devanagari alphabet. Also, from the goals, design ideas were generated. Also, more theoretical research for adult learning was carried out.

Further, moving on from this stage, design ideas were explored in the form of soft prototypes. These prototypes helped in understanding the feasibility of the solutions and ideas and gave further basis for more ideas.

Preliminary User Studies:

The following users were studied to understand more the problems faced by people who belong to either of the first two categories of potential target users:

- Users 1 and 2:

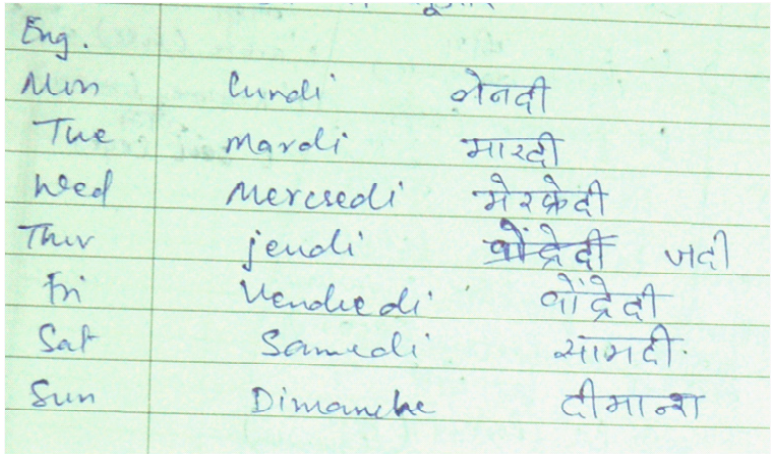
Aged around 24, these two users learnt new languages based on Roman Script (French and German respectively) They are both management students and they were taught these languages as a part of an extra course they took.

- User 3:

Aged 34, this user is trying to learn Russian (Cyrillic script). He is learning Russian out of hobby and interest in languages. He has interaction with Russian clients and friends as part of his occupation and hence he got interested in the language as well.

- User 4:

Aged 23, this user tried to learn Tamil. This user is a student whose mother tongue is Malayalam. It being so, he has a few advantages because there are some similarities between the two languages. Being with his relatives in Tamil nadu, he got interested in the language.



Findings and Insights:

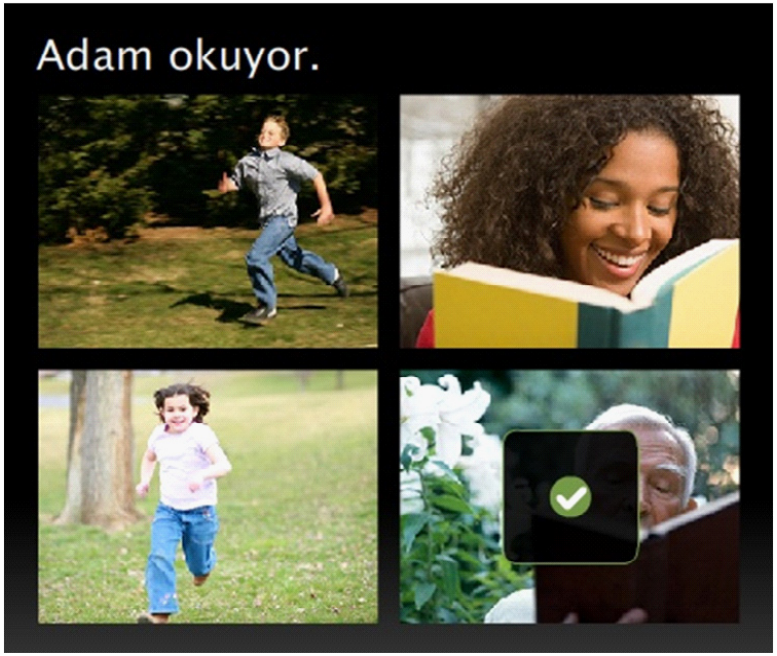
Users 1 and 2:

Findings:

- Learnt at college as an extra course of 20 hours
- Followed a printed manual
- Course aimed at quick introduction to the language
- More stress on learning to speak than to write
- Wrote words which were comparatively complex
- Taught through skits and songs
- First learnt alphabets, then names of days & months, followed by simple sentences

Insights:

- Writing used only to supplement the memory whenever complexities occurred
- Constantly referenced new letters/words with known languages (English or Hindi)
- Used Devnagri script to note the pronunciation
- Longer exercises (eg write passages) heavily relied on writing
- Special stress laid on teaching genders in Grammar



User 3:
Findings:

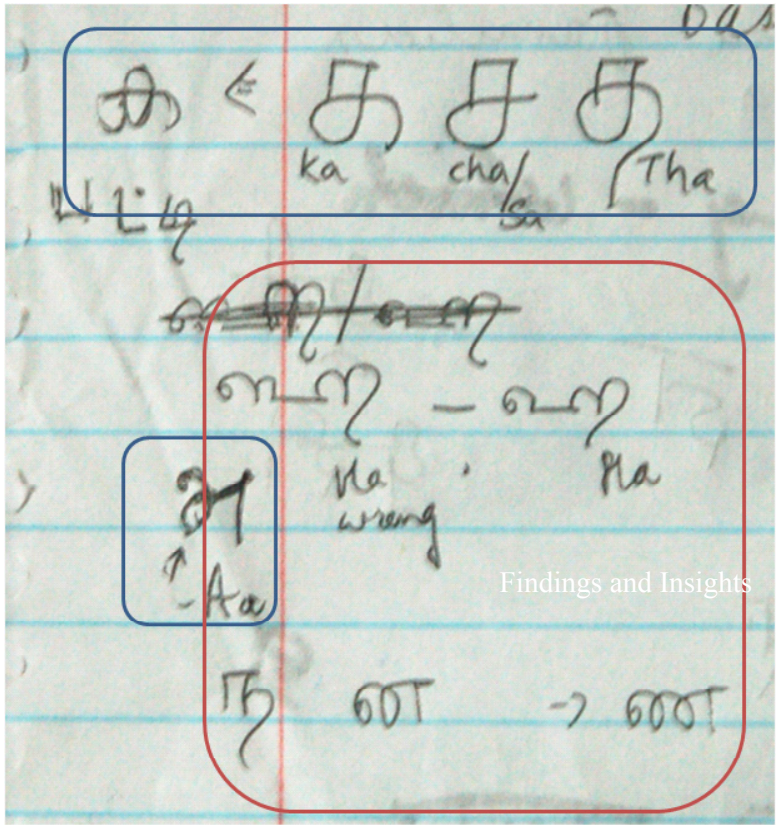
- Decided to learn Russian as a hobby
- Initial learning through Russian friends (chatting/talking)
- Began proper learning through **Rosetta Stone**
- Learning now for two months
- Finds difficulty when letters looking like English alphabet are associated with a different sound
- Repeated lessons to be thorough
- Used wikipedia as a reference for the alphabets

Rosetta Stone:
The following were the findings for Rosetta Stone, the software used by this user to learn Russian.

- It is a software that lends more importance on quick learning to talk and understand than to thoroughly learn to write
- Helps associate the sound of a word to its meaning by the help of visual aides and various repetitions
- Grammar is learnt through context and repetition of sentences using various subjects and objects
- Relies heavily on the user's capability to organize lexical and semantic meanings mentally

Insights:

- Writing is very less: Only out of curiosity
- Rosetta Stone almost completely eliminates the need to write for learning the language; does not teach the alphabet at all
- User has maximum difficulty in remembering alphabets not similar to English, as well as the grammatical rules which are new (eg 1 umbrella, 4 umbrellas, 5 <new word>)
- Cannot learn to write easily since he has never seen hand written Russian script – electronic forms are unreliable



Note that in the topmost box, we see how the user gets confused between the similar looking letterforms. In the red box, the user can be seen struggling with more complex letterforms while in the smaller blue box, the user is pretty comfortable with the 'Aa' since not only is it simple, it is similar to the already learnt Devanagari Aa.

User 4:

Findings:

- Tried to teach Tamil to himself with help from relatives
- Learnt for three months
- Used similarities with Malayalam as a starting point
- Learnt alphabets that were common, and those which were similar to the ones that were common, first
- Used writing to help remember a particularly complex letter
- Draws and gestures in air when trying to recollect or learn a new letter
- Never learnt the right way to write the letters

Insights:

- Used known language as a starting point
- Imitating pronunciation from relatives' talking was a major help
- Learnt letters by reading and matras by hearing
- Writing was used as a practice to memorize complex letters
- Needed proper guidance to learn how to go about writing letters
- Writing letters helped improve reading skills

So, finally, to sum it all up, the major learnings from these studies were as follows:

- Writing helps remember unfamiliar and/or complex words better
- Thorough learning of a language begins with learning the script
- Learning to write cannot be achieved without expert guidance
- Learning to write in a wrong manner may lead to permanent confusion and loss of efficiency
- Learning to write a language will speed up the process of learning to read, speak and understanding the language
- Users are eager to learn writing after gaining a little familiarity with the language

Revisiting the Focus:

After the initial user studies, on the basis of the findings, the focus was revisited and some changes were affected. The user group was decided as the adult illiterates of India. It was apparent that this user group had a lot more felt needs than the other groups. Also, these users were present in larger numbers, the problems faced by them were a lot more serious than the ones faced by the others.

Moreover, since the user group was adult illiterates of India, the script to be learnt through the system was decided to be Devanagari. Hence, at this stage, the focus of the project was to develop a tool for adult illiterates to learn Devanagari. Whether it was going to be Hindi or Marathi or some other language was to be decided as and when further data came.

Further User Studies:

After the focus was redefined, the next step was to find the new target users. In order to gain greater insight into the problems faced by them in terms of learning to read or write, it was decided that it would be of much significance to try and teach them.

So, to find users who would be willing to study, an NGO was contacted which ran literacy classes. The details of the same are as follows:

Oasis:
Oasis India works for the transformation and empowerment of individuals and communities through projects based on advocacy, health care, education, rehabilitation, training and resourcing.

From women sold to brothels to children affected by HIV to families living in slum areas, Oasis India works with some of the most marginalized and vulnerable people in India's cities. They do all they can to help them heal, unlock their full potential and play active roles in their communities (see [12] for the web link to obtain further details).

Users:
At Mira Road, Oasis India runs what they call as 'Half-way Home'. This is a place where they let women that they find in the red light areas of Mumbai stay to get rehabilitated. They teach these women to read, write and also some other skills such as drawing, painting, sewing etc. At the time of the user studies, there were nine women living there. All of them were in the age group of 23 - 40. Some of them had had schooling till the 7th or 8th standard while some others had never seen a school before in their lives. Most of the women who had had previous education had almost completely forgotten literacy. There was only one exception who retained some knowledge and hence was much ahead of her peers.

Literacy Classes:
The women were taught both Hindi and English daily for one hour each. The Hindi teacher was on leave so a substitute teacher was teaching them Hindi. The English teacher was new to the teaching practices. They used the books provided by the Literacy Foundation of Chennai. The teaching methods that were used were repetitive and monotonous, during the classes I attended. Students frequently seemed as if they had tuned out of the class.

Questions on the table for the user studies:

Why learn? What is the motivation?
The answer to this came while talking to the users and their teachers. The women had faced a lot of adversities in life just because they did not know how to read or write. They had been cheated so many times that now they had lost the ability to trust anyone. Moreover, for some women, it was an issue of hurt pride since most of the other family members were learned and would look down upon them as 'Angutha Chhap'.

What are the advantages of learning to read/write? What future plans do they have?
From the point of view of the users, the advantages were the prospective of being able to get a decent job and stand on their own two feet. Also, they could further avail services such as banking since they knew how to read and write. They could feel pride and hold their head high when they felt that surge of happiness at seeing their name written by their own hand.

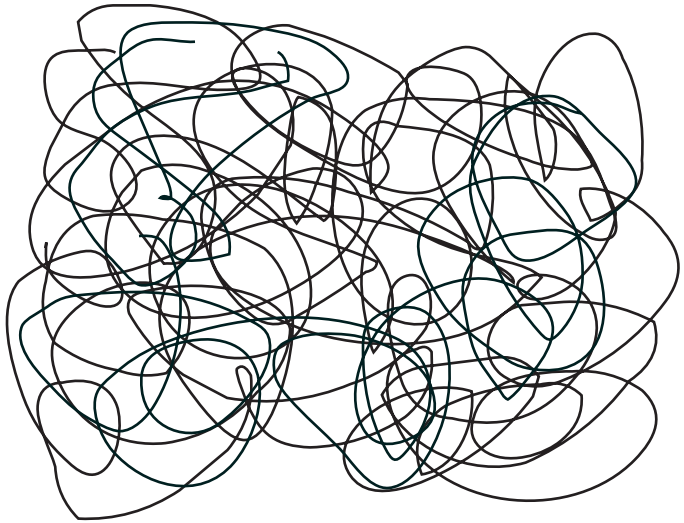
Are there drop-outs from these classes? Why?
Yes, there was one drop out during the duration of two weeks that was spent in the user study. This woman did not see any point in learning since she was a bully enough to get work done otherwise.

Also, an attempt was made to find the differences and relations between the processes of learning to read and learning to write. It was also an objective to find out what were the issues faced while learning to write. The answers to these follow as user study is described.

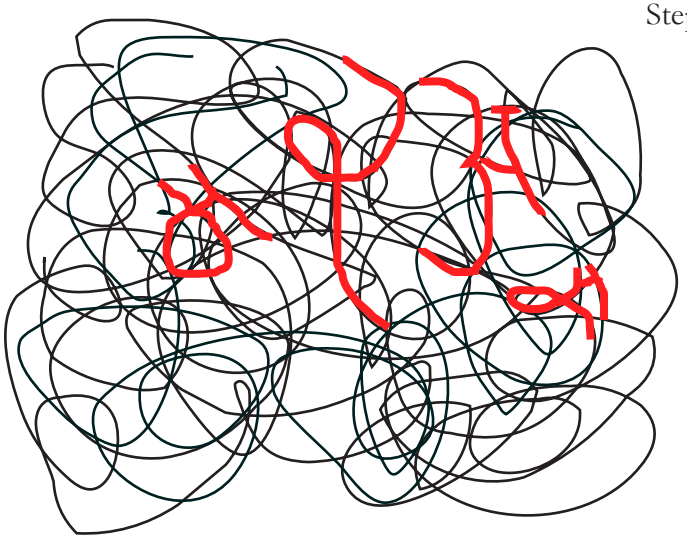
Ideation for teaching:
As seen here, many ideas were thought of to be tried out to see if the users can learn better in some other way. Through the observations in the first few classes, it was understood that the process of teaching is monotonous, inefficient and non involving. Also, students find it difficult to memorize and identify the shapes of letterforms. They were not familiar with the letterforms.

Out of these ideas, the following were tried out with the students:
- The scribble exercise
- The grid exercise
- The pattern exercise

Step 1



Step 2



Scribble Exercise:

Students were given blank A4 sheets and a pencil. They were then asked to freely scribble on the paper. They had to keep scribbling as long as the paper seems empty. It need not be anything recognizable, they just had to set their hands and wrists free so that they get accustomed to the paper and pencil interface.

Once this was done, the next step was to exchange scribbled sheets with others. Now the students had to find letterforms hidden in the scribble patterns that were given to them. The letters could be deformed, too big or too small. That did not matter. They just had to identify letterforms in the patterns.

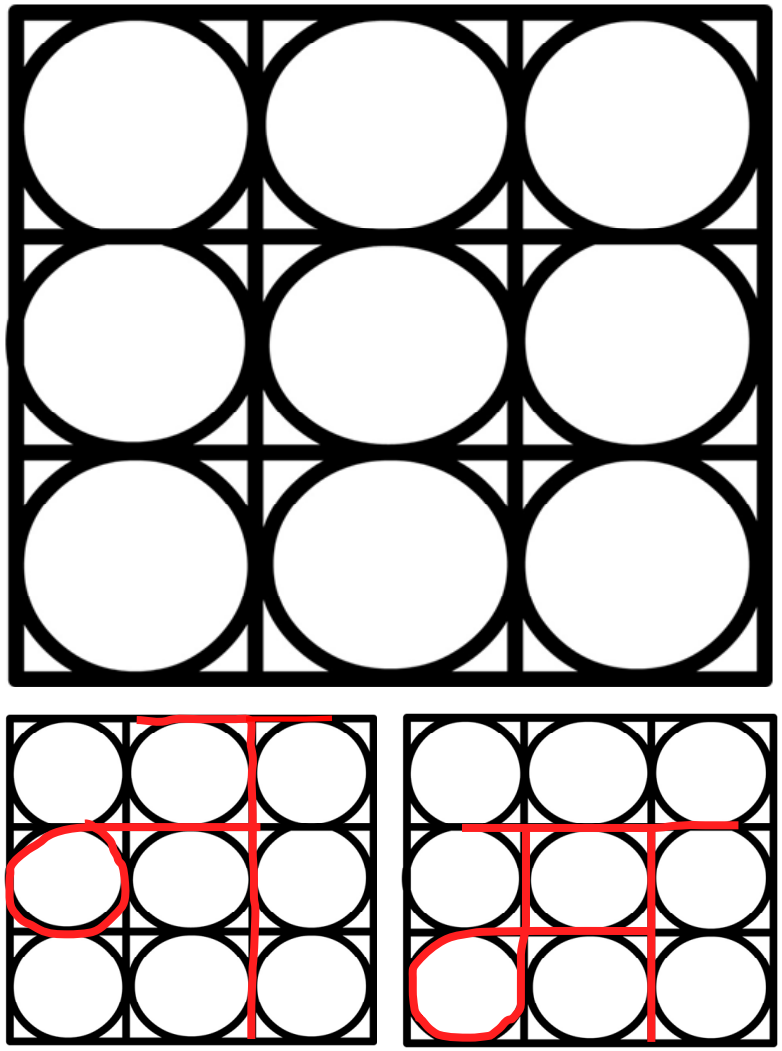
The objective was to firstly, get them used to the paper and pencil interface and help them be free with it; and secondly, to help them break the grid of letterforms, understand the shape thoroughly and be familiar with it, explore it to the fullest. I needed to see if they had the capability to stretch and skew the letterforms they had learnt. If they had trouble doing that, it implied a weaker understanding of the form. Also, if they stretched or skewed it beyond recognition for a literate person, it again implied lesser understanding of the shape. It would help me understand how they perceived the letterform.

Results:

Alongside are seen some of the results of this exercise. It was a fairly successful exercise in that, the students could understand its significance and build upon it. They learnt to stretch the boundaries of the letterform to find the right letterform in the random patterns. They got more familiar with the letterform as a shape, as a piece of drawing. The results varied over a wide range though.

As can be seen, there are really good performers like the green coloured tracing where she has found as many as 11 letters. On the other end, is the tracing in black, where she has not been succesful at all. At first, she refused to do anything with the pattern saying she did not get what to do. When I showed her how to go about it by tracing out a 'Ra', all that she did was find more 'Ra'. After being told that she can find other letters as well, and after being shown some examples from others' work, she still did not do anything else. I even traced out an 'Aa' for her, but to no avail.

Thus, as per their level of skills, the students successfully identified letterforms in their skewed shapes if they were familiar with it, while they missed the forms they weren't good with.



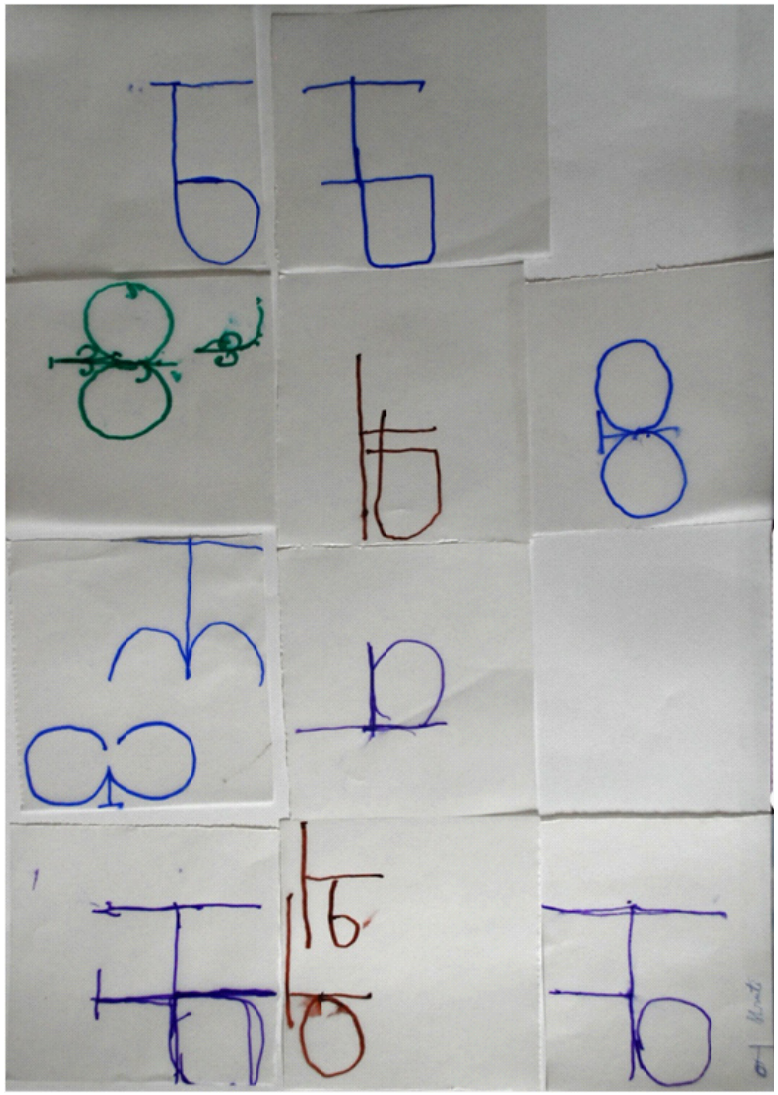
Grid Exercise:

The grid shown here was given to the students on a sheet of A4 size along with a tracing paper. They were to put the tracing sheet over the grid and trace out as many letters they could find. One sheet was given per letter.

This exercise was carried out to strengthen their power of identification for letterforms. It was aimed at making them more familiar with the shape and realizing that Devanagari uses repetitive motifs in its letters. The students were expected to get better at recognition of letters.

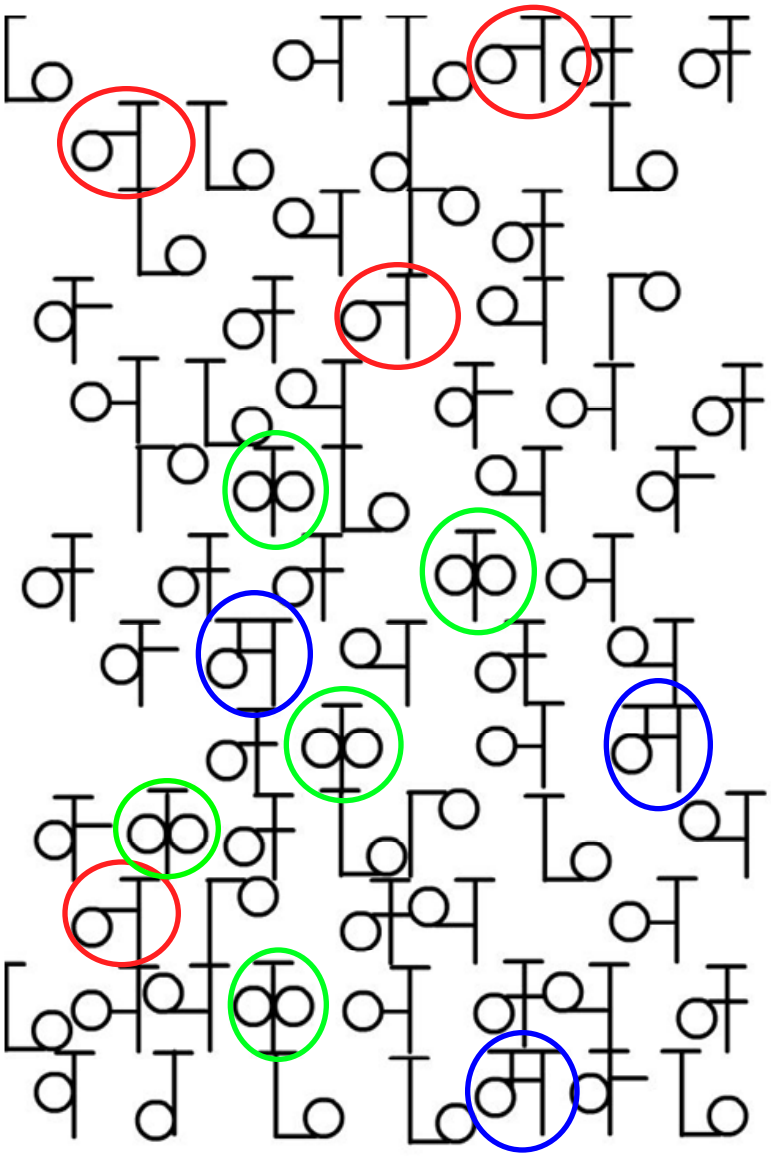
The results for this exercise were not as encouraging as the last one. It proved to be too complex for the beginners who had trouble identifying letterforms as it is. They could write the letter out normally and yet could not trace it on the grid. Hence, it was proved that the grid was an exercise for advanced students and not for beginners.

I wanted the students to understand the repeating motifs in the letterform. Also, I wanted to see if they could separate those out and rejoin them to create different letterforms. Moreover, if the neighbouring gridlines interfered with their power of perception, it implied weaker understanding of the letterform.



Results:

As can be seen alongside, some students were good at it (Blue) while some very bad (purple and green). The student using green colour faced maximum problems in comprehension at every step. No matter how much she was explained to, she would not understand that she had to follow the black gridlines. She kept drawing small 'Ka' as seen.

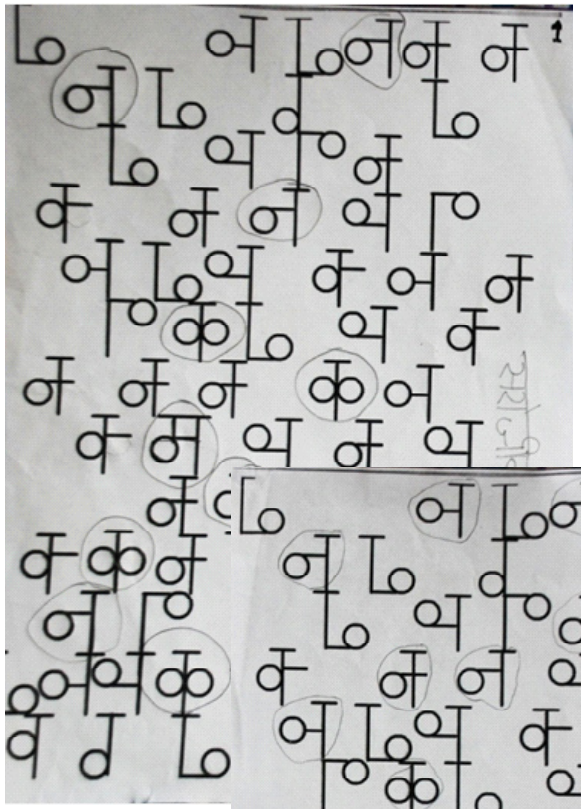


Pattern exercise:

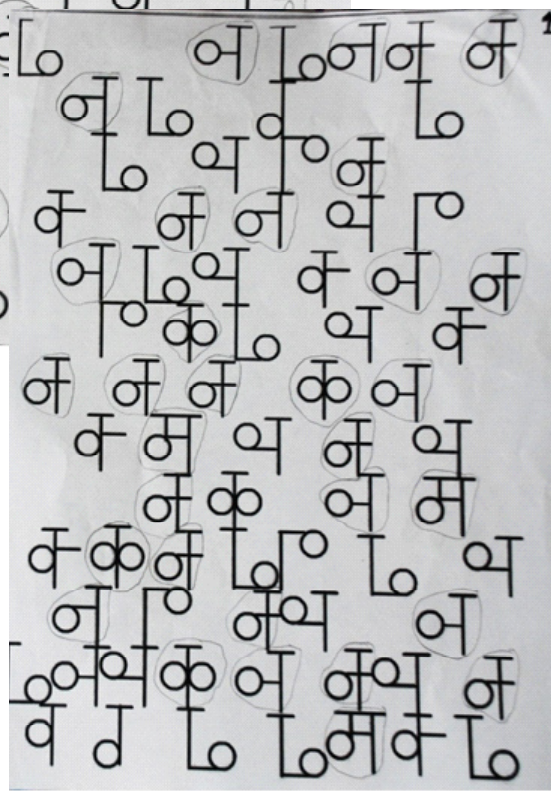
The pattern seen alongside was given to the students and they were required to find out three letters from it. It contained three 'Ma' (Blue), four 'Na' (Red) and five 'Ka' (Green). Rest of the shapes were confusing random shapes made out of the motifs that these three letters use.

The test made students think about the shape. It brought out the level to which they can correctly identify the shapes. It showed how close a shape should be to the original letterform for them to understand that it is a letterform. It also showed their power of recollection. It could be observed through this test as to how exactly do the students remember the shape based upon what they allow as a letterform and what they do not allow as a letterform in the pattern.

It proved to be successful since even the wrong markings told a lot about their recognition process.



Good at Identification



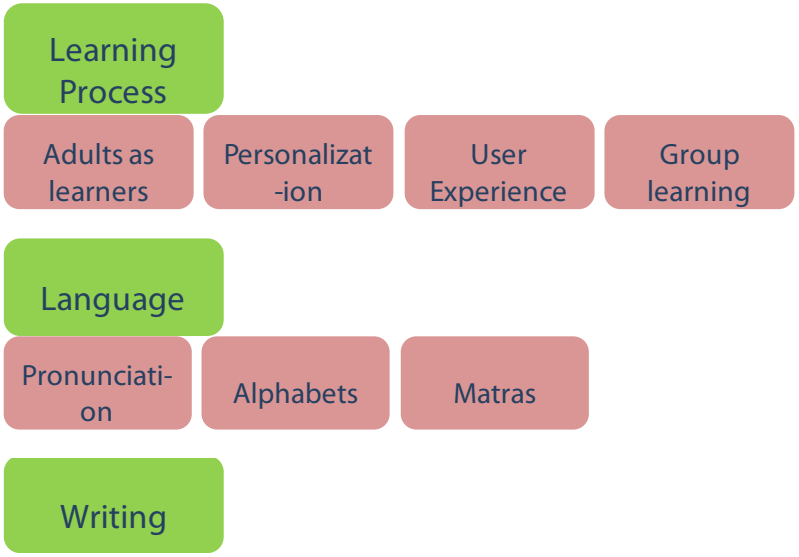
Not good at Identification

Results:

As seen alongside, some students who had prior education and were good at identification, made no mistake. They may have missed out a few but whatever they marked was the correct shape.

On the other hand, some students made mistakes which showed the range of variation that they still allow to pass as the letterform. It gave useful insights into what the user thinks about when identifying letterforms.

Thus, from these studies, I concluded that the familiarization of the students with the letterform as a shape is weak. It was apparent that they needed better and more powerful tricks to help them remember the letterform and correctly associate it with a sound. The way they enjoyed these exercises showed they were craving for a change and that they would perform better if they were to learn in an environment which invoked interest.



Data Analysis and Focus Refinement:

After analyzing the data that was obtained at the end of these studies, it was categorized into problems, and the subsequently arising goals. Also, a group of design ideas emerged from the goals as the solutions to the problems.

The focus of the project was revisited at this point and refined further:

- The system will help users of age group 20 - 30 to learn alphabets and matras of Devanagiri
- Words will be learnt as a support or a means to provide context to devanagiri alphabet and matras
- Writing will be used as a means to strengthen their understanding and grip on devanagiri alphabet and matras
- Word formation, sentences and grammar are not included in the scope of this system

The analysis of the data, as can be seen alongside, led to the mentioned categorization. At the end of the problem analysis, it was seen that 'Language' had problems relating also to the categories of 'Words' and 'Grammar/sentences' but these two categories were later dropped while refining the focus.

Problems:

The following are the problems that were unearthed at the end of the user studies and theoretical research.

Writing:

- Writing distracts from paying attention in class
- Sequence of strokes for a letter was never taught in the classes I attended
- Write mechanically without understanding what or why they are writing it
- No standard sequence of writing followed
- Not comfortable with using pen and paper

Language:

Pronunciation

- Accent hinders pronunciation
- Difficult pronunciations sometimes lead to wrong spellings since pronunciation is itself wrong

Matras

- Cannot judge the role of matras as something different from the letter. Probably think that a given letter and the same letter with a matra are actually two different letters, so when they are asked to write a letter with a matra, they come up with unrelated letters.
- Student skipped matra altogether

Alphabets

- Letterform to sound association is very less
- Have not become familiar with the letter as a shape
- Confuse similar letters easily
- Confuse letters and letters with matras

Learning Process:

Adults as learners:

- Inspiration and motivation: Why should I learn if I get stuff done anyway?
- Why should I learn HINDI at all? Today English rules everywhere anyway
- Relevance of studies to real life is not apparent
- Trust issues: They have been cheated so many times due to illiteracy that they trust nothing
- Lack of time due to other duties and ties of the day: work, pay bills etc

Personalization:

- Levels of IQ, Knowledge, skills vary
- Teacher missed a student's wrong pronunciation or the wrong letter written.

User Experience:

- Teaching: sometimes it spells stuff out before student's inquisitiveness is aroused
- Classes became boring and monotonous
- Very less pictures used: visualization is hampered

Memory:

- Very less repetition is done in terms of writing
- Some weak students have repeated अ to fill pages in their books but still find it hard to identify
- Retention over time is almost nil.
- "There's a student who can write letters sometimes but has no idea what they mean"
- No thought is given to what was learnt in the class during rest of the day

Group learning:

- Teacher did not catch a student copying.
- Isolated learning: No competition or peer learning but also, no missing out due to lack of speed
- Competitive environment sometimes is insulting for the full grown adult
- In group recitations, a few students get away with not repeating at all
- Students in a group tend to ask each other more and get wrong answers than ask the teacher

Goals:

Writing:

- System must treat writing reading and speaking as inter-related processes
- User must get familiar with the paper-pen interface
- User's Sequence of drawing Matras should not change over time or characters
- User must write all alphabets using only one standard sequence of drawing per alphabet. It may evolve as the user progresses

Language:

Pronunciation

- User must not make mistakes in pronunciation but must be forgiven for accent based variations
- Confusing pronunciation but not confusing letter-forms: User must not confuse one letterform for another because of the similarity in pronunciation (ज, झ)
- User must differentiate between similar looking letter-forms. (न, म)

Matras

- User must realize matras are separate from letters and are attachments to the same

- User should be able to attach the right matra to a given letter to produce a given sound
- User should not confuse among different matras (ा, ै), matras and letters(ा, र), letters with matras and letters without matras (स, रा, श)

Alphabets

- User Must identify all alphabets without any error
- User Should not confuse between similar looking alphabets

Learning Process:

Adults as learners

- User must feel the learning is relevant to his/her life
- User's existing knowledge and capability must be used
- The learning must get integrated with the user's daily routine to save user's time
- User must be able to trust the system just enough to learn from it but not so much that it discourages peer learning.

Personalization

- User should not require a physical tutor. The learning process must be self learning based.
- User should be able to ask doubts, questions or satisfy curiosities
- System should be personalized so that user feels in control and emotionally connected to the system.

User Experience

- User should not lose interest during the learning process
- User must feel this process is trustworthy and that it is making a difference.

Memory

- User should not forget what was learnt earlier as the course progresses
- User should be forced to repeat certain exercises of writing/recognition etc

Group learning

- User must not lose out on advantages of peer learning, competition and comparison
- User must have the feeling of companionship and that of being under surveillance by others

Design Ideas:

Writing:

- Scribble exercise
- Instructions/exercises to be carried out on paper: the system gives a printout of A4 size with the exercise in such a way that the system can check it later (like CAT answer sheet)
- Animation showing HOW to write a letter. Detect if the user has already got a standard method and use it as the standard for that user
- Use a range of tolerance in the pattern of the letter. Show how much off it currently is from the ideal shape and how much progress has been made from the earlier attempts

Language:

Pronunciation

- Use voice and pattern recognition together so that user can be asked to speak along when he/she writes. System compares the spoken letter and the written letter and gives feedback accordingly
- Show animation of lip and/or tongue to show the proper pronunciation of the character
- User pronunciation to differentiate between similar looking letterforms

Matra

- Use visuals to show how meanings change when matras screw up (putra, patra; ladka, ladki)
- System voice repeats pronunciation as a matra appears and disappears over various letters
- Use same letters but different matras and form various sentences(e.g.: yaha saadee hai, yaha sadee hai, yaha sadu hai). Try to make it funny, interesting, and/or relevant.

Alphabet

- Use shapes similar to the letter, animals or shapes made out of the letter etc to make the letter easy to remember and unique
- Word test: Finish the given word by filling in the blank. Use one of the given 4 options: 1. The right answer, 2. A similar alphabet, 3. Similar looking object, 4. Similar looking shape
- Use voice and pattern recognition together so that user can be asked to speak along when he/she writes. System compares the spoken letter and the written letter and gives feedback accordingly
- Grid exercise, Pattern exercise
- Give elements of letterforms and ask user to form a particular letter
- Follow a sequence of letters going from simpler shapes to more complex ones
- Group similar letters together to facilitate comparison and elimination of confusion

Learning Process:

Adult as learner

- Games used in the system must be based on a value system that is relevant to the user
- Give user tests based on relevant matter: Photos from real life places such as bus numbers, shop names, or snippets of a cook book
- System asks user to find 5 objects during the day that look like a particular alphabet
- User already can SPEAK. So user can speak and the system shows what they spoke.

Personalization

- Mobile: Locks/unlocks by drawing/identifying the letter or word they are currently learning
- Records and shows progress by repeating a set of tests every some interval of time. System adjusts pace of teaching according to the results (requires more repetitions if the user is slow)

User Experience

- Interactive TV: A soap like story built around a teacher which involves a lot about alphabets, learning, reading, characters etc (e.g. House MD for medical, Sesame's street for children)
- Use games as tests to remove monotony
- System gauges user progress and IQ and accordingly adjusts its pace

Memory

- Memory tests for the users: system asks user to identify letters taught earlier by looking at them or write letters by hearing them.
- Levels in a game/ progress in the system is locked until the user finishes repeating a certain exercise for a given number of times, even if the user is good at it.

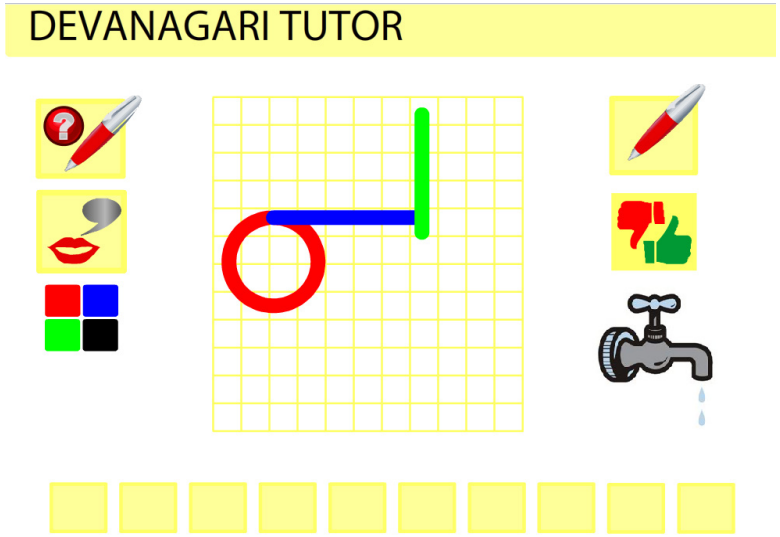
Group learning

- Classrooms: Interactive whiteboard with a library of images, tests and student records
- System has special social test where user can compare results with others
- Facility to float questions, doubts, opinions etc
- Alerts about the progress done by others throughout the day

Exploration:

At this point, an important decision was taken: The system was to be a touch screen mobile phone application.

After the generation of design ideas, exploration in the form of soft prototypes was begun for the ideas. A few ideas were tried out to see if they were feasible or not. the main objectives for this process were to discover the issues related to the unique interface at hand, to see whether or not these ideas work as properly as they sound.



The 'Write' button

The 'How To Write?' button

The 'How To Pronounce' button

The 'Check' button

Devanagari Tutor:

Objectives:

- Make user write the letter
- Checking the shape of the letter
- Strengthening shape to sound relationship
- Make user repeat tasks

Working:

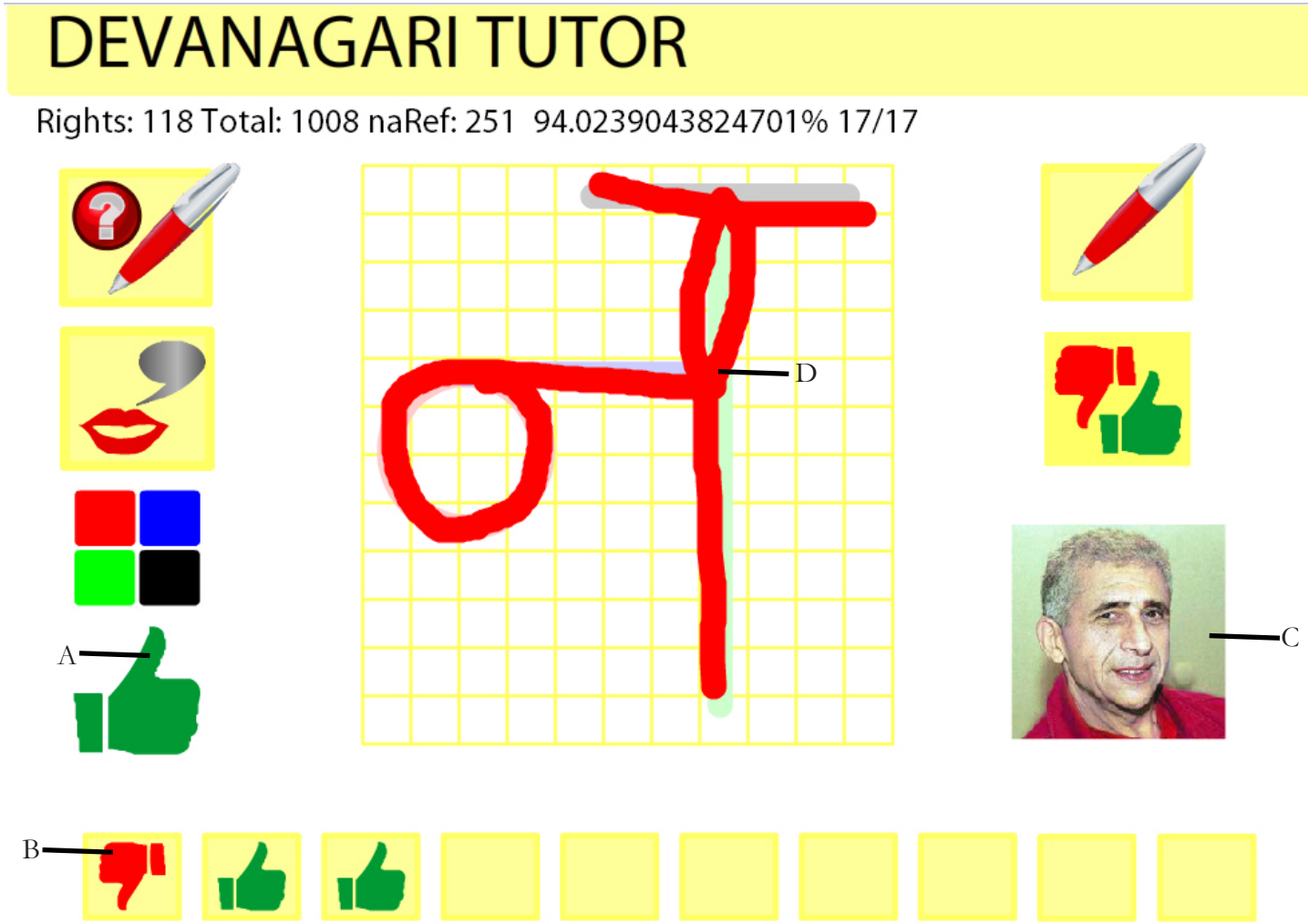
- User must draw on the watermark of the letterform in the central grid and then press the check button
- User must repeat it 10 times and can proceed if he is successful in at least 7 attempts

Features

- Animation to show how to write
- Pronounces every time the user writes correctly
- 10-shape memory for self evaluation
- Differentiates the motifs involved in the letter by colours

Features not in the prototype:

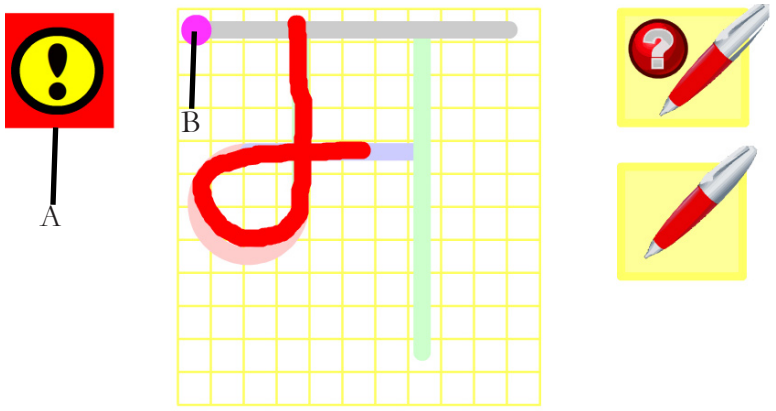
- Watermark colour should slowly lose colour as user gets better
- Shape tolerance should get stricter as user gets better
- Should show on the shape where user went wrong



A. Result of the current check
B. Previous results. Upon tapped, they show the pattern that was drawn by the user. This way the user can look at his own progress
C. Picture gallery relating to the current letter
D. Current pattern drawn by user

Drawbacks

- The reference letter is geometric
- The gallery should be a separate feature
- Icons need improvement



A: Red warning sign
B: Pink marker that indicates the path user must follow

Sequence Tutor:

Objectives:

- Make the user follow the appropriate sequence of drawing the letter
- Make user repeat tasks

Working:

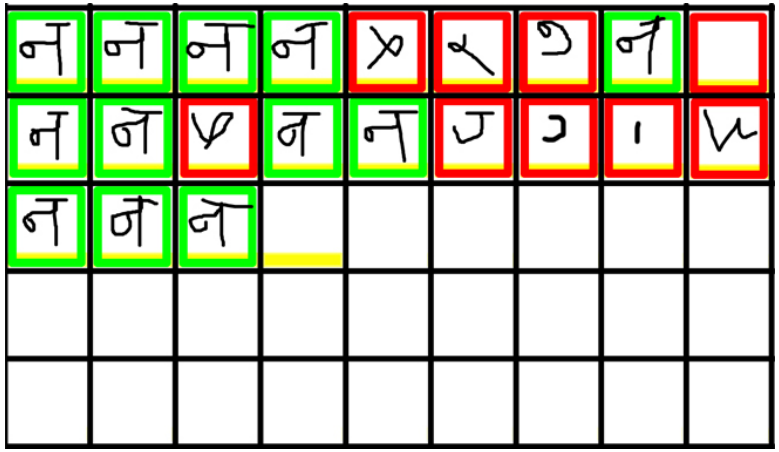
- User must click on the draw button and then follow the pink marker
- If the user loses track of the marker, the red warning sign flashes. This must be avoided as far as possible

Features not in the prototype:

- Marker speed must increase as user gets better

Drawbacks:

- Reference letter is geometric
- Does not allow user to go ahead
- Does not calculate basic speed based on user's performance
- Icons need improvement



Practice Page:

Objectives

- To give user a lot of repetitive practice
- To bring user closer to the realistic size of the letter
- To make an exercise similar to paper
- Make user practice the letter without the presence of the guiding watermark

Working:

- User must tap in a square in the grid to activate its drawing area
- Then user must draw the letter and press the yellow check button to see the result

Features

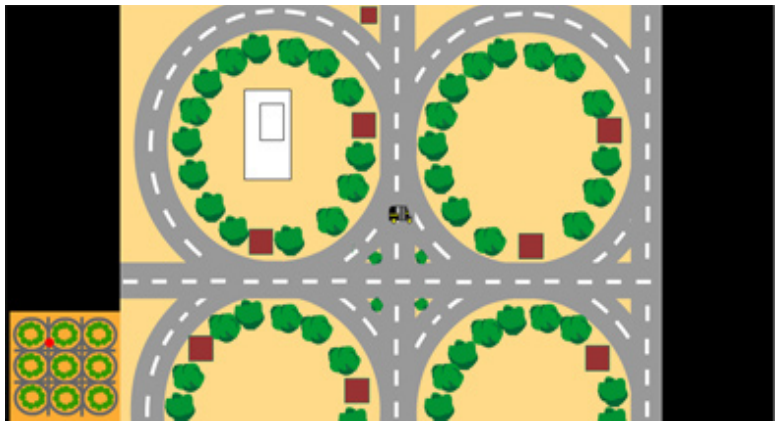
- Checks individually whether or not the pattern is correct
- Pronounces every time user is right

Features not in the prototype:

- Should calculate total rights and ask for a redo if its too less

Drawbacks

- Interface gets too uncomfortable
- Stylus shape is too small



Road Game:

Objectives

- To break monotony
- To draw parallels between real life and learnings
- To encourage spirit for learning
- To revise letters already learnt

Rules:
The user has a shopping list. He must hire an auto and go around the town looking for the correct objects.

All objects start with the **same letter.** All shops for the objects lie on the **path that forms that letter**. User must trace the **correct path in correct sequence** in order to be able to buy the objects.

Wrong turns and extra driving cost him extra auto charge. User has only enough money to pay for the auto charge of the right path.

Win: User shops for all objects properly
Lose: User runs out of money and auto driver beats him up
Levels: Letter gets more complicated, road map gets more complex

Sequence of Letters:

The system still lacked a proper sequence of letters in which they must be presented to the user so that it is easy for him to follow in the process of learning to write. There were issues such as simpler and complex shapes, similar shapes in letters etc to consider.

Hence, to find a proper sequence of letters which would be suitable for the user and would ensure that the learning efficiency is maximized, two schools namely, Kendriya Vidyalaya and Campus School (IIT Powai) were visited. After talking to the Hindi teachers at these schools, some insights were gained as to how the letterforms are taught in schools when children learn to write them. It was found that teachers do not follow separate sequence for learning to write. Every alphabet is first taught to read and then to write. They follow the sequence prescribed in the textbooks. So textbooks of all three boards (State board, central board and ICSE board) were studied to find a proper sequence.

Maharashtra State Board Text Book (Marathi)

- No introductory exercises
- Letters taught through small stories in chapters
- Sequence of letters governed by sequence of chapters

Sequence of letters:
आ ई घ र ब ह स न क म
ल च भ अ व ढ प ज य ग
ळ ट ठ ऊ श द ण त थ इ
झ ड फ ष औ छ उ ए ऐ ख ध ओ

Central Board Text Book (Hindi)

- A lot of images and stories used
- Chapters are easy to follow
- Letter sequence used, but is governed by the chapters
- Exercises are innovative

Sequence of letters:
न म अ ठ ए झ ल ड
छ ई आ क त प ऐ ख
ध फ व ह औ भ ज ग
ट य इ र घ थ ओ ढ द उ

Both these textbooks did not present a proper sequence of letterforms since their sequence was not governed by the complexity or similarity of the letter shapes. The sequence was governed by the order of the chapters in the textbook. Hence these sequences were not suitable for learning to write Devanagari Alphabet.

ICSE Board Text Book and Workbook

- Innovative ways and to teach letters
- Followed an easy shape to tough shape sequence
- Letters with similar shapes follow each other closely
- After each group of similar letter, comes a shape exercise
- Started off with picture stories
- Use of older knowledge to explain new knowledge
- Proper revision structure
- Various different exercises to familiarize with paper and pen

Sequence of letters:

उ ऊ अ आ ओ औ ग ट ठ द ढ प फ ष
त व ब क र ख स ए ऐ म भ न ज ञ
य थ घ ध छ च ङ इ ई झ ह ल श ड

Adaptable features from ICSE board books:

- Sequence of letters and exercises structure
- The usage of letters taught previously, in exercises of the letters being taught currently
- Organic letter shapes
- A few exercises for shape familiarization, if needed

Final Concept:

For the development of the final concept, ideation was carried out for the structure of the system. A few ideas were put together based on the extent to which they satisfied the important goals. When these ideas were put together, the system information architecture was developed.

Information architecture followed the intent prescribed in goals as well. The architecture attempted to put into a proper structure, the bunch of ideas which were finalized. The information architecture was then refined to reflect better the structure of a learning system. What follows on the next page is the collection of ideas that was finalized at the start of this stage. Following that is the initial information architecture, followed by the final information architecture.

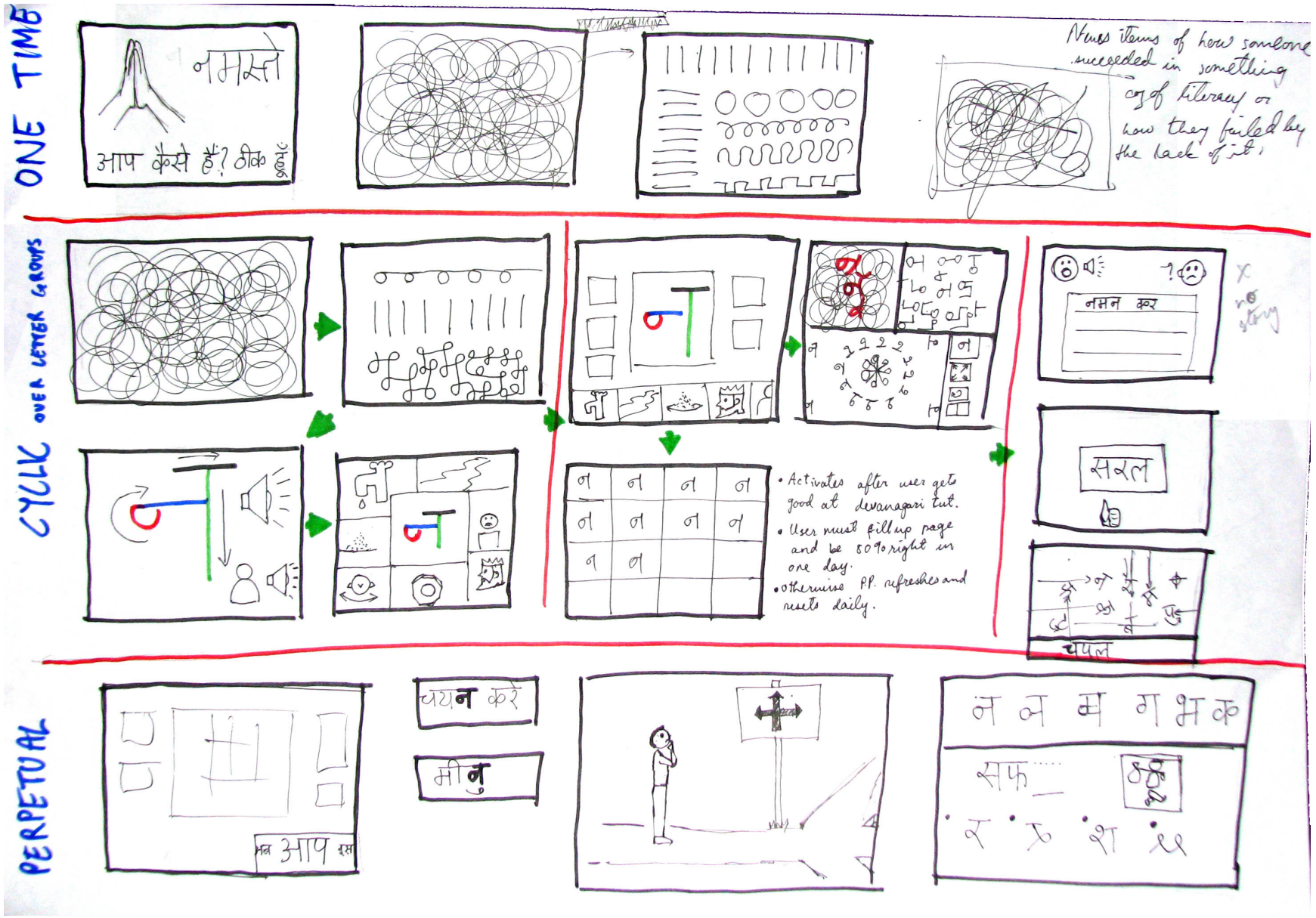
Finalized Sequence of letters:

अ आ उ ऊ ओ औ ग म भ न ट ठ द ढ

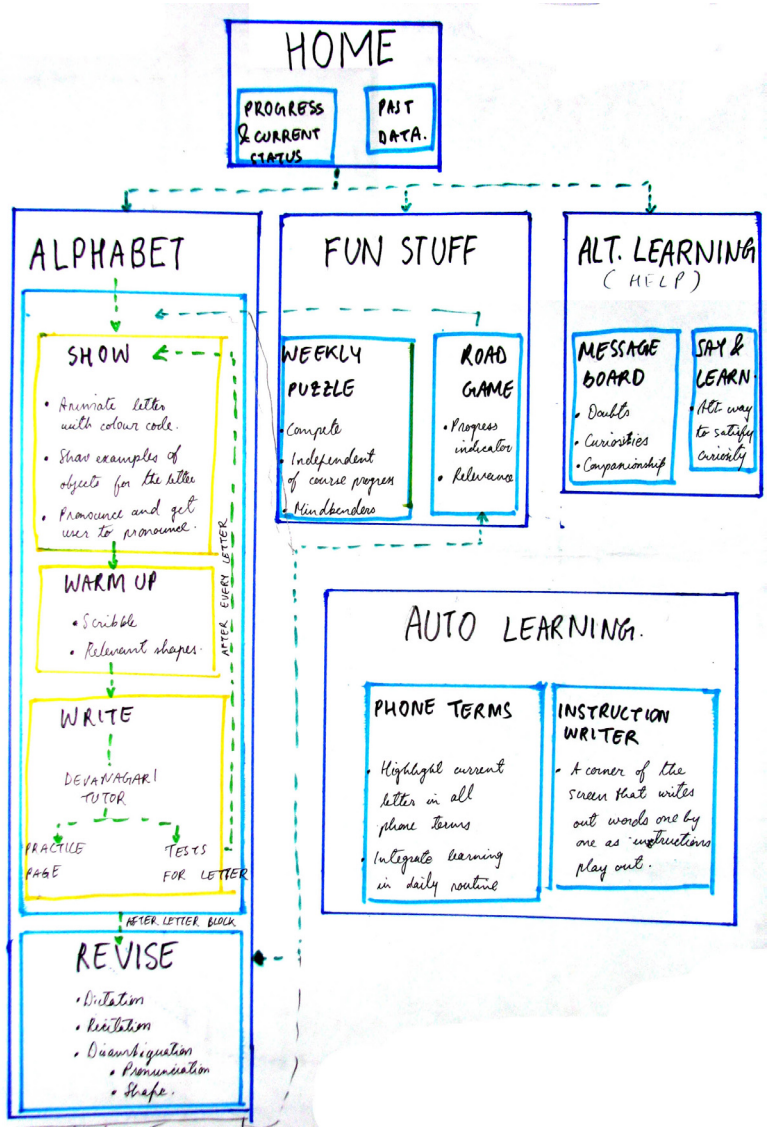
प ष ण फ क व ब र स श ख य थ ए ऐ

च ज ञ घ ध छ इ ई ड ङ झ

त ह ल



Finalized Ideas



Initial Information Architecture:

This information architecture was deemed too rigid for a learning tool. The learning tool should have a structure which is prescriptive and generates only an illusion of control for the adult. It should not give the reins of the cart into the adult's hands. Hence this architecture was revisited and refined as below.

The final system consists of three parts. The first part is the main learning sequence. This part deals with the formal learning course, following which is expected to lead to the complete familiarization and knowledge of the Devanagari alphabet.

This course runs in chapters. Each chapter is one group of letters (refer above for the groups of letters). At the end of each chapter, the learner underwent a revision section wherein the system made sure the newly gained knowledge gels together with the older knowledge. It also ensures retention over time. The revision section lays weight on ensuring disambiguation of similar looking shapes and similar sounding pronunciations.

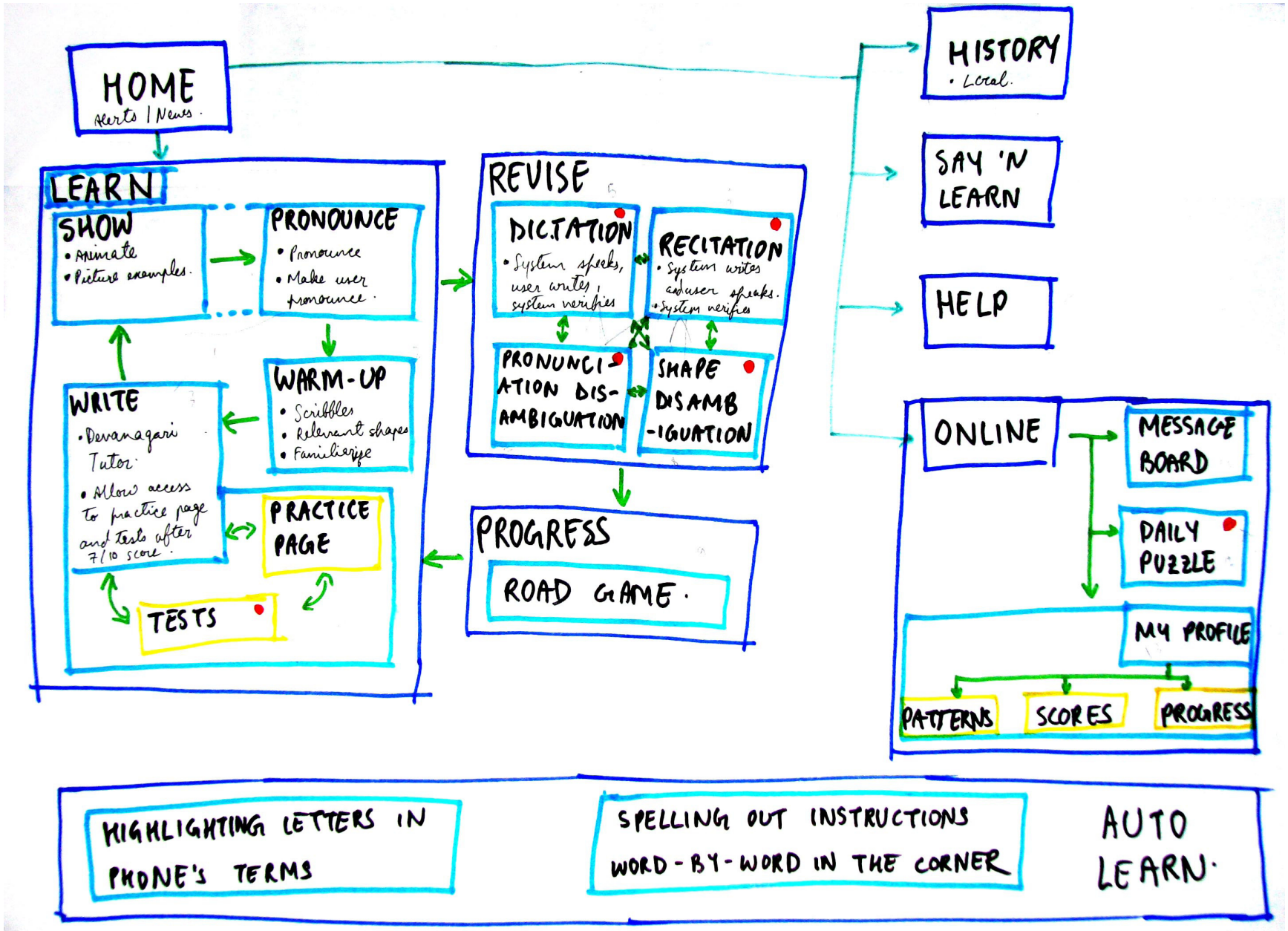
Every letter within a chapter is learnt by first learning to recognize, pronounce and read the letter, followed by learning to write the letter. The first part is achieved through various images and animations. After these, the chapter presents exercises and tests which test both recognition and writing skills. These exercises also provide the necessary amount of repetition.

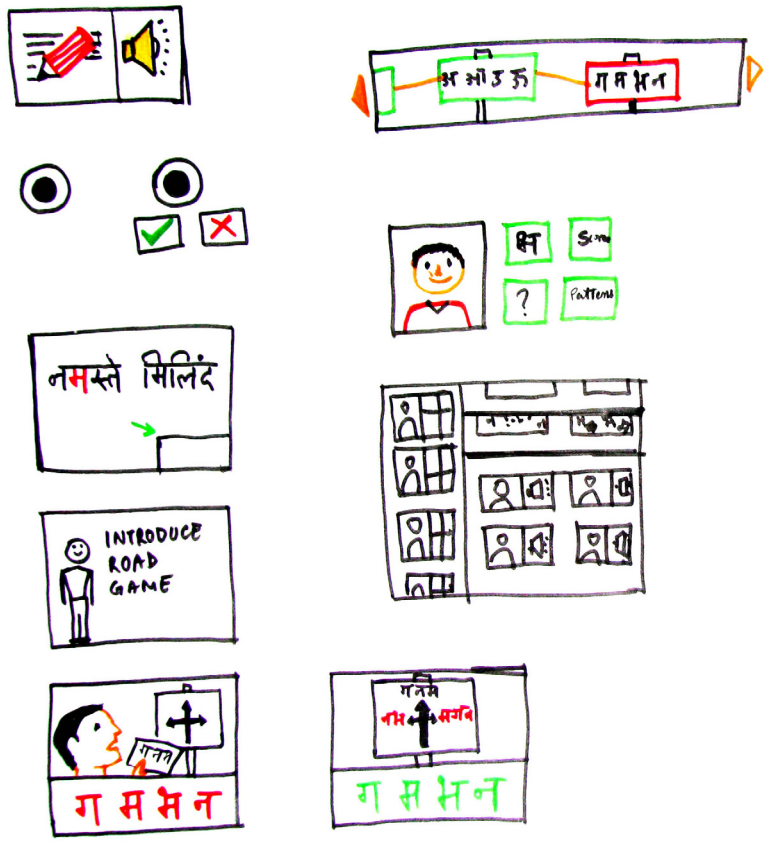
Apart from the course, the second part is the alternative learning part consisting the say 'n learn feature wherein the user can go and satisfy his curiosities. Here, the system writes out what the user says. In this way the system also capitalizes on user's present knowledge to help better

the learning process. Other features of this part include the daily puzzle section where every day, a puzzle gets added. The puzzles have rewards in the form of talk time for the cell phone. Also, learners compete within themselves for the rewards. This brings in the competitive edge and the will to learn and perform better. The learner can also interact with other learners or perhaps teachers with the help of this system. Learners can call and have a live conversation with anybody else who is concurrently logged into the system.

In addition to alternative learning methods, the system also includes auto learning methods. Most of the instructions are relayed by voice. So, a corner in the interface spells out word by word, the instructions as they get spoken. This helps the user to subconsciously register some characters or words and thus, enhance his grasp of the script. Also, the system sets the default language of the phone to any Devanagari language. Hence, all terms of the phone appear in Devanagari. The system then highlights whatever letter the learner currently is on, in all the terms where the letter appears. This way, learning is integrated into his daily routine.

The learning course is bound together by a narrative wherein the user helps a character navigate on the road by reading signboards. Boards get filled only by completing the chapters, hence enabling further travel.

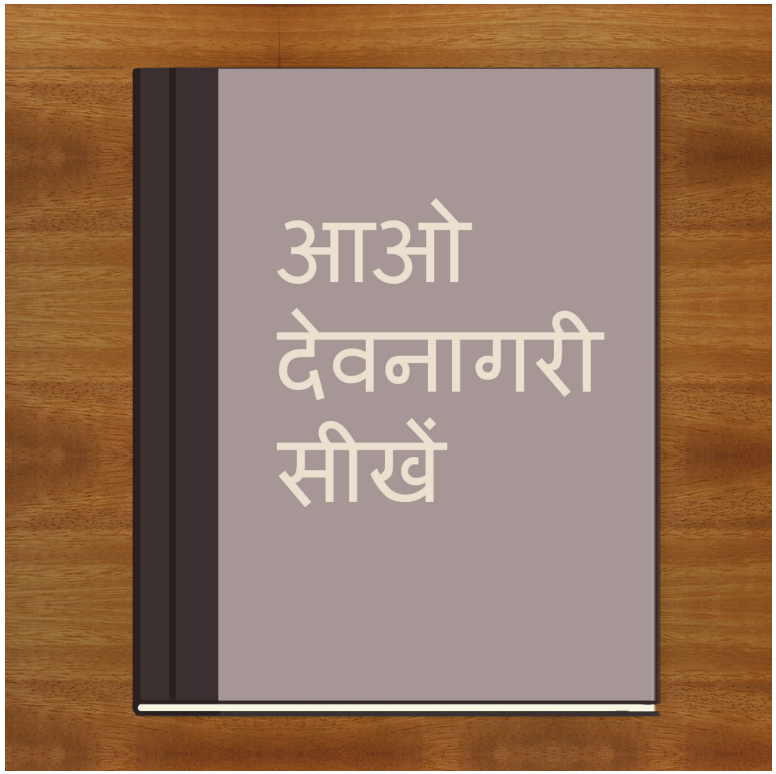

HOME
Alerts / News.
LEARN
SHOW
• Animate
• Picture examples.
PRONOUNCE
• Pronounce
• Make user pronounce.
WARM-UP
• Scribbles
• Relevant shapes
• Familiarize
WRITE
• Devanagari Tutor.
• Allow access to practice page and tests after 7/10 score.
PRACTICE PAGE
TESTS
REVISE
DICTATION
• System speaks, user writes, system verifies
RECITATION
• System writes & user speaks.
• System verifies
PRONUNCIATION DISAMBIGUATION
SHAPE DISAMB-IGUATION
PROGRESS
ROAD GAME.
HISTORY
• Local.
SAY 'N LEARN
HELP
ONLINE
MESSAGE BOARD
DAILY PUZZLE
MY PROFILE
PATTERNS
SCORES
PROGRESS
HIGHLIGHTING LETTERS IN PHONE'S TERMS
SPELLING OUT INSTRUCTIONS WORD-BY-WORD IN THE CORNER
AUTO LEARN.



Interface development:

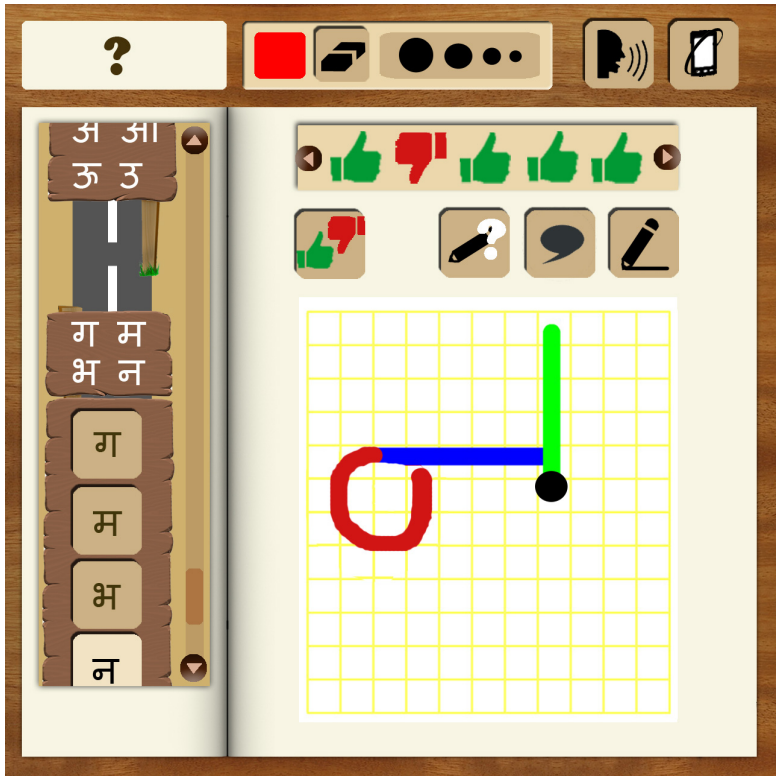
Based on the information architecture, initial concepts for interfaces were developed. Preliminary ideas for metaphors and icons were expressed in these interfaces. A metaphor of a book was adopted. A book served as a perfect metaphor since the book easily relates to learning. Also, the mental model of a book is familiar to the user, hence, a tool behaving in the same manner will not confuse the user. Also, a book is a good way to impose or imply a sequence without making it apparent.

A few examples of the preliminary screenshots follow.

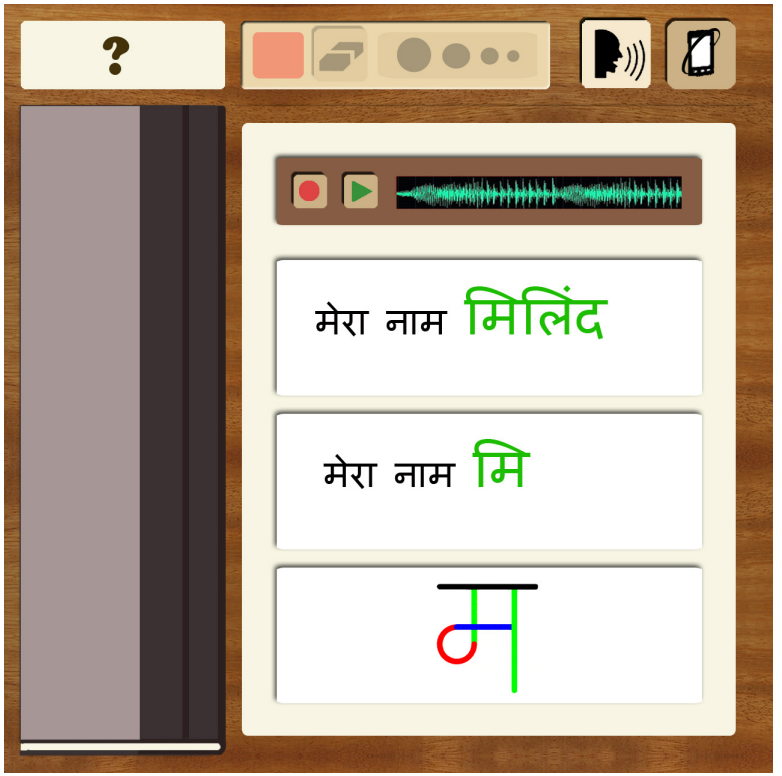


The first screen when clicked on the icon for the system

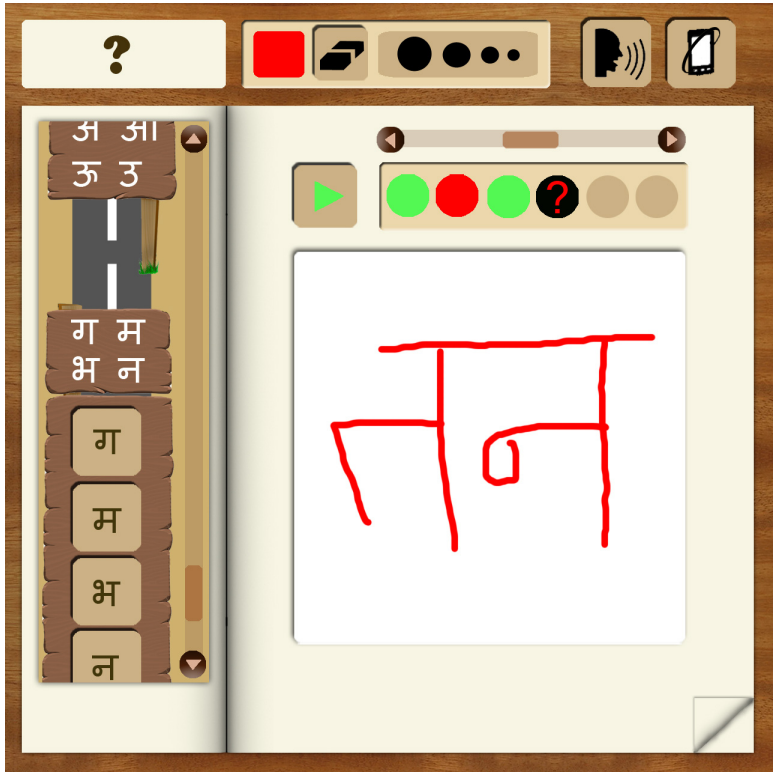
The screen where recognition of letter is taught using images



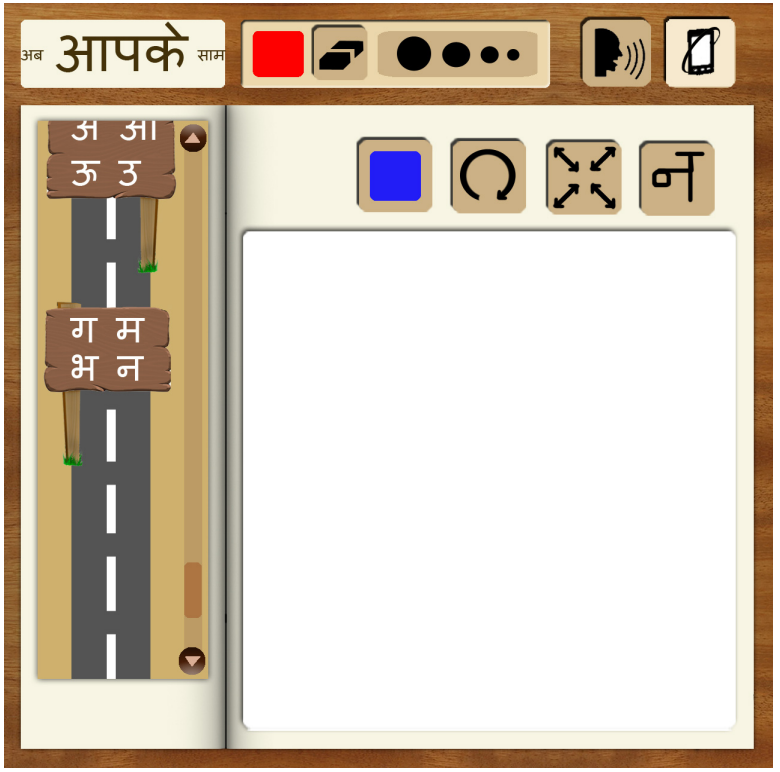
The screen where the letter writing is taught



The screen for 'say n learn', an alternative way for the curious to learn. It writes out word by word, then letter by letter and then finally each letter of what the user says.



The dictation test for pronunciation disambiguation



The make your own pattern exercise. This appears in the letter tests. Note the upper left corner where the instruction are getting spelled out.

Final Prototype:

The final prototype was developed in Adobe Flash and run on a Nokia 810 internet tablet. The interface was developed keeping in mind the fact that the screen could be as small as a hand held device.

The elements on the interface consisted mostly of buttons. The buttons, if pressed and held, gave an audio feedback explaining what the function of the button is. If tapped, the buttons performed that function. With the exception of a few select pages which needed to have more information but appeared very infrequently over a long usage of the tool, all the pages had buttons that would be big enough for interaction through tapping.

A few changes in terms of colour scheme, dimensions and visual elements were incorporated as compared to the older interface with the intention of making the interface simpler and friendlier. The metaphor of a book on a desk was maintained to facilitate the imposition of a structure on the adult users.

Below is the persona for which the tool is designed, followed by a few screenshots from the final prototype.

Mr. Vipul Chudasama
Age: 38
Occupation: Truck Driver
Education: Nil
Mother Tongue: Gujarati
Married with four children.

Mr. Vipul can converse in Gujarati and Hindi.
He has recently realized the drawbacks of not being able to read and write and hence has purchased the system for his mobile phone.
He has finished two chapters and now is learning the letter NA.

He has found a teacher named Mr Sudarshan Iyer on this system who is willing to help him.

This screenshot shows the first screen that the user sees when he launches the tool. To open the book and start learning, tap on the book.

Here we see the index page. The persona that we met earlier has already reached till the letter Na. Hence, he sees this page where he can either continue his lessons or choose to jump to some other letter.

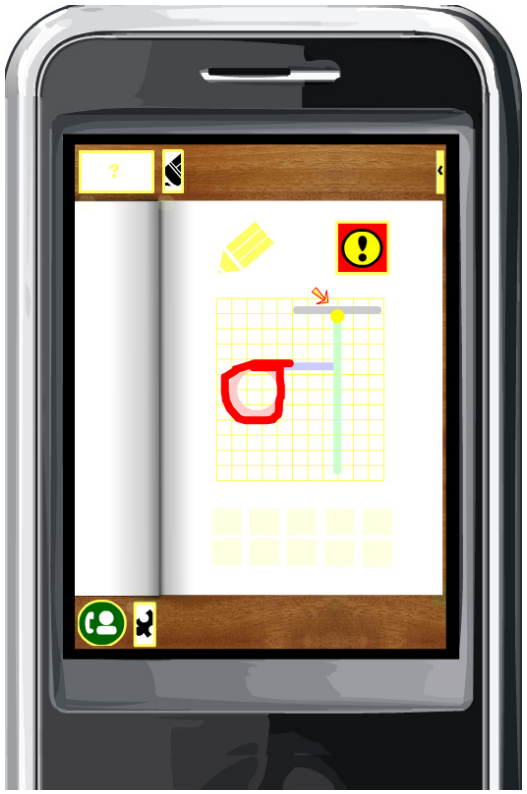
The user selected Na. Now we meet Rajesh who is waiting for the user's help. The user must help him go from one village to another in his journey. The only way to do that is to read out signboards to him. The signboards will fill up every time a chapter is completed.

This is the first step to learn the letter. The system traces out the letter to demonstrate how the letter is drawn. The curves in the letter are always red, the horizontal lines are always blue, the vertical lines green and the *Sheerorekha* is always black. This way, the users can quickly remember the shape by classifying its components mentally. The system also pronounces the letter once and asks the user repeat after it.

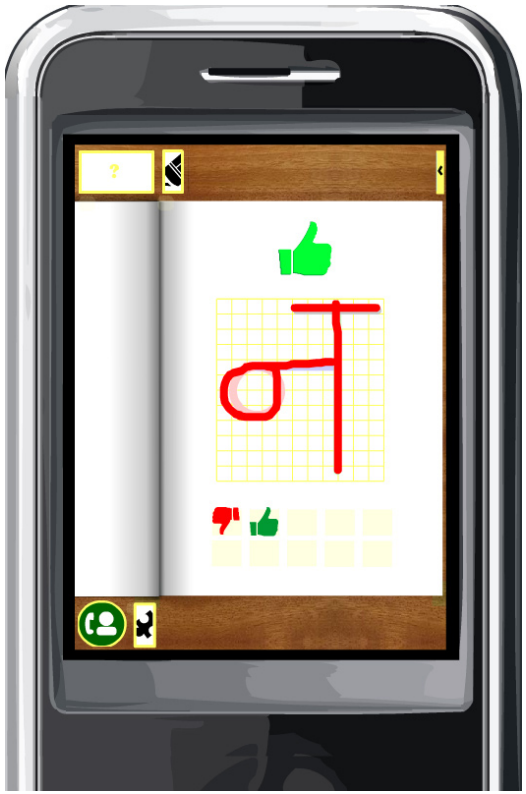
After the letter is drawn, the system shows nine examples of entities that start with that letter. These may contain movie names, colloquial appellations, actors etc too.

Once the user has been introduced to the letter in this manner, the writing exercises commence. The system first asks the user to simply scribble on the screen to get familiarized with using the stylus for an operation other than just tapping. Then the system provides exercises to draw shapes which are relevant to the letter at hand. In this case, the user is asked to practice drawing loops, horizontal lines and vertical lines.

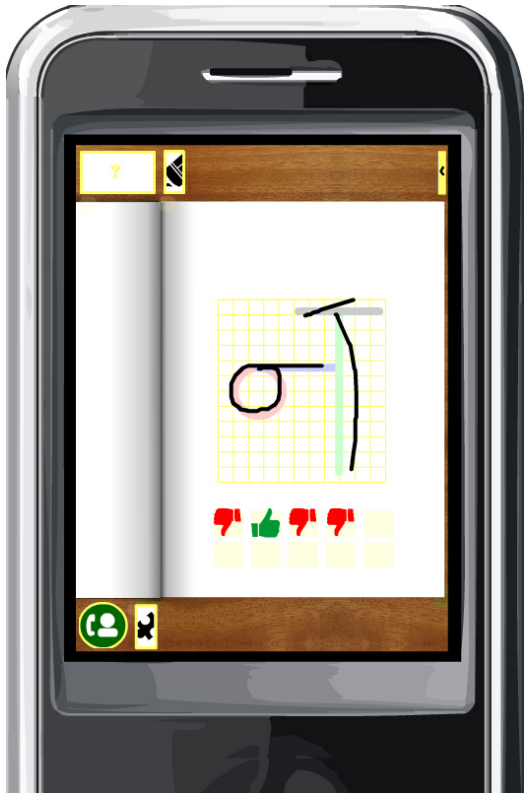
The user may, after a few letters, skip the scribble exercise if he wants. After a minimum number of exercises, if the user skips the exercise regularly, the exercise will get removed from the sequence.



After the initial practice exercises, the system now helps the user learn to write the letter. The user, in this step, is shown how the letter is drawn. Then, he must trace over the watermark of the letter. When the user touches the screen, a yellow marker appears which the user must follow to correctly draw the letter.



When the yellow pencil that we see in the previous screen fades out, the system starts verifying the pattern drawn by the user. If it is a good enough replica of the shape, the system approves. The checking system gets tougher as time passes. Also, after some progress, the system also needs the user to increase the speed by making the



yellow marker go faster. Moreover, the user can also review what he/she has done over the last few times. The system keeps a record of performance for evaluation. The user stays in this phase till he gets comfortable with drawing the letter.

After the stage of learning to draw the letter, the user is now made to write the letter. Meaning, the letter size is brought down such that it no more feels as if the user is drawing the letter. The first exercise are practice pages that the user must fill up with small Na shapes. Evaluation of patterns takes place as before.

After the practice is done, a few creative exercises follow which are meant to stretch the user's understanding of the letter and make him/her understand how well he/she has retained the letter form. The exercises include:
Finding the letter shapes in a page full of scribbles (pulled out from the exercise the user performed earlier)
Finding the right shape from a page full of shapes that look like Na
Creating a nice pattern using just the Na letterform. The user can resize, rotate or change the colour of the form. (No evaluation)

By the end of these exercises, the user will have not only thoroughly practiced writing the letter, he/she will also have evaluated how much retention for the letterform has happened.

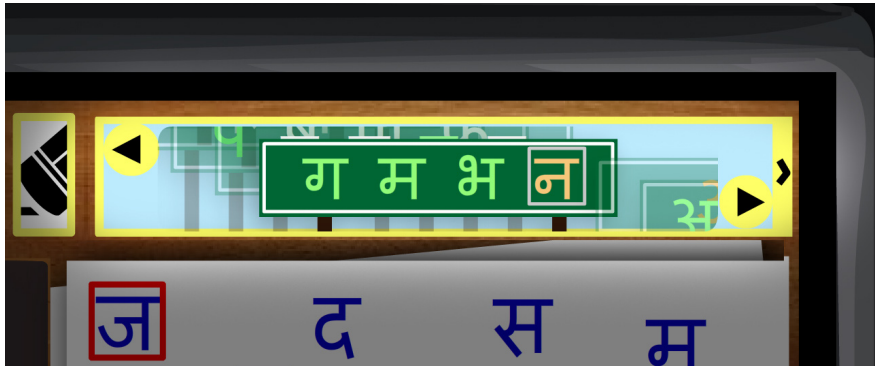
Here we see the exercises that now follow the exercises that help learn the letter. These exercises will now make use of letters that have been learnt earlier.

Dictation exercises:
The system dictates a word that the user must write and get evaluated by the system. Evaluation happens when the yellow pencil fades out. For those letters wherein the shapes are similar but the pronunciation is different, this exercise serves as a means for disambiguation.

Recitation exercises:
The system shows a word that the user must recite and get evaluated by the system. For those letters wherein the pronunciation is similar but the shapes are different, this exercise serves as a means for disambiguation.

As seen in the third interface, the exercises end with a game wherein the user must click on the appropriate letters which randomly fly across the screen to form the sentence shown below.

At the end, we see that the signboard is filled with names and the user can show Rajesh which direction he must proceed.



Apart from these series of exercises, there are parallel features in the tool. On the left we see the screenshot of the Daily Puzzle screen. Every day, the tool receives a new puzzle from the server, which is independent of the users' progress. The user to solve the puzzle in the least time gets rewards in the form of talk time.

Next to it we see a screen where the user can see online users. The user sees other users who are also concurrently using the tool. If the person has been contacted before, his icon is brighter green. Pressing and holding the icons tells who the person is. Tapping the icon places a call to the person. Teachers can log in through terminals online. In case a teacher is contacted, the screen that the user is seeing gets reflected on the teacher's screen.

On the top right corner of the interface is the help button that replays instructions. It also writes out anything that the system or the user says. It serves as a means for satisfying curiosity or self learning.

Shown alongside is the history browser. The user, at any point in the lessons, can browse to some other letter that he may or may not have accessed before. Green letters are finished letters, white are untouched ones, orange letters have been tried but not finished.

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