Revival of Ancient Sanskrit Teaching methods using Computational Platforms

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Abstract

We look at the Ancient Indian methods of teaching / learning to understand the advantages they have over the Western methods which failed to develop necessary proficiency among students. The ancient methods at the same time demanded good hold over the Pāṇini's grammar which the modern students lack. With the availability of various computational platforms for analysing Sanskrit texts, we then discuss, how we can revive the ancient methods of teaching / learning Sanskrit. And finally we illustrate with an example, how these computational platforms can be harnessed to develop domain specific learning capsules and on-line readers for specific texts.

1. Introduction

During ancient times, each Indian discipline had its own distinct style of interpretation of Sanskrit texts and employed various methods, critical as well as scientific, for teaching these texts. However, with the advent of British rule, Western methods were introduced in schools and gradually the Indian methods were forgotten. But the Western methods were found to be insufficient for teaching Sanskrit.

In what follows, we first briefly describe the two ancient Indian methods of teaching Sanskrit viz. *Daṇḍānvaya* and *Khaṇḍānvaya*, and compare them. In section 3 we briefly touch upon the Western methods employed for teaching Sanskrit. In section 4 we highlight the important concepts from Indian tradition of the theories of verbal cognition that are integral part of the process of *Khaṇḍānvaya*. In the next section, we discuss how it is possible to revive the ancient method of *Khaṇḍānvaya* by sharing the load between man and machine. Finally, in section 6 we describe on-line readers and domain specific grammar capsules that can be developed semi-automatically using these computational platforms.

2. Ancient Indian Methods

The study of original Sanskrit works reveals to us illuminating ideas on methods of teaching. Two traditional methods viz. *Daṇḍānvaya* and *Khaṇḍānvaya* were employed for effective teaching of Sanskrit.

- **Daṇḍānvaya Method :** Also known as *Anvayamukhī* where all the words are arranged in prose order according to their grammatical function and syntactical relation for easy understanding of a verse. The default word order (anvaya) or the 'canonical form' is governed roughly by the following verse:

  viśeṣaṇaṃ puraskṛtya viśeṣyaṃ tadalakṣaṇam /

  kartṛkarmakriyāyuktam etad anvayalakṣaṇam // [1]

  gloss: Starting with the adjectives, targeting the headword, in the order of kartṛ-karma-kriyā (subject-object-verb) gives an anvaya (natural order of words in a sentence).
  Through the *anvaya* a student could be able to determine the desired (*abhihita*) meaning.

1 *samāsacakram* - kā.verse 10

- **Khaṇḍānvaya Method :** Also known as *Dialogue / Dialectic Method or Method of Questions and Answers*, it resembles *Daṇḍānvaya* in first picking out the principal sentence, but differs from it regarding the construing of remaining words of the whole sentence which is carried on in sections (*khaṇḍas*) by framing questions on individual words or phrases. In other words, the basic skeleton of a sentence is given and other details are filled in by asking questions. Thus it is also called *Kathambhūtinī* due to the use of Sanskrit question words such as *kathambhūta, kim, kadā, kimartham*, etc. These questions are centered around the heads seeking their various modifiers. This approach is close to parsing a sentence showing various dependency (*kāraka*) relations.

2.1 Comparison of both methods

Both methods are analytico-synthetic processes in which several analysed units of a sentence are combined through comprehension of the inter-relations of words by means of the principles of mutual expectancy (*ākāṅkṣā*), consistency (*yogyatā*) and proximity (*sannidhi*) and finally, the students are led to the unified and comprehensive meaning or purport (*tātparya*) of a sentence or passage as a whole. *Daṇḍānvaya* method focuses on questions based on grammatical function which is helpful for quick understanding, but in the process, the poetic charm / aesthetic beauty is lost; while in the *Khaṇḍānvaya* method, the questions are principally based on the subject-matter. In the former, the subject is generally picked up first followed by other arguments of the verbs and finally the verb; while in the latter, the verb is first picked up followed by its arguments. The *Khaṇḍānvaya* approach gains an upper-hand over the *Daṇḍānvaya* in many respects as explained below:

1. Huparikar aptly puts it -- "Prose order or the regular construing in the *Daṇḍānvaya* mars the beauty of a poem instead of enhancing it; while questions in the *Khaṇḍānvaya* can be so framed as to bring the emotional content of a poem into prominence and lead the pupils to understand automatically the relations of different words in a sentence. Thus the *Khaṇḍānvaya* helps us to bring out the hidden charm of a poem, heightens our sentiments and creates living poetic atmosphere which is most desirable for the real appreciation of that poem."
2. *Khaṇḍānvaya* method appeals to the student's instincts, since predominance of questioning in it is expected to arouse their curiosity through expectancy (*utthāpyākāṅkṣā*) to the fullest extent and thus constant interest is maintained in the classroom.
3. Since there is direct interaction in the form of questions and answers, this method is more suitable for larger classes ensuring co-operation between the teacher and the taught where both of them are equal participants in contrast to the lecture method of *Daṇḍānvaya*. This increases the alertness and activeness among the students.
4. The commentaries following this method helps an individual in every minute detail regarding the inter-relations of words and ideas. This greatly improves the observational and analytical skills.
5. The method of *Khaṇḍānvaya* and the function of *tātparya* combined create the unified impression of a subject, aid memory by making assimilation of what is taught and lead to the mastery of the subject learnt.

3. Western Methods

With the onset of British rule in India, gradually Western methods of teaching and learning were introduced in schools for teaching not only the modern sciences but also to teach modern languages and even classical language like Sanskrit. The *Grammar-Translation Method* which was popular in Europe for teaching classical languages such as Latin and Greek was adopted for teaching Sanskrit by many. In *Grammar-translation* method, sentence constructions corresponding to different grammar rules are taught and students are also taught to translate them into their mother-tongue.

Westerners adopted this method for learning and understanding Sanskrit language and Indians followed this trend till now. Many Sanskrit teaching books were written based on this methodology starting with *R. G. Bhandarkar's* 'First and Second Book of Sanskrit', *K. P. Trivedi's* 'The Sanskrit Teacher' in two volumes, *M. M. Deshpande's* 'Saṃskṛtasubodhinī', *Thomas Egene's* 'Introduction to Sanskrit' in two parts, *Michael Coulson's* 'Teach Yourself Sanskrit', *Robert and Sally Goldmans'* 'Devavāṇīpraveśikā', etc. to name a few. It is assumed that students learn how to understand the source language text and express it in the target language. Hence though historically this was the first structural method, later it was found to be ineffective by itself and new methods such as Functional and Interactive ones were introduced. In both Functional as well as Interactive methods, more focus was on communication aspect and grammatical aspect was made subordinate or eliminated altogether which again was ineffective in teaching Sanskrit. The reason being mere practice of conversation without knowledge of how a language works intricately would be a shortcoming.

4. Utility of Indian Methods

Huparikar reports that generally, students trained in modern schools were incapable of analysing Sanskrit texts and resort to translations rather than the original works for understanding, which is often unsatisfactory. On the contrary students trained in traditional methods were more apt at grasping the subtle shades of meanings of words in the texts. In both the above mentioned Indian traditional methods, it is essential to have prior knowledge of minimum set of grammar rules for *sandhi, samāsa* and *kāraka* along with the theories of verbal cognition (*śābdabodha*). The essential factors that help in *śābdabodha* such as mutual expectancy (*ākāṅkṣā*), consistency (*yogyatā*), proximity (*sannidhi*) and purport (*tātparya*) also play an important role in the process of verbal cognition. The *Khaṇḍānvaya* method helps a student understand the process of verbal cognition through worked out examples. The concept of *ākāṅkṣā* teaches a student *where* to look for clues for establishing relations between the words in a sentence, *yogyatā* teaches *which* meaning to look for among the *abhidhā, lakṣaṇā* and *vyañjanā*, while *sannidhi* puts some constraints on possible combinations of relations between the words, and *tātparya* helps in disambiguation of ambiguous words and understanding the whole purport of the utterance.

5. Changing Teaching / Learning scenario in Technology Era

Traditional methods of teaching required minimum eight to twelve years of dedicated study which seems impractical in todays fast-paced scenario. Additionally, teaching or learning of Sanskrit unlike other modern languages requires lots of memorization in the form of word-formations and various grammatical rules involving lexical, syntactic and semantic information. The students of this generation shy away from this kind of memorization. Todays generation is more technology savvy and frequently use the internet/web for socialising, working as well as learning. In recent years there has been rapid advancement of several computational tools for Sanskrit.[2]

Is it possible to use these computational platforms to reduce the burden of learning Sanskrit? Bharati et al. discuss how the *Anusāraka*, a language acccessor, helps in overcoming the language barrier by sharing the load of language learning between man and machine. Tasks which are difficult for human being are handled by machine and human being takes the load of the tasks that are difficult for a machine. We describe below how *Sanskrit-Hindi Anusāraka*, a language accessor, developed using the services of Sanskrit Computational Linguistics (SCL) Platform and Heritage Platform, in addition to reducing the burden of language learning, also helps in reviving back the method of *Khaṇḍānvaya*.

2http://sanskrit.uohyd.ac.in/scl
http://sanskrit.inria.fr
http://sanskrit.jnu.ac.in/index.jps
http://kjc-fs-cluster.kjc.uni-heidelberg.de/dcs
http://sanskritlibrary.org

5.1 Teaching / Learning Tool

Normally learning Sanskrit involves learning a new script (for many who do not know *Devanāgarī*), learning its phonetic repository along with *sandhi* rules resulting into euphonic changes across the word boundaries, learning morphology both inflectional and derivational including various semantic conditions for compound-formations (*samāsa*), learning syntax and finally word-meaning association. In addition, one needs to be familiar with the culture in order to understand and appreciate the literary works. This is a lengthy and time-consuming process. However the existing on-line computational tools for Sanskrit show possibility of man-machine interface sharing the language learning load.

- **Overcoming Script barrier** Though Sanskrit is written in *Devanāgarī*, in different parts of India we find Sanskrit manuscripts in the local regional scripts such as Telugu, Malayalam, Bengali, etc. Even though Unicode has different code pages for all these Indic scripts, it being derived from the ISCII which had a common code for all Brahmi based scripts, it is possible to faithfully transliterate Sanskrit texts from one Brahmi based Indic script to another. And thus todays technology makes it possible for anybody familiar with one Brahmi based script to access Sanskrit text in any other script. IAST provides a faithful roman transliteration of a text. In other words, the problem of Script barrier, with reference to Sanskrit texts has technological solution. The SCL and Heritage platforms recognise Sanskrit texts in *Devanāgarī* as well as IAST. Moreover, in principle, it is possible for the system to accept texts in any Brahmi based script.

- ***Padapāṭha* (Segmentation)** In Sanskrit, unlike other modern Indian languages, the text is presented in *saṃhitā* form (as a continuous stream of characters), being influenced by the oral tradition. In order to split such a text into words (*padas*), one needs to be familiar with the word forms in Sanskrit, and also the *sandhi* rules that result into the euphonic changes at the word boundaries. And here come these computational tools to the rescue of a student who can not memorise hundreds of word forms and finds it difficult to remember several exceptional rules of *sandhi formation*. Machine can remember millions of word forms and also remember the *sandhi* rules including all exceptional cases. The *padajñāna* (word morphology) and sandhi rules for segmentation together typically produce more than one splits. For example, for the famous sentence discussed in *Patañjali's* 'Mahābhāṣya' '*śvetodhāvati*', SCL splitter produces 28 various splits and Heritage segmenter produces 36 possible splits. But *Patañjali* has discussed only two possible readings viz. *śvā itaḥ dhāvati* and *śvetaḥ dhāvati*. Machine produces many more than these because machine does not have the *padārthajñāna* -- knowledge of word-meanings. Machine therefore does not know whether the produced splits are meaning-wise compatible or not. And it is here the concept of sharing of load becomes important. Heritage segementer provides an interactive interface that helps a student / reader to choose appropriate segments. Human being is good with the context, word-meanings, world knowledge, etc. and can use the essential factors for verbal cognition viz. *ākāṅkṣā*, etc. to decide the correct split by interacting with the machine (See Fig 1), whereas machine takes the load of memorising various word forms and *sandhi* rules.

- ***Padārthajñāna* (Word-meaning association / śaktigraha)** After selecting the correct segmentation (Fig 2), the next task is to get the meaning of each word and suffix. Since many modern Indian languages are either originated from Sanskrit or have borrowed heavily from Sanskrit, students know the gross meanings of Sanskrit nominal and verbal roots. However, in order to instill the correct and original meaning of Sanskrit words, these computational tools also provide a direct link to the bilingual dictionaries such as *Apte's* 'Sanskrit-Hindi dictionary', or *Monier-Williams* 'Sanskrit-English dictionary', or thesaurus such as 'Amarakośa'. (See Fig 3). Of the eight factors which help in knowing the word-meaning association (śaktigrahas)[3], machine

3 *śaktigrahaṃ vyākaraṇopamānakośāptavākyād vyavahārataśca l*

vākyasya śeṣād vivṛtervadanti sānnidhyataḥ siddhapadasya vṛddhāḥ ll - śabdaśaktiprakāśikā of Jagadīśa

(Grammar, Analogy, Lexicon, Statement of trustworthy persons, usage of words, other words in the sentence,

provides help on grammar by showing the morphological analysis, it also provides links to the dictionary entries. Bilingual dictionary entries provide the meaning in other languages and monolingual dictionary provides a paraphrase in Sanskrit. They provide citations and example usages and also provide the explanation if needed and collocations. Thus now a student acquires the meaning of each word either by correlating the meaning of Sanskrit words through his mother tongue or directly through the monolingual dictionaries

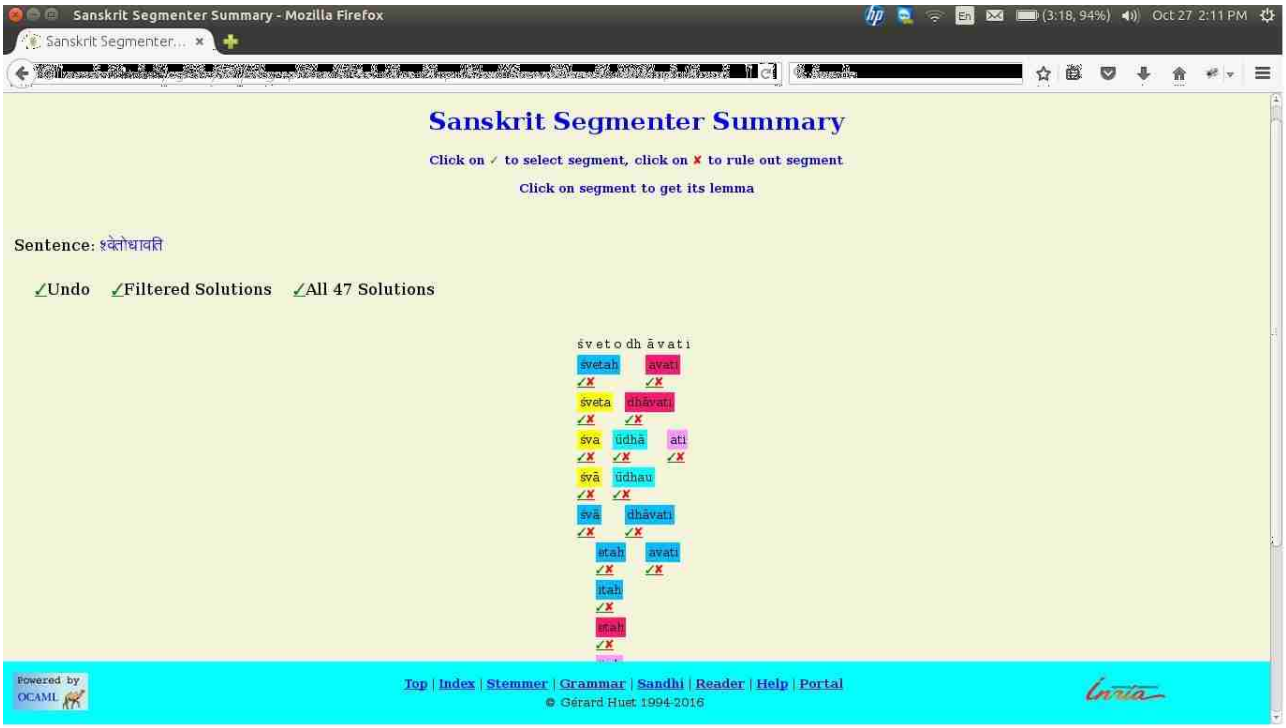

Figure 1 : All possible segmentations svetodhavati

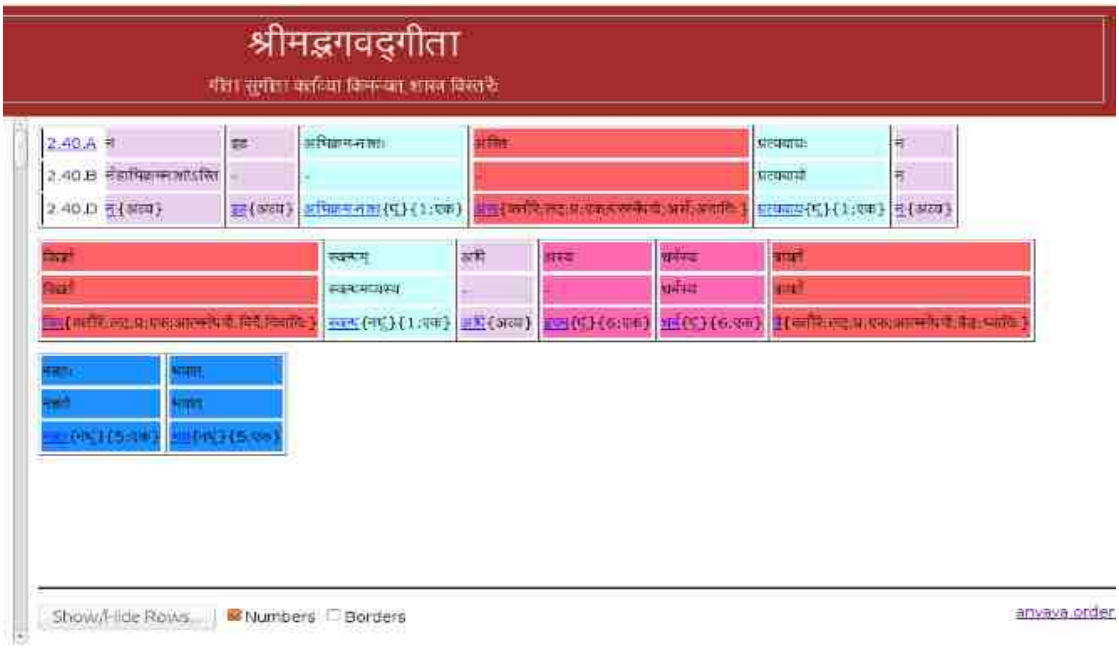

Figure 2 : This figure shows the original Sanskrit text in the second row and the segmented text in the first row. Third row shows the morphological analysis for each segment.

explanatory notes and collocation of words)

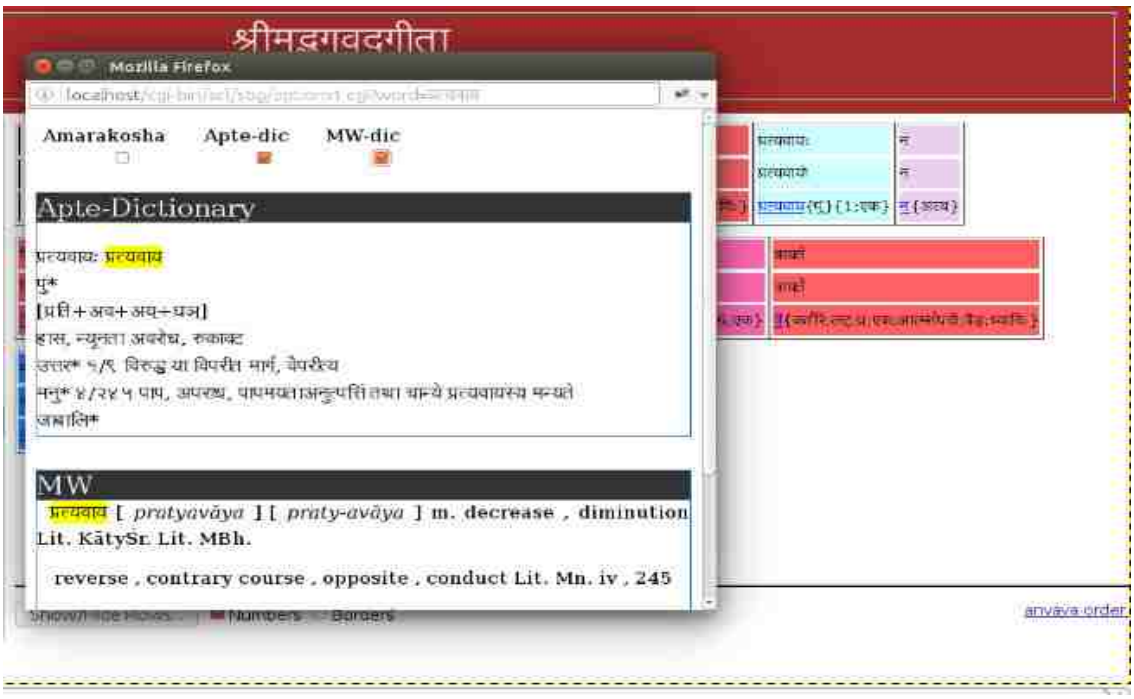

Figure 3 : On-line dictionary help

- ***Vākyārthajñāna*** **(Understanding the sentential meaning)** In order to understand now the sentence meaning, one needs to understand how the words in a sentence are mutually related. Pāṇini's grammar provides various clues to understand the relations between words. Sentential parser in SCL uses these rules and the *ākāṅkṣā* (expectancy) of words to propose possible relations between words. It also uses the constraint of *sannidhi* (proximity) to rule out those combinations of relations which do not satisfy the constraint of proximity. Now in order to have proper verbal cognition, a reader should check whether the meanings of the words thus related are congruous (*yogyatā*) and also use the contextual knowledge to decide the intended meaning (*tātparya*) of ambiguous words. This is the second stage where there is a sharing of load between a man and a machine (See Fig 4). While machine remembers all the grammar rules of sentence formation and using it analyses a sentence, a human being using the context and the compatibility of word meanings, chooses appropriate relations leading to the anvaya of a sentence. With this interface, now a teacher can follow the process of *Khaṇḍānvaya* to make student understand the sentential meaning. The interface acts like a puzzle-solver where teacher and students have a dialogue with *kathambhūtinī* kind of question-answering sessions, and based on the clues now a student selects the correct answer, and machine then removes all other answers conflicting with the choice made. A good teacher, then, can also take this opportunity to tell students why the filtered out relations were conflicting, and so on. This game continues till a student resolves all ambiguities of choices in relations. This method thus not only brings back traditionally well tested teaching method of *Khaṇḍānvaya* but also greatly improves the observational and analytical skills of a student.

Thus we observe that with the help of available computational platforms, a teacher can follow the method of *Khaṇḍānvaya* method to make student comprehend any unseen Sanskrit text.

6 Domain Specific Teaching Capsules

Sanskrit has a vast repertoire of literature and each discipline has its own set of terminology. There are several disciplines which require moderate knowledge of Sanskrit in order to understand the texts in their disciplines. For example, a historian needs to refer to the original Sanskrit texts. Disciplines such as *Ayurveda* insist that students should have good knowledge of Sanskrit in order to read and understand the original Sanskrit texts in *Ayurveda* with its terminology. However, all

these students fail to gain the needed expertise in Sanskrit within a short span of time available with

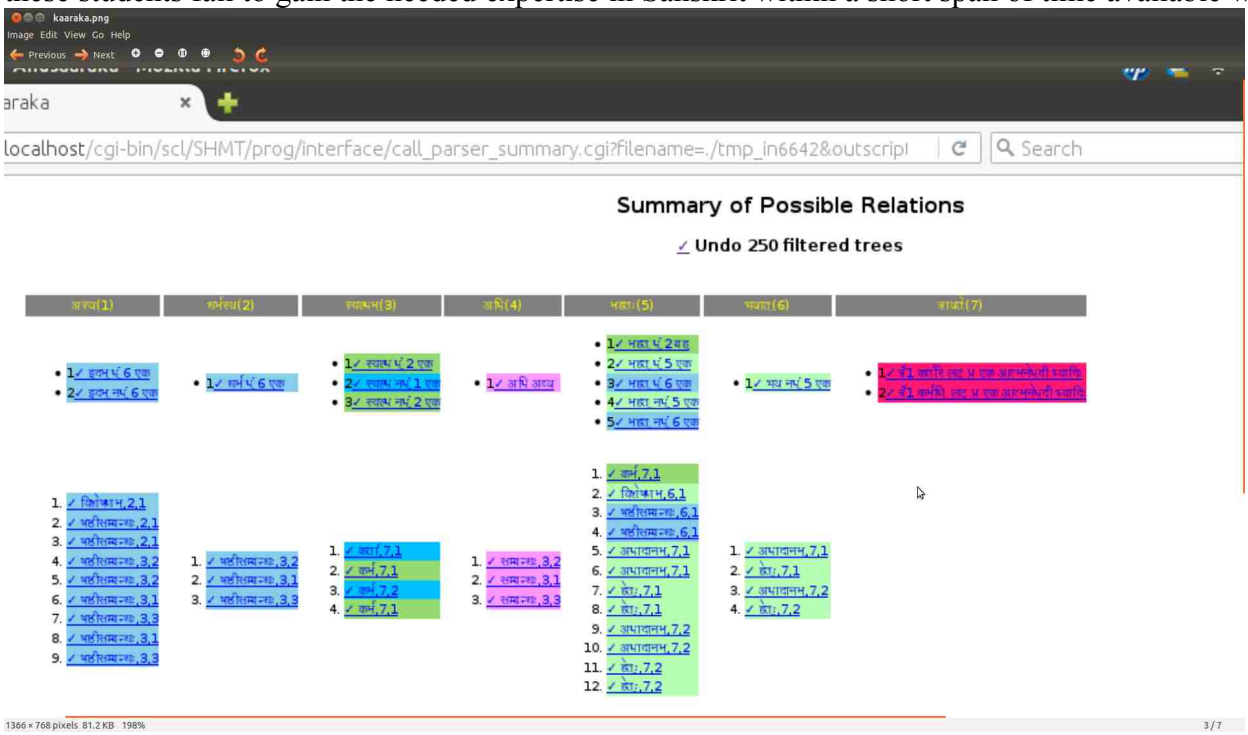

Figure 4: Possible relations among words

them for studying Sanskrit. In another scenario, in recent years in India, there is a growing trend among the elderly persons to understand Sanskrit philosophical texts such as *Upaniṣadas, Gītā*, etc. Both these scenarios demand domain specific teaching / learning capsules. These capsules can be in two different formats.

6.1 On-line reader

The need for domain specific teaching / learning capsules was felt in earlier days also. We see several commentaries on various popular as well as important works. These commentaries, following the *Khaṇḍānvaya* method has explained each and every verse of the selected text providing the segmented text, etymological details, exceptional grammar rules etc. sometimes following *Khaṇḍānvaya* method and sometimes following the *Daṇḍānvaya* method. With the available computational platforms now it is possible to analyse any Sanskrit text semi-automatically with all these possible nuances of commentary tradition and present the same analysis in a more compact and user-friendly way. The user interfaces can be tailored to the needs of a student. Such on-line readers for various texts such as S*aṅkṣepa Rāmāyaṇam, śrīmadBhagavadGītā, śiśupālavadham*, etc. are available.[4] These readers provide an access to the original text following the traditional method of learning Sanskrit. Just as the commentaries present any text with *saṃhitā pāṭha*, followed by the analysis of *sandhi* and *padapāṭha*, followed by the word analysis providing the etymology wherever necessary, analysis of compounds explaining its constituency structure and the type of compounds and its paraphrase, and then the word meanings and finally the anvaya between the words, the on-line readers also provide the texts with the following information.

- *saṃhitāpāṭha* (original continuous text)
- *padapāṭha* (segmented text)
- *padaviśleṣaṇa* (morphological analysis)
- *samasta-pada-viśleṣaṇa* (compound word analysis)
- *anvaya* (parsed structure)
- dictionary help for each word

4 http://sanskrit.uohyd.ac.in/scl

Below we show some snapshots of such an interface for *śrīmadBhagavadGītā* (BhG). In Fig 5 we see the output of *forty-seventh śloka of second chapter* of BhG[5].

Figure 5: Row-wise information

The first row (2.45 A) presents the segmented text. The second row (2.45 B) shows the original text with sandhi. The third row (2.45 C) shows all possible word analyses for every word. The fourth row (2.45 D) shows the analysis of a word after choosing the correct parse. The ninth row (2.45 I) gives the Hindi gloss of the Sanskrit word and the tenth row (2.45 J) shows the English gloss. All these rows are collapsible. So the reader has freedom to show / hide any of these rows. Thus the reader has a choice over which information to display and which to hide. Words with different case markers have different colors. Thus a student once gets familiar with the color-case marker association, can always hide the morph analysis row, and open it only when in doubt. The analysis of a compound word is shown in sixth row. Bringing the cursor on the link of this analysis shows the constituency analysis as a parse-tree displayed in Fig 6. The *kāraka* analysis is graphically shown in Fig 7. The fourth row also links every word to the dictionary entry shown in Fig 8.

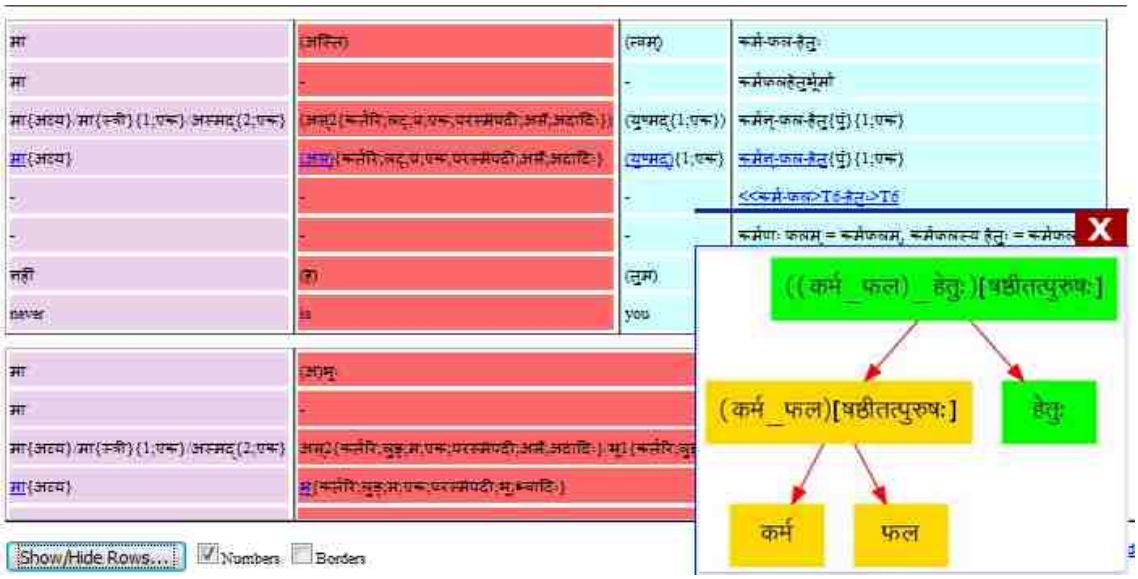

Figure 6: Constituency analysis of a compound

5 *karmaṇyevādhikāraste mā phaleṣu kadācana /*

mā karmaphalaheturbhūrmā te saṅgo'stvakarmaṇi // --BhG 2.47

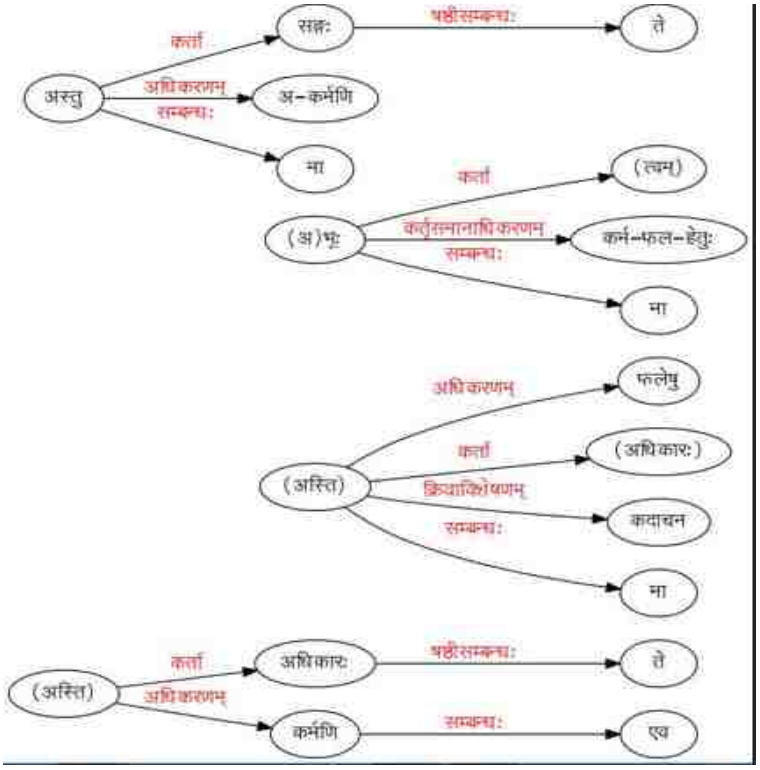

Figure 6: Karaka Information

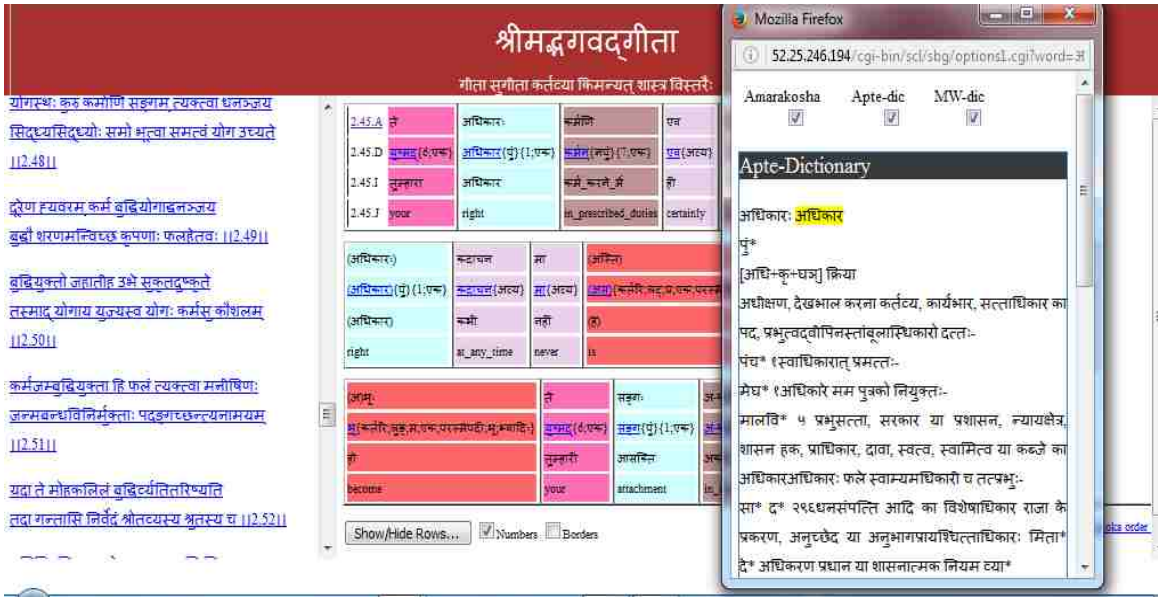

Figure 7: Dictionary Link

This interface can be beneficial to both a student as well as a teacher.

6.3 Domain specific Teaching Material

Another use of available computational platforms is to develop crash course material to teach Sanskrit just enough to access the texts a person is interested in. T. Kulkarni used these computational platforms for analysing texts on *Vedānta* and gathered statistical data pertaining to these texts. He collected statistics for *sandhi* rules needed for understanding the text, and various noun and verb paradigm tables a student should know before reading the texts. Based on this

information, he then developed a course material (*Vedanta Samskrita*) for teaching the just essential aspects of Sanskrit in order to gain confidence in reading *Vedānta* texts independently. His experiments show that with the teaching capsules he developed, a reader gains confidence in reading original Sanskrit *Vedānta* texts with a training of just 10-15 hours. Similar material for *Gītā* following the same approach is underway.

6.3 Utility to a student

The interface contributes directly to student learning in following ways:

- A student can have access to first-hand knowledge of original Sanskrit text.
- By effective use of tools and technology, one can be better motivated to understand a given text.
- Students can have easy access to different tools in order to meet their personal needs and preferences thereby improving their weaker areas of learning.
- One is greatly benefited by having the opportunity of personal learning space. This way one could gradually improve and hone ones learning skills at ones' own individual pace.
- Through constant practice, development and refinement a student can gain understanding of a text.

6.4 Utility to a teacher

Blending technology with teaching practices could be a challenge for teachers. By recognizing the potential of interface in ones' practice, a teacher can gain confidence in utilizing the educational tools and technology.

- Teacher can ensure active student participation once one has understood a text with the help of interface and determine what linguistic expressions should be more stressed.
- It is essential to teach grammar side by side with literature. The statistical analysis through interface can help a teacher to decide which aspect of Sanskrit Grammar is more relevant for the study of a text.
- One could devise good application exercises and assignments for the self-study of students. This could be a contributing factor in their personal development supporting personal reflection and collaboration.
- Once the subject matter is clearly understood by the students, teacher could then provide for and encourage multiple perspectives and representations of content.
- Effective management of time and energy is required for teaching lengthy and tedious word-formations. This could be reduced considerably by engaging the students in using the tools.
- Those teachers who are inclined in improving the quality of teaching, raising standards and gaining better standing in further education could explore, model and experiment with new approaches of lesson planning and preparation with the help of interface. The primary and secondary points of a lesson could be prioritized.
- One could easily develop similar domain specific interface or even create virtual courses by adopting the methodology.

Hence teachers and students can build on their own past learning and on each others' ideas with teachers taking the role of guides and facilitators of learning and not just as instructors.

7. Conclusion

New developments in teaching and learning technology could open up new vistas in effective and efficient teaching and learning environment. With the help of available tools, a better approach for developing curriculum for teaching could be developed. Additionally, one could improvise or even customize the interface by adding additional information.

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