

Integrating STEM in Teaching and Learning of World Language

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Abstract: Language learning goals, and assessment criteria to monitor learner's progress and proficiency are determined according to standard based performance benchmarks at different levels of language learning. In a standards based curricula, content in humanities, literature, art, music, cuisine etc. are more favored over content in Science, Engineering, Technology and Math (STEM) to connect language and culture in a meaningful context. Although focus of language learning is not the content, in this paper, some results of integrating STEM content in teaching Hindi Language will be presented. It is observed that in a language classroom, learners find STEM content to be more interesting.

Introduction: Until recently, Foreign Languages in the United States were taught at all levels in very few public and private educational institutions, and specialized language training institutions. Foreign language programs in main stream education system (K-16 levels) are often limited to a few select languages like,

Spanish, Russian, French, German, Italian and Chinese.

New languages are being added to this list with expanded business and strategic interests emerge in different parts of the world. Teaching of many such languages often grouped as Less Commonly Taught (LCT) languages, are confined to a less organized premise of culture or religion centers or in Heritage Schools. While teachers in those centers are native speakers of the language, they have limited or practically no formal training or experience in pedagogy of Language Teaching.

Many LCT languages now identified as critical languages, are being introduced in Foreign/World Language programs in educational institutions (K-16). As new languages are introduced, it is also important to ensure that these languages are taught according to common standards, such that teaching and assessing is at par with other foreign languages.

Furthermore, there is a paradigm shift in teaching of foreign languages, particularly Hindi. The focus at early stages of language learning is more on communication skills in the target language. Literacy, grammar, structure and form, and variations of language which require higher level of skills are learned as communication skills improve.

Standards of Foreign Language

Teaching & Learning: There are different agencies that provide guidelines for teaching and assessing foreign language training. Traditionally, these agencies formulated the standards mainly for defense services and business sectors. Higher Education institutions used their own standards, curricula and teaching methods for a very long time.

More recently, standards for foreign language education are being unified for educational institutions (K-16) by the American Council on the Teaching of Foreign Languages (ACTFL) and define goals and assessment criteria for learners' performance of language functions [1] at each proficiency level (there are 5 proficiency levels). The goals for foreign language learning are codified in terms of performance indicators and benchmarks for different proficiency levels. Details can be found in several ACTFL publications [2, 3, 4, 5,] on ACTFL website.

It is well recognized that foreign language learning is more effective when contextualized in the culture of the native speakers of the language. According to ACTFL guidelines Communication, Culture, Connection, Comparison and Community (5Cs) must be integrated in a

foreign language teaching program as shown in Figure 1.

Foreign Language Teaching & Learning Goals:

Goals: One important aspect of setting language learning goals is to integrate language, culture and content in a meaningful real life context such that the learner clearly understands the language functions and be able transfer it to another context in a culturally appropriate manner to have a meaningfully communication.

'Connections' are made with other disciplines to provide windows to real world scenarios in which language is learned and practiced in an interesting, engaging and meaningful context. More often disciplines such as humanities, literature, art, music, travel, food, festivals, social life, religion, etc. are more favoured content areas over STEM subjects/topics for providing a connection between language, culture and content.

It is particularly challenging to incorporate STEM topics in teaching of Hindi language for two reasons; a) because of the colonial past there is a lot of assimilation of English and other European languages in Hindi, particularly in teaching of STEM subjects in higher and professional education, and b) use of scientific terminology in their original language has become the mainstream choice over the native equivalent

terminology and is well understood and used even by native population in everyday life.

Although learning content is not a primary goal of language learning, the two may be integrated creatively to also make content learning including STEM topics, accessible in the target language in the context of the target language culture. It also provides learners opportunities to draw comparisons not only in the content area that they learn outside the language classroom but also in the structure of the target language and their first or other language they know. It widens their knowledge base in language, culture and content including STEM content, and enhances their perspective to the culture of India and Indian people which is not accessible without knowing the language.

To the knowledge of the author, there are few examples of including STEM topics in STARTALK programs in Chinese and Russian languages. However, systematic study of integrating STEM in a language program, is limited. The goal of this particular study is to address some key concepts in teaching Hindi language using a curriculum designed according to ACTFL standards incorporating STARTALK principles where language culture and STEM content are connected to provide a meaningful cultural context.

More specifically, the study tests following hypotheses-

- a) STEM content may be successfully integrated with language and culture in a thematically organized standard based Hindi language curriculum,
- b) STEM content when integrated with language and culture is effective in providing a meaningful context for teaching and learning Hindi language,
- c) As compared to contents that are used more traditionally in foreign language teaching and learning, STEM content is more engaging or less engaging to keep learners focused in their language learning goals, and
- d) Integrating STEM content with language and culture provides a different perspective to facilitate content learning.

Integrating STEM in foreign Language Teaching and Learning: The above mentioned hypotheses are being experimented with in STARTALK-ESHA Hindi Language Immersion Summer Schools held in Marlboro, NJ, for the past three years (2013, 2014 and 2015). The Summer School program is for learners in grades 3-11 (age group 8-16) having different background in Indian culture and have different levels of language skills. Although Science and Math relate to

universal knowledge, Technology and Engineering often develop around cultural practices and perspectives.

Therefore, it was important to select STEM content that has particular significance and relevance in the target culture. To fully engage learners in a language classroom it is also important that content area is of sufficient interest to learners and appropriate for age and cognitive abilities of learners. It is further important that language learning goals take priority over content delivery and those goals are shared with learners early in the program.

In the following section, few examples will be presented to illustrate how STEM content is integrated with language and culture in a standard based curriculum for teaching and learning of Hindi Language which is spoken widely in India and other countries with significant population of Indian origin.

In one example, ‘Monsoon’ is selected as the context for language learning. Monsoon is a well-known complex global weather pattern observed in many parts of the world. In India and the Indian sub-continent the complex weather pattern is not only synonymous with annual rainy season, it is heart and soul of life, culture, economy and trade through ancient times, even before a

scientific interpretation of Monsoon weather pattern was discovered by Arab traders. Therefore, ‘Monsoon’ was selected to integrate language, culture and content for teaching Hindi language.

The graphic shown in Figure 2 depicts progress of southwest and northeast Monsoon (red and green arrows, respectively) in India for the year 2015. While the graphic has a wealth of scientific information, when used in the context of Indian culture in a Hindi language classroom, it is a useful tool to learn vocabulary, sentence and grammar structures in a meaningful context according to the language skill level of learners.

For example, for Novice learners, the map was used to learn vocabulary (for example, map, regions, direction (east, west, north, south, up down, left, right, up, down), land, air, sea, ocean, wind, etc.)), colors, simple sentence and grammar structures to ask and answer questions, and so forth. The learner applied the basic language learned through this graphic, to other contexts, for example, giving directions, making a travel plan to different part of the country, weather and weather prediction (temperature, rain fall, etc.) in different regions using a satellite map, etc.

As learners acquired higher language skills, prior or new content knowledge of more complex scientific concepts such as data acquisition (e.g. rain fall data from different geographic regions), data analysis and statistics (of rain fall), correlations (geography, wind direction, air and ocean temperature, etc.) were used to introduce more vocabulary and complex sentence structures. It is observed that as learners progressed through the language goals, they readily acquired new content knowledge that can only be accessed through the target language by research (in Hindi or English) and peer-to-peer interaction.

They learned about science and technology of Monsoon prediction which is a multi-disciplinary field including atmospheric, ocean and earth science, data science, statistics, computational science, and super computer technology, just to name a few. Learners having even higher language skills were able to connect their content knowledge from different disciplines to have a better perspective of cultural practices.

In another example, wildlife conservation is selected as the context for teaching Hindi language. Global decline in tiger population is well known. Currently, India has the largest tiger population in the world. It is also well

recognized that decline of forest ecosystem and tiger habitat (in sq. km) is one of many causes for the decline in the tiger population. Therefore, preserving the forest eco-system in India provides a very good context to connect language, culture and content for learning Hindi language.

The chart shown in Figure 3 represents tiger population (in thousands) estimates in India until 2007. Although the data is little outdated and may not be representative of current status, in a Hindi language classroom, the scientific concepts of this chart was used for language learning goals.

As an example, basic vocabulary related to telling large numbers, population, prediction, calendar years, going up and down, more, less, etc. may be introduced. The language learned may be applied to other context (e.g, human population, comparison of growth/decline of other animal species during the same period).

To make learning more interesting and meaningful, at a higher language skill, the same chart may be used to introduce language of questions- ‘why’, ‘when’ and ‘how’, did tiger population decline, ‘what’ can be done to prevent extinction, language of description, expressing opinions, etc., to make connections with other disciplines and local scientific and

technology knowledge about methods for measuring and tracking tiger population, etc. To expand language learning goals, e.g. to build upon vocabulary, grammar and sentence structure, e.g. vocabulary for comparison, deduction, prediction, etc. by combining data from different studies.

For learners having higher level language skills, new vocabulary and grammar/structure pertaining to forest ecology and eco-systems, food chain, balance in nature, habitat, projection of data, reasoning and expressing or presenting a viewpoint, was learned through self-paced research and peer-to-peer discussion to exchange ideas.

General observations are that learners respond more positively when language learning has a meaningful purpose and that purpose and the roadmap. For example, the chart shown in Figure 4 draws a correlation between decline in global tiger population and loss of global tiger habitat. Language learning goals were to learn vocabulary pertaining to description of a chart, large numbers, cause and effect, prediction. (language learning goals) is shared with learners early on. For example, the shared purpose in the context of wildlife conservation theme was to produce a proposal for funding from a Government/Non-Government Organization (NGO) to

increase awareness amongst local population (therefore the campaign must be in Hindi) to protect tiger habitat. With a shared purpose, learners were motivated towards learning new content and also applying their prior content knowledge from other learning experiences outside the language classroom.

Learners are more enthusiastic to contents that are easy to relate to in real life, something they can easily visualize or observe (less abstract), that are engaging in multiple ways and that are appealing to their logical and creative side. From these aspects STEM context tried for the Summer Schools were very successful. Younger learners are more receptive when multi-media is used for inputs (instruction, research). Preferred media for producing language output for assessment is electronic (slide shows, video-clips, audio recording, blogs, writing e-mails, etc.) and 3-D models over traditional presentation modes (poster, chart, text, etc.). Expressing their viewpoints using skits and music were other modes learners were enthusiastic about. Most learners and particularly the heritage learners, also respond to other content areas (food, travel, festivals) they are somewhat familiar with.

It was further observed that response to STEM content is more

enthusiastic over traditional content used for language teaching and learning. It is difficult to master all the science and technology vocabulary within the duration of the Summer School because vocabulary is harder, unfamiliar and do not overlap much with other content area. One reason may be, that program duration is short and there is limited opportunity to recycle and reuse vocabulary in a different context. Having a prior knowledge of content (even if limited) helps learners to focus on the language learning goals.

Conclusion: In summary, few examples presented in this paper highlight how Hindi language may be effectively taught and learned in a meaningful reallife context using a standard based curriculum and integrating STEM content with language and culture.

This is an ongoing project with limited resources, and has generated limited data points for making sweeping conclusions. Due to short duration of the program, inferences drawn from this study may not be very accurate and a longer duration program may have a different and/or better outcome. Some of the inferences are-

- a) Language learning goals must be realistically defined particularly for a short duration program, must include differentiation, and the roadmap shared

with the learners early on for better results.

- b) In short duration program, language learning goals must take priority over delivering content knowledge.
- c) Learning the language widened learners' knowledge base including scientific and technology knowledge, that they would not otherwise seek.
- d) Learners acquired new content knowledge (in a limited way due to the short duration of the program) that is not accessible without knowing the target language and culture.
- e) Learners showed interest in learning more about the topic and enhanced their perspective towards culture of India and Indian people.
- f) The new knowledge acquired through a target language and culture perspective may be applied to learning outside the language classroom.

Moving forward, the concepts will be applied to other STEM contents (health and nutrition science, personal health and hygiene, alternative energy, natural resources conservation, global climate change, etc.) in future summer and longer duration (semester or year long) language programs and may be, extended to other languages through the STARTALK program.

References:

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4. "ACTFL Performance Descriptors for Language Learners", ACTFL, 2015.
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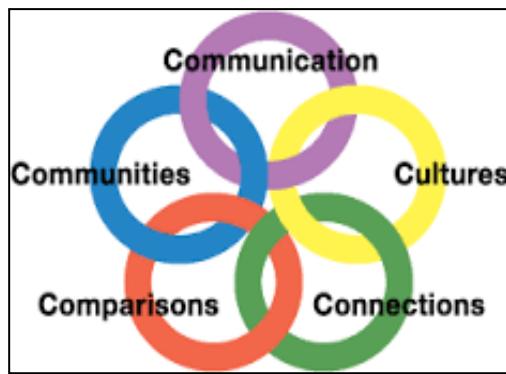


Figure 1: 5Cs of Language Learning
From ACTFL Guide

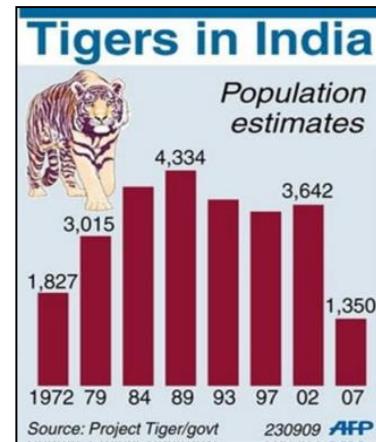


Fig.3: Estimated Tiger population



Fig.2: Prediction of Monsoon

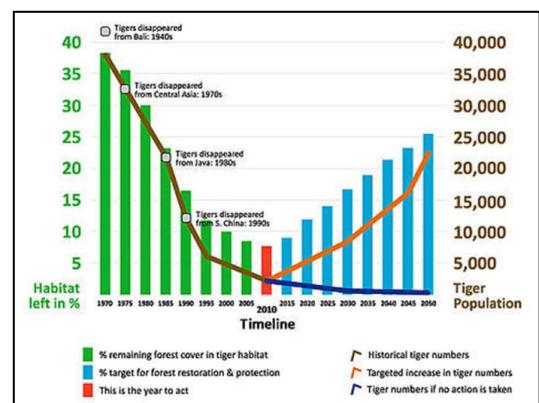


Fig.4: Correlating tiger population and habitat