Integrating Aesthetic Subjects with STEM Education

Dr. Nishad Handunpathirana



In this 21st century the STEM (Science, Technology, Engineering, Mathematics) education method is successfully practiced in many developed countries. The basic foundation to introducing the STEM education method to the Sri Lankan school system also has now begun. In this country if it is called STEAM education is to include Science, Technology, Engineering, Arts and Mathematics there by accessing a deeper human development in a wide sense.

STEAM reflects an integration of the subjects including Science, Technology, Engineering, Arts and Mathematics. As used here 'Arts' represents the study of subjects related to humanities. Through this more attention (or emphasis) has been paid to the integration of the subjects of the aesthetic stream. According to the opinion of the American psychologist Roger Sperry experiencing the subjects such as Science, Mathematics, Technology and Engineering contributed to the development of the left hemisphere of the brain while the stimulating subjects such as Aesthetics, Arts and Literature make a beneficial contribution to the development of the right hemisphere. Accordingly, an integrated education method such as the STEAM method would undoubtedly be more successful and fruitful in molding a citizen with a balanced mind.

In order to achieve this, it is necessary to pay attention to building the learning-teaching process such that the subjects Science, Technology, Engineering and Mathematics are integrated with the aesthetic subjects. (If it is necessary to employ methods which will minimize the weaknesses of the current education process which has separated out these subjects into different time slots in the time table) Therefore it is necessary to investigate this depth how the teaching of aesthetic subjects can contribute or intervene in STEAM education scheme.

The aesthetic education stream in the schools of this country is built on the four columns of the basic subject areas – music, dance, drama and theatre and drawing. (Art). Of these the three subjects Music, Dance and Drama are related. These subjects are included in the subject confluences (Center) of performing arts, drawing and sculpture fall under the field of visual arts. The performing arts are considered as intangible heritage. It is possible to identify three facts that should be stimulated/activated in the education/teaching process in our schools, if we are to more effectively bring about a merger of the aesthetic stream with STEAM education. There are ;



1. To effect the understanding of some of the contents of the subjects of Science, Technology, Engineering and Mathematics it is necessary to relate them to the experiences of the subject of aesthetic or integrate with it.

2. Bring about the various concepts of the subjects Science, Technology, Engineering and Mathematics which are integrated with the contents of the aesthetic stream subjects and through this provide the related experiences.

3. Provide general or shared experiences of performing arts through practical programmes of aesthetics, exhibitions and competitions which are introduced as extra-curricular activities and also as activities which are conducted in parallel with the or regular curricular teaching of the subjects.

Now time is ripe for the subject experts in the field of education to focus their attention and get involved in dialogues in order to carry out analytical studies and conduct subject related research on specific aesthetic subjects as relevant to the three (1 – 3) activities stated above.

The basic aim of this article is to briefly investigate (as an introductory measure) selecting music on the theme from among the subjects of aesthetic studies.

As an example let us consider the lessons on sound which is part of the contents of the subject Science. In order to get practical experience related to the basic concepts of sound using the musical instruments and obtaining the assistance of the music teacher should be sought. If the education process is developed through this, then space is created for the advent of STEAM education. For example as relevant to the lesson on sound :



I. How is sound produced?

II. How do we hear sound?

III. How does sound travel?

IV. What are the media through which sound travel?

V. What factors influence the variety of sounds produces (Such as amplitude, pitch, timbre)?

When discussing the answers to the above questions if it is possible to present lessons in Science citing examples and in a more appealing and a practical manner, through singing, sound modulation and playing musical instruments as relevant to the subject of Music. In such instances it is possible to introduce examples by playing musical instruments such as string instruments, percussion instruments (Drums covered with animal skins) solid instruments (metal instruments such as the 'Thalampota') and wind instruments (Instruments such as the flute producing sound with the help of wind)

For example it is possible to show how the string instruments produce variation in sound by varying the nature of the strings:

I. By increasing or decreasing the length of the string

II. By increasing or decreasing the thickness of the string

III. By increasing or decreasing the tension of the string

IV. By changing the nature of the material of the string example: Steel, Brass, copper, intestine of animals used as string material

V. By altering the nature of the string : around some strings another fine string is wound in a spiral manner as in the strings producing the low sounds in the guitar

VI. The way the string is attached or fixed – a goat skin is spread over an area with a hole and on it a bridge is placed and the string run across the bridge (*Israge*, *Dilruba*, *Sarangi* and *Sarodh*) In the case of the violin and the Sitar the bridge is fixed to a wooden covering and the strings run across the bridge

VII. The variation in the vibration of the sound is dependent on the number of strings layed in the instrument in some musical

instruments for the some note either two or many strings are placed close to each other and they are strung to produce the sound. For example, in the mandoline four groups of two strings each are layed. In the instrument santhar a series of strings each group having three strings are fired. The series of strings are tuned to the same note. The sound is produced by playing the three strings of each of the series simultaneously. In some instruments the variation in the spreading quality of the sound is due to the vibration of the sympathetic strings (In instruments such as the Sitar, Israj, Sarangi, Surodh and Dilrubah the sympathetic strings which are tuned to be the same as the note played, vibrate

VIII. The variation of the sound is what brought about by the nature of the "helper" that in employed to produce the sound in the string (using a bow, fingertips or finger nails are employed.

IX. Variation of the sound is brought about in the same note or series of notes, depending on the friction or pressure exerted on the string (stroke) to produce the sound (modulation)

X. Producing the sound by playing the string just once and allowing the sound to spread. The nature of the vibration imposes the 'feeling' of the sound. In music these situations are identified as minor, major, diminishing minor and so on. The sound produced by playing a scale just once in instruments such as the Sarodh and Sitar and allowing the sound to gradually decrease and diffuse, may be cited as an example.

XI. In certain musical instruments the position in the string that comes into confact with the bridge is specifically indicated, so that the musical drone is made possible. In the jargon of music this is called "Javari" e.g. In the Sitar and Thampura. The bridge in the sitar is slightly curved. In the Thampura the position where the string in placed on the bridge is indicated by fieing a piece thread the resulting vibration of the sound because this is specific.

XII. For the production of scales, various methods of music adopters are employed (Gamak, Meenol, Ghasheef, Kan, Moorki, Aandelen) for these the strings are played using various methods. Due to the Technical devices used to generate the sound and the specific vibrations of the sound and its expansion, the vibrational changes in the sound are also specific.

The 12 above mentioned instances indicate only a few of the ways by which a science session on sound may be practically integrated with a lesson in music. The examples sited above are with respect to the playing of string instruments. However if is also possible to discuss and explain across a wider field to explain in many ways the nature of sound by using percussion, wind and solid instruments, and by voice modulation many such lessons can be identified in the science syllabus. Teachers should carry out further studies along these lines.

The above discussion explored the use of suitable examples on how music can be used to study the subject of Science in one of the lessons. Similarly to make students understand certain subject areas singing of songs have been employed as a learning technique in this country in the past . There are instances where such methods have been used in the school system also. As an example we can show how singing (songs) has been used to learn the multiplication table connected with the subject of Arithmetic. Given below is how a song/verse comes in a book of songs produced on multiplication tables and in a CD. The title of the book is



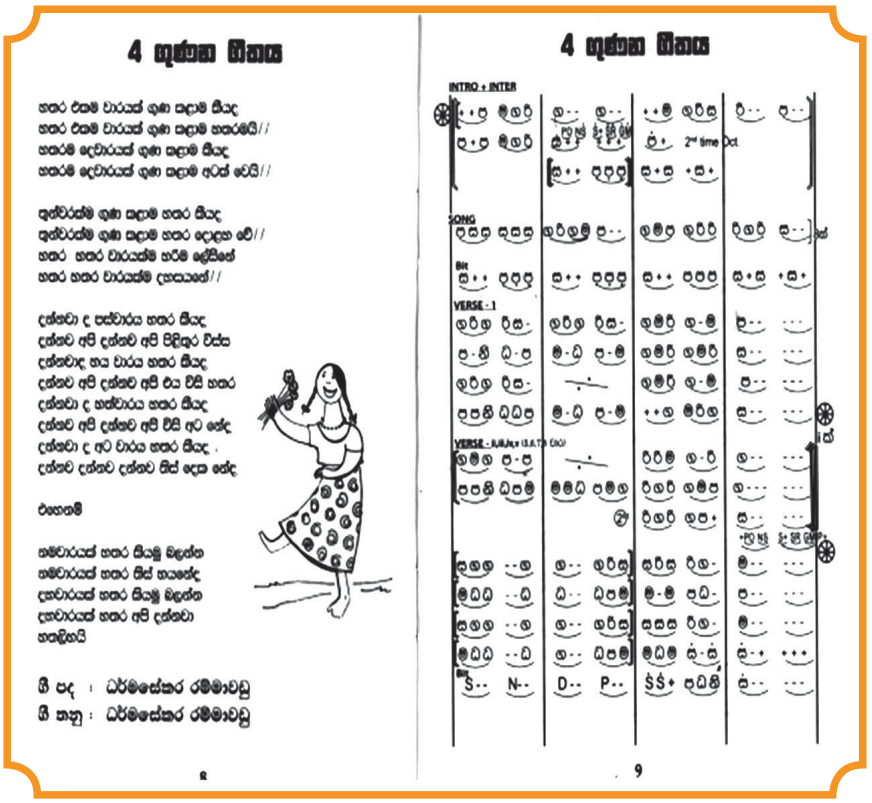


Figure1: "චක්කරේ ගුණන ගී" Song to learn the multiplication tables

"චක්කරේ ගුණන ගී" (Song to learn the multiplication tables)

This shows an instance where the subject of music has been integrated with an Arithmetic lesson. There are instances where drama and theatre are used as subjects of aesthetic that have been successfully used and integrated with lessons in mathematics. The teacher Amitha Rabbidigala who was a Teacher in the school Kingswood in Kandy has written many dramas with musical concepts as the theme. She produced mant stage plays using the publication of students of this school. She also produced some dramas (over a period of time) through the National Rupavahini channel for the programme titled "නිම් වළලු" (Nim Walalu) and these dramas were used to clarify (explain) certain mathematical concepts. These productions can be cited as examples which provide more successful learning opportunities regarding mathematical concepts through informal learning methods.

"Providing experience by surfacing the concepts in science, Technology, Engineering and Mathematics" is the second matter/issue raised earlier. Therefore, it is especially important to identify a few such experiences in the subject of Music.

The syllabus of the music subject as in our system of education encompasses a wide range. It includes Raghadari music, Folk music, simple creative music, computer music and indicators of the theoretical and practical aspects of the content under each of the subjects and lessons it in possible to bring out the basis and analysis related to the subjects of Science, Technology, Engineering and Mathematics. This article does not intend to discuss all these areas, but it intends to initiate a basic approach to build up a teaching method connecting all these subjects.

Music is a practical subject. Through music it is expected to give experiences related to transfer of culture in creativity and performing arts and thereby assist in the development of intelligence and knowledge. In order to suitably align / relate the learning – teaching processes of the subject music it is necessary to separate the concepts of the subject content. The content has to be identified as concert concepts and abstract concepts. It is possible to teach the basics, theories and principles which are included in the concrete concepts. On the other hand, the abstract concepts such as creativity and emotional expressions which originate in the mind have to be learned (as it is difficult to teach these concepts)

In order to build up the subject of music the foundation is layed primarily on Science, Technology and Mathematics according to the concrete concepts of Music who reflects the Scientific, Technological and Mathematical contents. The scientist who studies the content by adhering to this foundation will present a creation or an expression which reflects the results of brain storming. In so doing he will match the content and substitute the content as deem fit by him. It can be composed with subject of

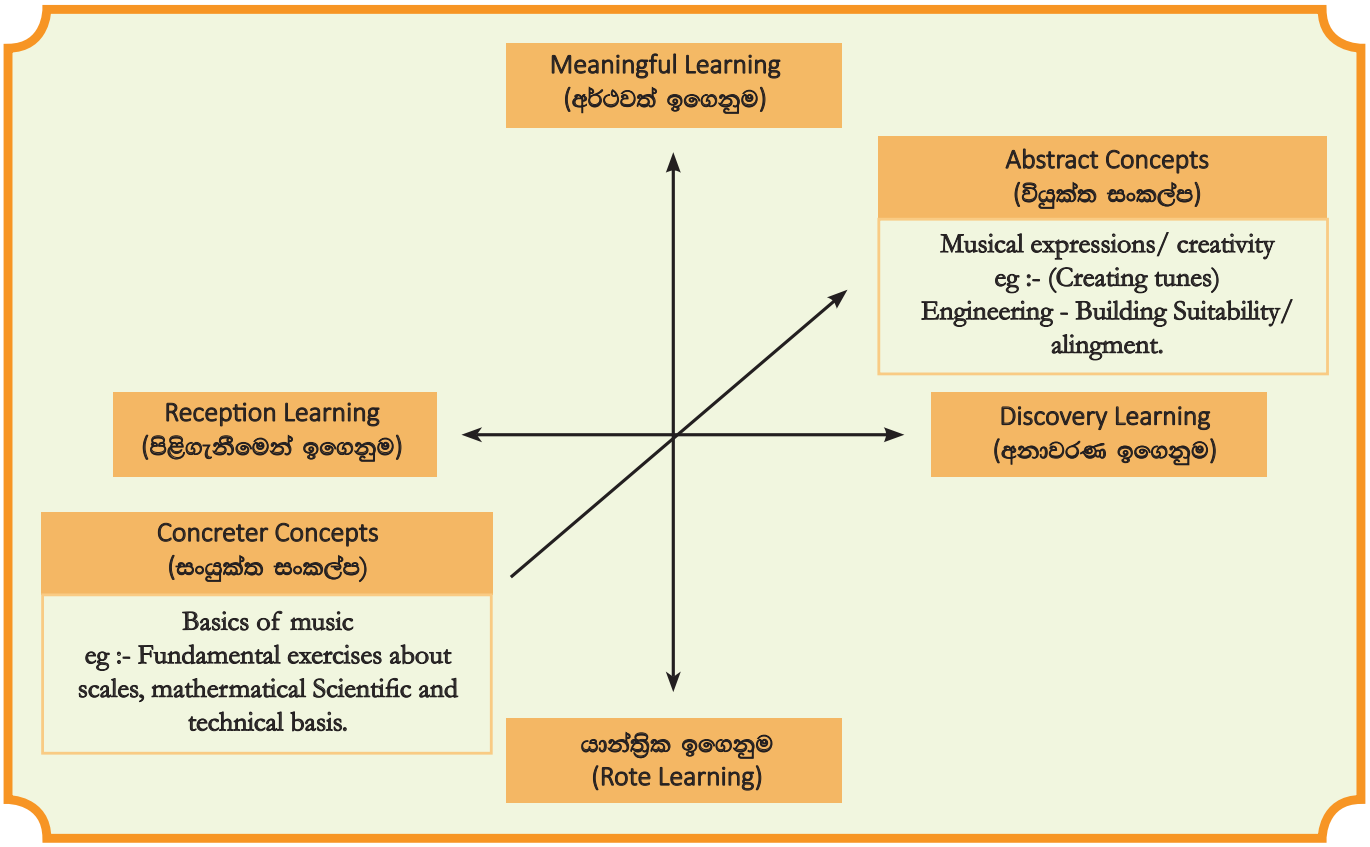


Figure 2: Meaningful Learning

Engineering. Here there is the presentation as through performing arts or there could be the build up of an abstract concept through the expression. The following diagram may impart a better understanding about this.

The above figure can be further explained by giving a simple example relating to exercises on "ස්වර" (scales) (For concrete concepts)

Science ⟶ In order to correctly produce the sounds for scales (ස්වර) relate it to the vibrational frequency (eg: In සඩ්ජ the vibrational frequency for (ස) is 256 Hertz.

Mathematics ⟶ Include exercises in which the scales are played rhythmically according to a definite pattern.

ස රි ග - / රි ග ම - / ග ම ප - following a pattern like this
1 2 3 - / 2 3 4 - / 3 4 5 -

ස රි, ස රි ග (1 2 / 1 2 3) රි ග, රි ග ම (1 2 1 2 3) expressing rhythmically like this

Technology ⟶ Voice modulation, correct pronunciation, if it is a musical instrument- the posture, tuning and the fingering exercises can be given as simple examples.

Engineering ⟶ The creation of a tune in a song (abstract concept) based on correct comprehension of scales and skill, using imagination and creative thinking, may be given as examples.

It is possible to realize that instances of integration with STEAM is possible not only with the subjects of music but also with the areas such as dance drama and other fields of aesthetics. For this it is necessary to study this in depth for the respective subjects.



Dr. Nishad Hadunpathirana
Additional Secretary (Quality Development, Education)
Ministry of Education