Music And Its Effect On Cognitive Performance

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Abstract

This research aims to investigate the effect of music on students' problem-solving ability. Music is known to have implicit influence in a human brain – either in enhancing spatial-temporal skills or stimulating intellectual performance. Many researches have already been conducted to substantiate Math-music multi-dimensional link. However, this particular research is specific to a homogeneous population of students aged 15-23 years.

For this research, large population sample (n = 87) was taken, and divided into two sub-groups, and results were analyzed. Results show that there is a positive relationship between music and Math.

Acknowledgement

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Introduction

*"A surprising proportion of **mathematicians** are accomplished **musicians**."*

- *Martin Gardner, American Mathematician*

Learning musical instruments require understanding on complex concepts. Students who are trained to play instruments or have a habit of listening to music on a regular basis have an increased tendency to outperform non-music practitioners [1]. They are observed to have better standardized test scores, and Mathematics score.

Music, in general, triggers the frontal lobe of human brain which is responsible for cognitive reasoning and problem-solving skills [2]. Playing instruments or listening to music enhance executive functions of our brain, like adjusting motor movements [2]. Hence, a strong connection between two discipline is evident.

Johann S. Bach's, an exceptional German violinist, work displays intellectual depth, technical command and artistic beauty [3]. His compositions have aesthetic perfection and reveal symbolic significance of numbers [3].

That is why, this study is done to confirm its veracity in case of high school students for which statistical tests are performed. The subject of test is **'Relation between music and problem-solving ability'.**

Research Procedure

For the purpose of data collection, a questionnaire, consisting of ten questions, was prepared. The questions included varied in type based on their level of difficulty. However, candidates were not informed about the level of difficulty of any question.

Then, the questionnaire was distributed among the selected population via online platform. The process of questionnaire distribution was random as students were selected not in an orderly-fashion. The form was shared on national/ multi-national forums, and students from varying background submitted their responses.

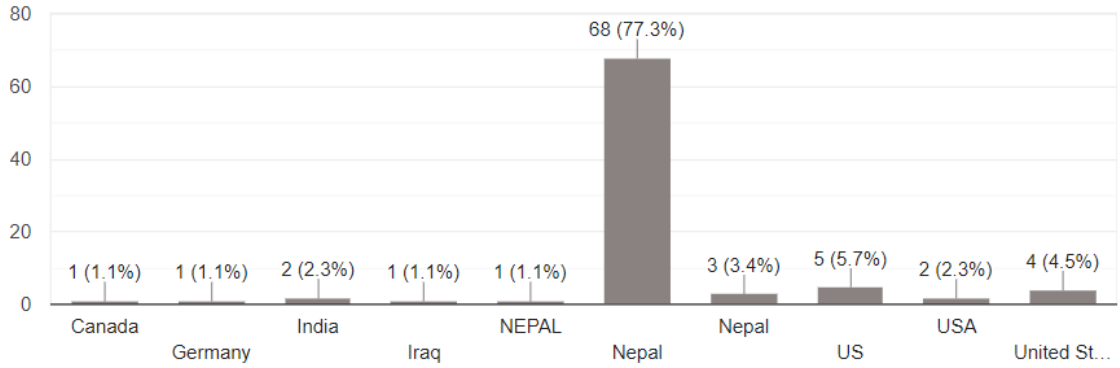

Figure (a): Classification of responses based of geographical location.

The candidates were given time limits at the very beginning of the form. Also, it was promised to maintain confidentiality regarding the responses submitted.

The form, itself, was categorized into three sections – Section 1, which consisted of personal details and information about their involvement in music, Section 2, which consisted of a music clip (audio and video of two different instrumental tracks) prepared for this very purpose, and Section 3, which consisted of ten unique questions.

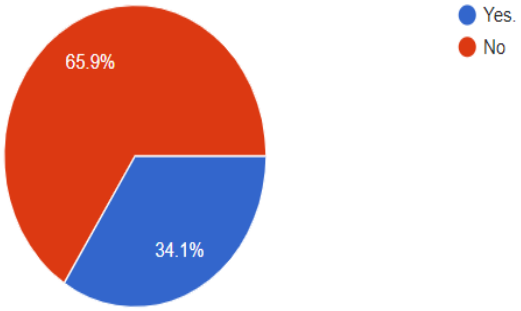

Figure (b) Classification of S-1 and S-2

Yes – S-1 [Students who did not listen to music (of Section-2)]

No – S-2 [Students who listened to music (of Section-2)]

The first step of data analysis was **Categorization of files** which was done using the 'Pandas' library (on Python). Those who were subjected to listen to music [in Section 2] were categorized on one Excel sheet, while remaining were listed on the other sheet. Then, once again, using Pandas, from each sheet, correct responses for each question were extracted on different Excel files. Hence, at the end, 22 different Excel files were collected for analysis.

The second step was **Categorization of questions**. Here, all the questions were divided into three major sections – Easy, Difficult, and Logical. Later, based on responses, latter two sections were merged into one type, hence leaving with two sections – **Easy, and Difficult**. Then, the number of correct responses were filtered for each of the easy and difficult questions (separately).

The third step was to analyze the data using statistical tool. For this particular test, since all the following criterion were matched, Chi-square test was performed to come to a conclusion:

1. It is a 'Qualitative Test'
2. Trials are independent of each other
3. Random population for response collection
4. Number of samples, $N \geq 50$ (Large population)
5. No expected frequency, E, is less than 5, $E < 5$
6. Expected frequency is equal to observed frequency, $\sum E = \sum O$

Analysis

The responses were tabulated as below in order to perform Chi-square test:

Population Samples	Easy Questions		Difficult Questions		
	Answered	Unanswered	Answered	Unanswered	
S-1	9	6	5	10	30
S-2	8	21	3	25	57
	17	27	8	35	87

Let us set up Null-hypothesis (H_0) and Alternate-hypothesis (H_1) as below.

H_0: There is no correlation between music and its effect on problem-solving ability.

H_1: There is correlation between music and its effect on problem-solving ability.

Using level of significance, $\alpha = 10\%$. [*]

Now, using the data in table (using 3 d.p.):

O	$E = \frac{R_T . C_T}{G_T}$	$\frac{(O-E)^2}{E}$
9	5.862	1.680
6	9.310	1.177
5	2.759	1.821
10	12.069	0.355
8	11.138	0.884
21	17.690	0.619
3	5.241	0.959
25	22.931	0.187
		7.681

Here, since $2.759 < 5.000$, it, along with its corresponding value, is combined with 9.310 to give

$$\text{E}_{\text{combined}} = 12.069 \quad \text{and} \quad \frac{(O-E)^2}{E} combined = 2.998.$$

We have,

$$\text{X}^2_{.cal} = 7.681$$

To find out $\text{X}^2_{.tab}$, we need 'Degree of freedom, Df' and 'value of α'.

Degree of freedom, Df = $(R-1) \times (C-1)$

$= (2-1) \times (4-1)$

$= 3$

So,

$$\text{X}^2_{.tab} = \text{X}^2_{3,\ 10\%}$$

$$= 6.251$$

Discussion

We have,

$$|\,\mathrm{X}^2_{.tab}| < |\,\mathrm{X}^2_{.cal}\,|$$

Which means, H_0 is rejected.

Therefore, at 10% significance level, it can be concluded that there is relation between music and its effect on problem-solving abilities.

Limitations of the research

It was a tentative research; hence it incorporates a few shortcomings [*]:

a. The responses were collected from students of specific age group (15-23 years). In general, they have similar abilities. Hence, it might have caused some inconsistencies.
b. Although, questionnaire was prepared after prolonged review and repeated editing so as to include suitable questions to examine IQ, these questions are not the ultimate basis to generalize problem-solving ability.
c. Additional factors are at play to evaluate one's ability. However, in this research, only certain variables were analyzed.
d. The test was performed on only two-groups of students. Repeated data collection might have yielded a better set of result.

Due to unaccounted variables, and aforementioned shortcomings, the level of significance surged to 10%. I do not concur that these data are prototypes for global population. Nevertheless, it can be used as an additional reference by students, researchers, and mathematicians.

Conclusion

Based on the statistical analysis done on the data collected, it's evident that music has a positive effect on high schooler's problem-solving ability.

However, neurologists and mathematicians are still researching on this subject. It is supposed that music influences student's cognitive-skills. PET imaging of brain shows activation of regions of brain when subjected to music. It's cogent that music stimulates human brain. Overall findings indicate that music has a biological basis and a functional organization for music [4]. Let's hope, in the days to come, music will be a prime method to increase individual cell response, cure a psychological ailment(s), and retune our cognitive-performance.

References

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