Investigating the Effectiveness of Digital Interactive Multimedia Package in Astronomy to Promote Scientific Temper

A Case Study of the Tertiary Level Students in India

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Abstract

A criterion for a good scientific material is that it should not only impart knowledge but must go beyond that and should develop scientific attitude among the users. This paper reports on an investigation of the effectiveness of the interactive multimedia package in Astronomy, already developed by the authors, to inculcate scientific values among the tertiary level students in India. To quantify the change in behavior of target students, a tool was designed by the authors based on the Likert's method. Standard statistical tests were employed for the analysis. The investigation revealed that the students, who were exposed to the multimedia package, did significantly well compared to those who were given only the print material. A retention test was also conducted which indicated statistically significant retention of scientific temper.

1. Introduction

The night sky full of stars is a treasure of celestial beauty. There will be hardly anybody on this blue planet who has not cast glance towards the night sky. But stars form only a small subset of the billions of celestial objects. Astronomy is a branch of science which deals with the study of these celestial objects. During his tenure as a lecturer of physics for 28 years, one of the authors (GP) has keenly observed that though the students take interest in this branch at amateur level, they do not to seek career in this domain. Therefore the authors thought of developing a digital interactive multimedia package in astronomy for tertiary level students to motivate them. Such package has already been developed by the authors using the principles of e-learning and has already been reported. It is accepted widely that a good scientific material must help to inculcate scientific values among the users. Hence the package developed was tested statistically to check whether it satisfied this criterion.

2. Background

A good number of online courses on astronomy are available on the Internet for the undergraduate students. However the fees charged for these online courses are too exorbitant for the tertiary level students in a developing country like India. It is quite unlikely that students with limited resources in developing countries will enroll for such online courses. Hence the challenge of promotion of scientific temper cannot be met using such courses. It is a matter of concern that astronomy -- probably the oldest branch of Science -- is associated

by general public with many superstitions and misconceptions. Not much effort has been made to go beyond the knowledge of the subject and to test whether the knowledge has been instrumental in eradication of superstitions. This makes the duty of an astronomy teacher many-fold. A teacher of astronomy should not only impart ideas in the subject but should also make conscious and persistent efforts to remove superstitions related to the subject. As an umbel attempt in this direction, the authors have already developed and reported a customized package for the tertiary level students in India and in the present paper, they report on the investigation for effectiveness of the said package to promote the scientific temper. The scientific temper essentially means "an attitude which involves application of logic and avoidance of bias and preconceived notions". (On- line resource 7).

3. Objectives

In order to check the promotion of scientific temper, a tool has been developed by the authors, which is explained later in this paper. The objectives of the present paper are as follows:

1. To investigate whether the tertiary level package developed for astronomy is effective in promoting the scientific temper of the target group.
2. To test whether the print material prepared by the authors is effective in inculcating the scientific values in the target group.
3. To compare the effectiveness of the print material as compared to the multimedia package to create the scientific temper in the target group.
4. To test the effectiveness of the package for retention of the scientific temper of target students.

4. Methodology

4.1 Background study

To begin with, a review of various DVDs, CDs and video cassettes (Video resources 1 to 24) on astronomy was taken. It was observed that most of the audio-visual material is excellent but is prepared with western students in mind and is not suitable culturally for the target group in India. Also, it was observed that most of the material is not in tune with the philosophy and methodology of self-learning material. Therefore the authors contemplated of making a need-based package for Indian students which can serve as an e-learning material for them.

4.2 Developing the package

Before making the final package, a pilot package was made. It was made by considering the educational background of the tertiary level students in India. The pattern adopted in making the package was in tune with the self-learning material developed by the Indira Gandhi National Open University, New Delhi which is a nation-wide mega open university in India. A group of tertiary level students in Nasik, India was then exposed to this pilot package. They were given a tool in the form of an opinionnaire. The students were asked to register their true opinion. Their suggestions and comments were incorporated and the package was modified accordingly.

During preparation of the text, standard books **(**Mitton 1991; Moore 2003; Moche 1993; Pasacheff 1990) on astronomy were consulted. A large number of diagrams, pictures and video clips (On-line resources 1 to 7) were included in this package to make it fascinating. Soft-ware packages like Flash, Microsoft Word, Photoshop and Front Page were also used.

4.3 Development of print material

In India, astronomy has not been included in the tertiary level formal education in most of the universities. In some universities it is included as an optional course. Therefore the number of tertiary level students undergoing astronomy course is very small. Hence no 'text books' are available in the market. Therefore the researchers prepared a booklet explaining fundamental ideas which are required for tertiary level students. This booklet was prepared for the control group.

4.4 Formation of samples

The population for the present study was the tertiary level students in the city of Nasik, India. Two unbiased samples were obtained from this population of target students using random number generation technique.

Each sample consisted of 31 students. One of the groups was arbitrarily named as the experimental group and the other one as the control group.

4.5 Development of tool

The tool developed was in the form of an opinionnaire. It consisted of 16 statements based on some common superstitions in the society. They were pertaining mainly to astronomy. A superstition, as defined in the Oxford Advanced Learner's Dictionary (Hornby 2005) is "The belief that particular events bring good or bad luck". Superstitions are considered to be contrary to the scientific temper.

The opinionnaire was made according to the Likert method (Best & Kahn 2004). For each statement, five options were given. They included "Strongly Disagree", "Disagree", "Undecided", "Agree" and "Strongly Agree". Each option was given weightage as (+2), (+1), (0), (-1) and (-2) respectively. All these statements were made in such a manner that disagreement to a statement implied rational thinking.

4.6 Testing of samples

Firstly, both the groups -- experimental and control – were administered pre-test. The test was useful to obtain the profile of their rational thinking. The experimental group was then administered the multimedia package. Sixteen computers were arranged for this session which lasted for four hours. At the same time, the control group was given print material to study. Then, both the groups were asked to take the post-test.

It is always worthwhile to check whether the impact made by the treatment is temporary or it lasts for a sufficiently long period. To check this, one month was allowed to pass and then a retention test was conducted for the experimental group.

To quantify the promotion (or demotion) in scientific temper, following method was used. The tool consisted of 16 statements. According to the Likert's scale, as stated earlier, if a student strongly disagrees with a statement he / she gets maximum (+2) marks in that question. It means the maximum score possible for the questionnaire in the tool was 32.

The authors have defined an index called as Scientific Temper Index (S.T.I.) as given below:

Score obtained by a student

$$STI = (\text{Net score}/32) \times 100$$

Thus the maximum value (+100) of STI corresponds to totally rational thinking while the minimum value (-100) implies complete subscription to superstitions. Using this formula, STI values for each student were calculated for the pre, post and retention tests of experimental group. Similarly the values were calculated for the pre and post tests of control group.

5. Results and discussions

5.1 Testing the scores for normality

Before statistical tests are applied, the data should be checked for the normality. If it satisfies the condition, a parametric test like the 't - test' in statistics could be used for the data analysis. If it does not, non-parametric test is required. To check whether the data fits in the normal distribution, a probability graph is plotted for the data. Montgomery (1992) has given this method and has been widely used in statistical domain. He has remarked that a probability plot is an alternative to the histogram that can be used to determine the shape, centre and spread of the distribution. He has further indicated the advantage of such plot. According to him, in such case, it is not necessary to divide the range of the variable into class intervals, and it often produces reasonable results for moderately small samples. This is not possible with a histogram.

To get the probability plot, following steps were followed.

a) A special "paper" (scale) is used for such graph. One can use such "papers" for normal, exponential and several other distributions. It has been stated by Everitt (1998) that such probability paper is structured in such a way that the values in the cumulative frequency distribution of a set of data from a normal distribution fall on a straight line. He has further indicated that it can be used to assess sample data for normality.

In a nutshell, if the given data is plotted on the normal probability paper and if the points lie nearly along a straight line then the data is said to follow normal distribution.

b) First, data-points are arranged in ascending order. This process is called as the ranking of data. The serial number is called as rank and is denoted by j. The corresponding score is called strength and is shown by Xj. Xj is plotted on the X axis.

c) Then the sample cumulative frequencies are obtained. The plotting positions of points, P_j corresponding to these frequencies are obtained as given below.

$$P_j = (j - ½)/ n, \text{ where n means sample size.}$$

Values of P_j are multiplied by 100 to get percentage and are plotted on the Y axis. This terminology is used in the following graphs.

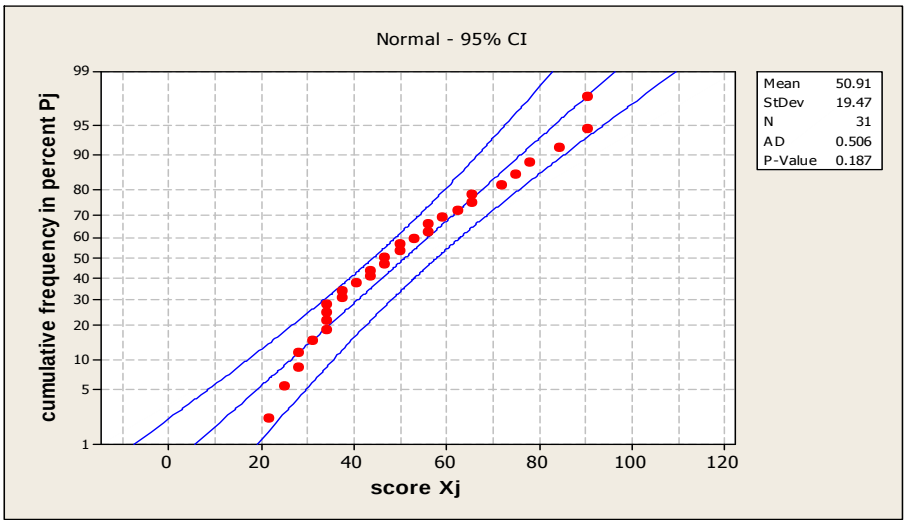

Figure 1. Probability plot for the pre-test of experimental group

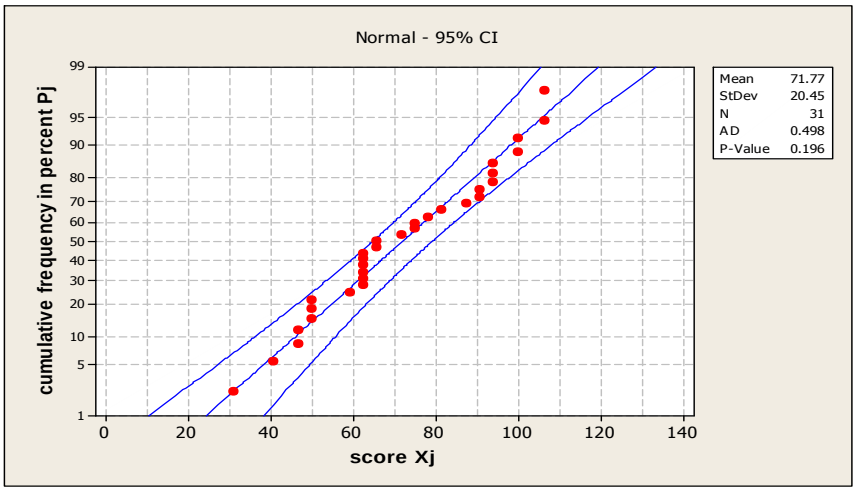

Figure 2. Probability plot for the post-test of experimental group

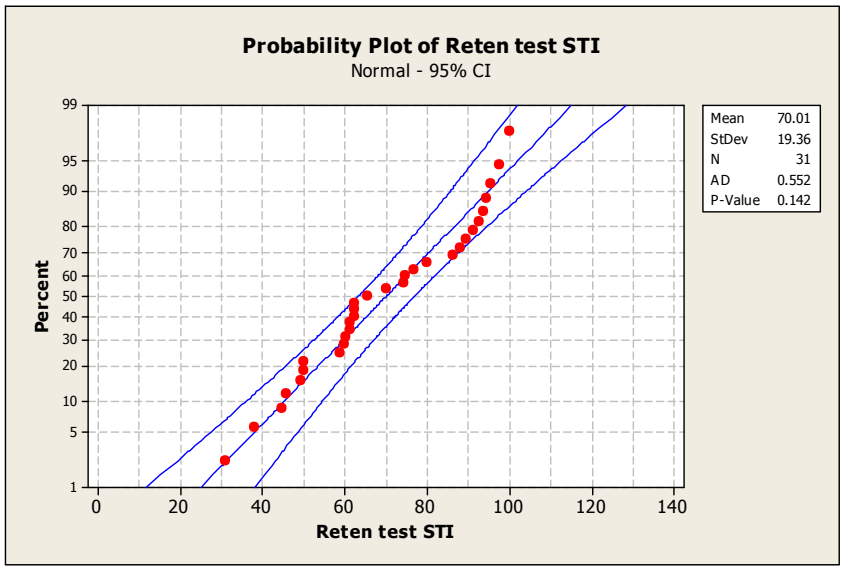

Figure 3. Probability plot for the retention test of experimental group

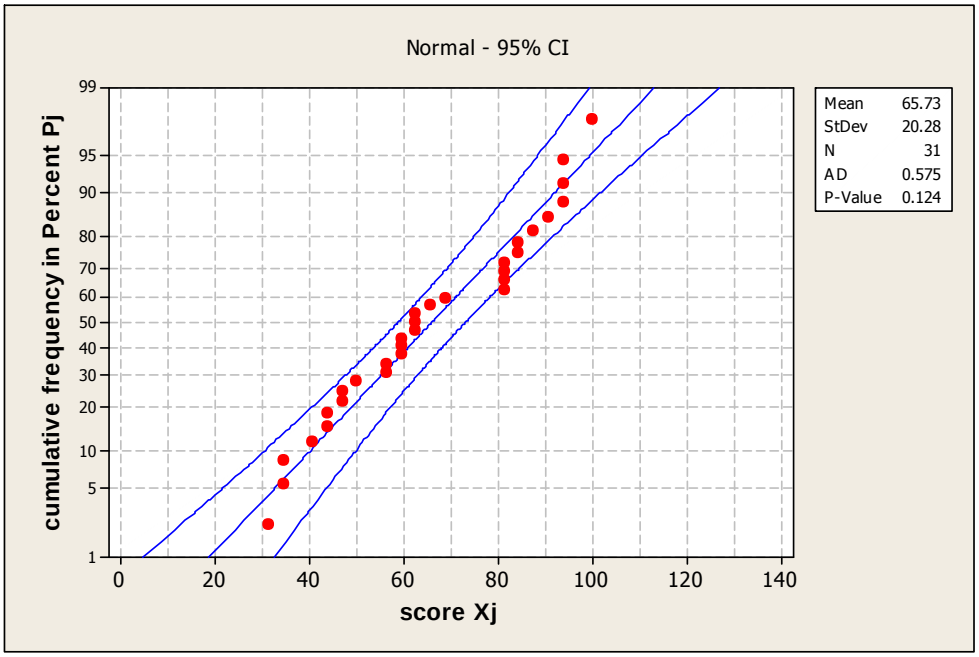

Figure 4. Probability plot for the pre-test of control group

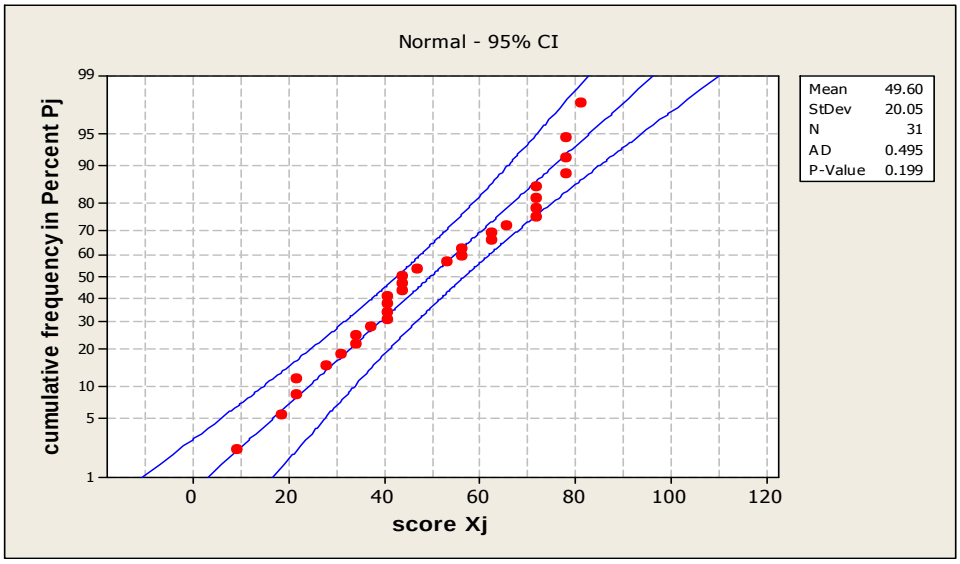

Figure 5. Probability plot for the post-test of control group

Figures 1 to 5 show plots of P_j against Xj on the normal probability paper. It is seen that the data points lie nearly along a straight line for the Figures 1, 2, 4 and 5. It implies that the normality assumption is valid in each case and one can proceed further for the parametric test. Figure 3 indicates that the distribution of data points is not normal. Hence non-parametric test need to be used in that case.

5.2 Comparison of pre and post tests of experimental group

Table 1 Paired t – test for Pre and Post tests of Experimental Group

Test	N	Mean	S. D.	t- value
Post	31	71.77	20.45	10.69
Pre	31	50.91	19.47	

Table No.1 shows that the mean score for post-test is much greater than the corresponding value for pre-test. If the t - value equals or exceeds 2.58, it is concluded that the difference between means is significant at the 0.01 level. The calculated value of t for the data obtained by us is 10.69. It is greater than 2.58. Hence it can be inferred that there is a significant increase (at 0.01 level of significance) in the Scientific Temper Index of Experimental group after it was exposed to the Package.

5.3 Comparison of Pre and Post Tests of Control Group

Table 2 Paired t – test for Pre and Post tests of Control Group

Test	N	Mean	S. D.	t-value
Post	31	65.73	20.28	6.47
Pre	31	49.60	20.05	

Table No. 2 shows that the mean score for post-test is much greater that the corresponding value for pre-test. If the t - value equals or exceeds 2.58, one can conclude that the difference between means is significant at the 0.01 level. The calculated value of t for the data generated is 6.47. It is greater than 2.58. Hence it can be inferred that there is significant increase (at 0.01 level of significance) in the STI of control group after it was administered the print material. However, the t-value is less than the case (Table 1) where the multimedia package was used. Hence we may concluded that the package is more effective compared to the print material**.**

5.4 Comparison of the experimental and control groups

Table 3 Two Sample t – test for the difference between Mean values of Scores in Post tests of Experimental and Control Group

Group	N	Mean	S. D.	t
Experimental	31	20.87	13.90	2.10
Control	31	16.13	10.90	

Table No. 3 shows two sample t – test applied for the difference between the Mean values obtained for both the groups. If the t - value equals or exceeds 1.96, we can conclude that the difference between means is significant at the 0.05 level. The calculated value of t for the data obtained by us is 2.13. It is greater than 1.96. Hence it can be inferred that there is significant increase (at 0.05 level of significance) in the scientific

temper for the Experimental group. This clearly shows that the package developed by the authors is effective.

5.5 Comparison of Post and Retention Tests

From figure 3 it is observed that the scores are non-normal. Hence a non-parametric test is required. In the present case, the scores are related to each other i.e. they are matched-pairs in the data. Therefore the Wilcoxon matched-pairs test is appropriate here.

Table 4 given below shows that the test statistic z = (-4.20) is lesser than the table value

(- 2.58). Hence the null hypothesis is accepted at 0.01 level of significance and it is concluded that there is no significant difference between the performance of the experimental group in the post test and the retention test. It means that there is statistically significant retention of the scientific temper for the target students even after one month of exposure of the digital multimedia package developed by the authors.

Table 4 – Paired t-test for the Post and the Retention Tests of Experimental Group

N	**n**	**T**	**U**	**σ_T**	**z value**	**Table value**
31	23	0	138	32.88	(- 4.20)	(- 2.58)

6. Conclusions

The experimental group was exposed to the digital multimedia package while the control group was given only the print material. From analysis of the results obtained, we arrive at the following conclusions:

1. From the scores of pre and post tests of the experimental group it was observed that there is statistically significant promotion in the scientific attitude among the target students. Thus the package has been successful in inculcating the scientific values in the target students.

2. From the pre and post tests of the control group it was observed that there is significant promotion in the scientific temper. Thus the print material written by the authors has proved to be useful in inculcating scientific values. Further it can be noted that the t -value calculated in case of the experimental group is much greater than the t -value calculated for the control group. Hence it can be inferred that the multimedia package is more effective compared to the print material.

3. From the performance in post-tests of the experimental group and the control group, it is observed that there is significant increase in scientific temper of the experimental group. Therefore we can conclude that the package is effective to inculcate scientific values.

4. From the post-test and retention test conducted for the experimental group, it was found that there is statistically significant retention of the scientific attitude among the target group. Thus the package is

found to be effective to create lasting impression on the minds of users.

Thus the results obtained using standard statistical test clearly indicates that the difference between achievements of the target groups is not due to the sampling error but because of the treatment given to the experimental group. In other words, it can be concluded that the package developed by the authors is effective to inculcate scientific attitude among the students of target group**.**

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