Effect of Interactive Instructional Material in Statistics on Mental Imagery and Academic Achievement among Higher Secondary Students

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Abstract

The present study investigates the impact of interactive instructional materials in statistics on the development of mental imagery and academic achievement among higher secondary students. Traditional instructional approaches in statistics often rely mostly on theoretical content, leaving students disengaged and unmotivated. The study explores how these materials influence students' ability to visualize abstract statistical concepts (mental imagery) and improve their academic performance. Drawing from the recommendations of educational frameworks such as NCF (2005) and findings from educational scholars like Kochhar (2012) and (Gray et al.,1954), the research emphasizes the need for innovative teaching strategies to address the limitations of conventional methods. A quasi-experimental design is adopted to compare the outcomes of students exposed to interactive instructional materials with those taught using traditional methods. The findings aim to contribute to educational best practices by demonstrating the effectiveness of interactive tools in enhancing students' understanding and application of statistics, thus bridging the gap between theoretical knowledge and real-world utility. This study underscores the potential of interactive instructional materials to transform statistics education at a higher secondary level, promoting deeper engagement and improved academic outcomes.

Keywords: Instructional Material, Mental Imagery, Statistics

Introduction

Learning in 21st century is both personal and personalized as it is more meaningful, practical and experiential. Quality education is considered as a prominent element of today's era. In2012, United Nation passed the resolution "the future we want" which reaffirmed that full access to quality education on all levels. In order to achieve quality education, the capacity of education system should be improved through methods such as implementing interactive teaching learning process, better awareness and revamping of implemented strategies. The learning environment in the human mind tend to understand things easily when it is presented

with the help of data and infographics. To collect the information around the world the internet is a source which helps us in that. In this globalized world, the role of statistics is undeniable and increasing day by day. It is prominent for the students to understand the phenomenal concepts and applications of statistics in daily life. Uses and importance of statistics can be seen in fields as diverse as decision making, banking, business economics, business management, industry, as well as in research in all areas. Statistics teacher need to move away from using teaching methods that promote rote learning in basic concepts of statistics. Teacher needs to be more interactive, task based and learner centered. The shift from use of traditional methods of teaching statistics to modern methods will help us to achieve the objectives of curriculum and will contribute to national development and empowerment of school graduates to survive in the modern world of 21st century. Anderson (2005), states that" We need to process visual information even when it is not present. Doing so enables us to anticipate how things will look in the future." Mental imagery is used to understand information and events that need to be remembered. For providing wealth of knowledge in all topics, offering in depth information based on facts interactive instructional materials allows then instructor to engage learners by supporting concepts through the usage of hand on experiences, learning by doing concepts. Interactive instructional material may sound like something that might require advanced technology, but it's actually a pedagogical technique which encourages students to interact with each other and with subject matter. Interactive teaching is a learner centered and activity-based teaching method which is used to get learners fully involved because it enables the learner to construct her/his knowledge and skills through active participation in the teaching learning process. Orji (2000) asserts that instructional material "is a guidance of learning materials" that "a teacher uses to motivate and arouse student's desire to learn". From fore going statement, it can be agreed that for effective learning to take place, a student need to be properly guided by teacher by way of interactive instructional materials to build mental imagery of concepts in statistics and have high academic achievement.

Statistics is a crucial branch of mathematics, yet in higher secondary classes, instructional materials like textbooks often become monotonous. These materials tend to emphasize theory over practical application, making learning less engaging. While using instructional materials to teach statistics in schools is not a new concept, the focus now is on making them more interactive to enhance the teaching-learning process. Kochhar (2012) emphasizes the

importance of instructional materials as effective teaching tools, advocating for teachers to use relevant resources to complement textbooks and foster student interest in the subject.

According to UNESCO (2005), the lack of instructional materials in teaching contributes to students' poor academic performance and the declining quality of education. Similarly, the NCF (2005) highlights that the stress caused by fast-paced classroom teaching, excessive homework, and private tuition can be alleviated by textbooks that elaborate on concepts, include activities, encourage reflective thinking, and promote group work, leaving technical definitions for subject dictionaries. Lewis and Harland (1999) note that the demand for instructional materials has grown significantly since 1900, driven by social and economic changes that called for more efficient educational approaches. Gray (1954) also points out in the *Journal of Educational Research* that interactive books not only convey information but also help shape attitudes and develop critical thinking. Although interactive instructional materials are often associated with early education, they hold great potential for higher secondary students, who approach studies with a broader perspective. Statistics, being relevant across various streams, plays a significant role in both academics and real-life applications, making interactive materials vital for engaging students and enhancing their understanding of the subject.

Objectives of the study:

1. To study the effect of Interactive Instructional Material in statistics on Mental Imagery among higher secondary students.

2. To study the effect of Interactive Instructional Material in statistics on Academic Achievement among higher secondary students.

3. To study the relationship between on Mental Imagery and Academic Achievement of Higher Secondary Students.

Hypotheses:

H_o1. There will be no significant effect of Interactive Instructional Material in Statistics on Mental Imagery of Higher Secondary Students.

H_o2. There will be no significant effect of Interactive Instructional Material in Statistics on Academic Achievement of Higher Secondary Students.

H$_o$3. There will be no significant relationship between Mental Imaginary and Academic Achievement of Higher Secondary Students.

Methods and Materials

Development of Interactive Instructional Material in Statistics

Instructional materials give students the chance to apply concepts and create a product that showcases their understanding. In the present study, Interactive Instructional Material included online quizzes and interactive power point presentations. This instructional material was used to teach students in online set-up.

The content of the present Interactive Instructional Materials was selected from the Subject Statistics of Class XI. The material was developed on five chapters of Statistics from NCERT Textbook of CBSE Board including introduction to statistics, collection, organization and presentation of data, measures of central tendency, and measures of dispersion. The instructional materials were given to five subject experts in Statistics. Their responses and suggestions are used for giving final shape to the instructional material.

Mental Imagery Questionnaire

Mental Skills questionnaire (MSQ) measures various aspects of mental skills such as concentration ability, mental preparation, Imagery ability, self-confidence, and Motivation (Bull et al., 1996). The MSQ consists of a total of 28 items, with each variable represented by four questions. Students were asked to indicate how frequently they encountered the situations described in each question using a 6-point Likert-type scale. The response options ranged from strongly disagree, disagree, slightly disagree, slightly agree, agree, to strongly agree.

Construction of Achievement Test in Statistics

Five chapters of statistics of class XI were selected for the present study. The test was prepared based on four objectives-knowledge, skills, understanding and application. The weightage to each of these objectives is given in Table 1(a). Items were prepared in conformity with blueprint as mentioned in Table 1(b). In the preparation stage, the test items were written in the light of following considerations - i) The language used was

simple ii) Text book language was avoided. iii) Interdependence among the items was avoided. iv) Items providing a clue to the answers were avoided. After the expert verification, the test items were finalized. The first draft of the achievement test contained 30 items.

Table 1 (a)

Weightage to Objectives

S. No.	Objectives	Score	Score%
1	Knowledge	4	13.34
2	Understanding	13	43.32
3	Application	9	30
4	Skills	4	13.34
	Total	30	100

Table 1(b)

Blueprint for achievement test

Objectives / Unit	Knowledge			Understanding			Application			Skills	Total
	Obj.	S.A	L.A	Obj.	S.A	L.A	Obj.	S.A	L.A		
UNIT I	1(1)			1(1)				2(1)		2(1)	6(4)
UNIT II	1(1)			1(1)	2(1)	4(1)			4(1)	2(1)	14(6)
UNIT III	1(1)			1(1)			1(1)	2(1)			5(4)
UNIT IV	1(1)					4(1)					5(2)
TOTAL		4(4)			13(6)			9(4)		4(2)	30(16)

Analysis and Interpretation

The performance scores of participants at the pre - test and post - test are presented in Tables. t-test was used to determine statistical significance of difference in mean scores of the experimental and control group.

Table 2

Mean, S.D. and t-test pre-test of Mental Imagery Scores

Phases	No. of Students	Mean	S.D.	t-test	Significance
Experimental	30	38.46	8.83		Insignificance at the level of 0.05
Control	30	35.56	5.45	1.53	

The table exhibited that the mean and standard deviation of pre-test scores of experimental group were 38.46 and 8.83 and the mean and standard deviation of pre-test scores of control group were 35.56 and 5.45 respectively. The calculated t-value was found to be 1.53 with 28 degree of freedom was more than the table value which was insignificant at 0.05 level. This t-value indicates that higher secondary students showed insignificant improvement in pre test scores.

Table 3

Mean, S.D. and t-test of pre-test of Achievement Scores in Statistics

Phases	No. of Students	Mean	S.D.	t-test	Significance
Experimental	30	10.13	2.76		Insignificance at the level of 0.05
Control	30	9.10	3.67	1.23	

The table exhibited that the mean and standard deviation of pre-test score of experimental groups were 10.13 and 2.76 and the mean and standard deviation of pre-test scores of control group were 9.10 and 3.67 respectively. The calculated value was found to be 1.23 with 28 degree of freedom was more than the table value which was insignificant at 0.05

level. This t-value indicates that higher secondary students showed insignificant improvement in pretest scores.

Table 4

Mean, S.D. and t-test of post-test of Mental Imagery Scores

Phases	No. of Students	Mean	S.D.	t-test	Significance
Experimental	30	79.33	18.66		Significance at the level of 0.01
Control	30	50.70	13.16	5.77	

The table exhibited that the mean and standard deviation of post-test scores of experimental group were 79.33 and 18.66 and the mean and standard deviation of post-test scores of control group were 50.70 and 13.16 respectively. The calculated t-value was found to be 5.77 with 28 degree of freedom was more than the table value which was significant at 0.01 level. This t-value indicates that higher secondary students showed significant improvement in post test scores. Hence the Null hypothesis "There is no significant effect of using interactive instructional material on mental imagery of higher secondary students" was rejected.

Table 5

Mean, S.D. and t-test of post-test of Achievement Scores in Statistics

Phases	No. of Students	Mean	S.D.	t-test	Significance
Experimental	30	18.66	3.88		Significance at the level of 0.01
Control	30	13.16	5.07	4.71	

The table exhibited that the mean and standard deviation of post-test scores of experimental groups were 18.66 and 3.88 and the mean and standard deviation of post-test scores of control group were 13.16 and 5.07 respectively. The calculated t-value was found to be 4.71 with 28 degree of freedom was more than the table value which was

significant at 0.01 level. This t-value indicates that higher secondary students showed significant improvement in post test scores. Hence the null hypothesis "There is no significant effect of using interactive instructional material on academic achievement of higher secondary students" was rejected.

The value of correlation was 0.77 for mental imagery and academic achievement of higher secondary students, which is lying between -0.1 and +0.1. It indicates high correlation between mental imagery and academic achievement. It shows that both the variables move in the same direction and follow the positive correlation between them. Hence the null hypothesis "There will be no relationship between mental imagery and academic achievement of higher secondary students" was rejected.

Discussion

Interactive instructional materials enhance the learning experience by making it more engaging, practical, realistic, and appealing. These encourage active participation from both teachers and students in the classroom. These materials facilitate skill acquisition and knowledge development while fostering self-confidence and personal growth. Teaching with Interactive Instructional Material proved to be better mode of teaching learning process than the traditional method. It can be used for normal student, slow learners and low achievers. It increases the curiosity and potentiality of students and makes them enthusiastic. Teaching through Interactive Instructional material will reflect their mental ability to grasp and visualize fundamental concepts. Teaching with Interactive Instructional Material is found to be feasible and applicable for teaching Statistic at Higher Secondary Level.

The findings of the present study were supported by Roseline Olufunke Buoyed (2019), Abdu-Raheem Bilqees Olayinka (2016); which showed that students who were taught with instructional material performed better than the taught without. The t-value between pre-test score of Mental Imagery of Higher Secondary Students was found to be 1.53. This t-value was found insignificant at 0.05 level, suggesting that there exists no significant difference between the mean of pre-test score of Mental Imagery of Higher Secondary Students. The findings of the present study concluded that the students who were not taught were Interactive Instructional Material possess less memory retention power. The t-value between pre-test score of Academic Achievement of Higher Secondary Students was found to be 1.23. This t-value was found insignificant at level

0.05, suggesting that there exists no significant difference between the mean of pre-test score of Academic Achievement of Higher Secondary Students. The findings of the present study concluded that the students who were not taught using the Interactive Instructional Material showed fewer academic scores. The t-value between pre-test and post-test scores of Mental Imagery was found to be 5.77. This value was significant at 0.01 level. This finding suggests that there exists a significant difference between the means of pre-test and post-test score of Mental Imagery, indicating that there was an improvement in the post test scores. Thus, teaching with Statistical Based Interactive Instructional Material improved the Mental Imagery of Higher Secondary Students. The findings of the present study were supported by Himani Raichur, Revati Vijay Shivnekar (2017) shows significant increase in higher retention power. Gregorius, et al. (2010) showed that animations can effectively be a substitute for traditional teaching method. The t-value between the pre-test and post-test scores of Academic Achievement in Statistics was found to be 4.71. This t-value was significant at 0.01 level, revealing that post-test scores exhibited a significant improvement in achievement score in Statistics when they were taught with Interactive Instructional Material. This finding was in conformation with the findings by Rose Kangyangchong (2016), which showed that the performance of students improved when Interactive Instructional Material was introduced in the lesson. Stephen a. Adalikwu and Isaac t. Iorkpilgh (2013) revealed that students who are taught using instructional materials demonstrate significantly higher performance compared to those who receive instruction without such resources. Furthermore, the incorporation of instructional materials generally enhances students' comprehension of concepts, contributing to improved academic achievement. The value was correlation was 0.77. This was significant at 0.01 level. This score depicts that there is a positive relationship between Mental Imagery and Academic Achievement of Higher Secondary Students. This value is lying between -0.1 and +0.1, which shows that both the variables move in the same direction and follow the positive correlation between them. This Correlation score satisfy the main objective of the study which was to study the Effect of Interactive Instructional Material on Mental Imagery and Academic Achievement of Higher Secondary Students

Conclusion

The role of instructional materials in the effective execution of educational programs is indispensable. These materials extend the range of experiences accessible to learners, enrich the teacher's verbal explanations, and enhance the learning experience. By making learning more engaging, instructional materials provide opportunities for diverse activities, supplement and clarify teaching, and improve the transmission of knowledge, ideas, skills, and attitudes. This highlights the need for teachers to be resourceful and creative, particularly for statistics teachers who may need to substitute "local" materials for standard, pre-made resources to make lessons more effective and improve student outcomes. The study also concluded that instructional materials play a crucial role in fostering students' intellectual development and achieving teaching and learning objectives. Students taught using instructional materials demonstrated significantly better achievement scores compared to those taught without them. Additionally, the study revealed a significant interaction between the use of interactive instructional materials and the development of mental imagery among higher secondary students. A strong statistical relationship was observed between mental imagery and academic achievement. The findings suggest that interactive instructional materials can serve as effective tools for self-learning, enabling students to engage in hands-on activities and learn at their own pace and interest.

REFERENCES

Skinner, B.F (1975), Why we need teaching machines. Harvard Education. Rev., 31,337-339

United Nation. The future we want: united nation: Rio de Janeiro, Brazil, 2012

Yahola Dodge, Daniel Commences (2006), the Oxford dictionary of statistical terms, Oxford university press.

Anderson, J.R. (2005). Cognitive psychology and its implication. New York, NY: Worth publishers.

Orji, A.B (2000), Guidance to instructional material. Journal of educational research

Kochhar, S. K. (2012). The Teaching of Social Studies. New Delhi, India. Sterling Publishers Private Limited

UNESCO, EFA Global monitoring report (2005), Beyond the horseless carriage: harnessing the potential of ict in education. Pg28

Gray, William S (1950). "Summary of reading investigators, july 1,1952- 1 june 30, 1953. Journal of educational research XLVII, no.6

Abdu-Raheem Bilqees Olayinka (2016). Effects of Instructional Materials on Secondary

Ibok, E. (2016). The challenge of improvisation in science teaching in the present day Nigeria. Journal of committee of Provosts of colleges of Education, Nigeria. 1 (1),92 – 123.

Ikot, A.S. (2008).Effects of Instructional Materials Utilization on performance of Junior Secondary Students in Practical Agriculture in Ikot-Abasi Local Government Area. Unpublished M.Sc. (ed) Thesis. University of Uyo, Uyo.

Kochhar, S. K. (2012). The teaching of social studies. New Delhi, India. Sterling Publishers Private Limied.

Latchanna, G. & Dagnew, A. (June 2009). Attitude of teachers towards the use of active learning methods. E-journal of All India Association for Educational Research, 21(1), http://www.ejournal.aiaer.net/vol21109/12.%20Latchana%20&%20Dagnew.pdf

Nori R, Giusberti F. Predicting Cognitive Styles from Spatial Abilities. The American Journal of Psychology.2006; 119(1): 67-86. doi:10.2307/20445319

Ogaga, G. A, Igori Wallace, 3Egbodo Benson (2016). Effects of instructional materials on the teaching and Learning of social studies in secondary schools in oju local Government area of benue state. International Journal of Current Research Vol. 8, Issue, 07, pp.3385933863, July, 2016

Ogbondah, L. (2008). An appraisal of instructional materials used to educate migrant fishermen's children in Rivers State, Nigeria. International Journal of Scientific Research in Education, 1(1), 13-25.

Okon, A. &Iyeke, U. (2014). The availability of instructional materials and students' academic performance of students in Biology. Journal of Education Review, 8(7),68-99.

Oladejo, Maruff A. (PhD), Olosunde, Gbolagade R. (PhD), Ojebisi, Amos O. & Isola, Olawale M. (2011) Instructional Materials and Students' Academic Achievement

Students Performance in Christian religious Knowledge at WASc in Southern Zaria, Kaduna State. Olumorin, C. O., Yusuf, A., Ajidagba, U. A., &Jekayinfa, A. A. (2010). Development of Instructional materials from local resources for art-based courses. Asian Journal of Information Technology, 9(2), 107-110.http://dx.doi.org/10.3923/ajit.2010.107.110

OrhanErcan (2014). The effects of multimedia learning material on students' academic achievement and attitudes towards science course. Kahramanmaras_Sutcu_Imam_University.

Dr. Osama M. Kraishan, Mrs. Hana R. Bajes (2015). The Relationship between Mental Imagery, Creative Thinking and Academic Achievement of Tenth Grade Students in Physics. ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) Vol.6, No.25, 2015

Osokoya, I.O. (2007). Effects of Video taped Instruction on Secondary School Students' Achievement in History, Int. J. Afr. Am. Stud. 6(1):27-34.

RoselineOlufunkeBukoye (2019). Utilization of Instruction Materials as Tools for

Effective Academic Performance of Students:Implications for Counselling †. Proceeding2019, 2, 1395; doi:10.3390/proceedings2211395   Some Policy Implications. European Journal of Humanities and Social Sciences Vol. 2, No.1

Oliagba, D. A. (1985) "A Comparison of factors Influencing Secondary School