Original Article

Comparison of Teaching by Conventional Method and by using Cognitive Theory of Multimedia to Post-graduate FCPS radiology students: A comparative study

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Abstract

Objective: The objective of this study was to teach postgraduate radiology resident physics by both conventional methods and by using the cognitive theory of multimedia, comparing the results and see if there was any improvement in their learning and performance.

Study Design: Comparative Experimental study.

Materials and Methods: Two groups of PG FCPS students of the first year and second year comprising of 10 students each were formed. Two groups had similar attributes.

Results: Statistically these two groups were similar. At the end of the first-round mean pretest score in the conventionally taught group I was 4.1 and the mean post-test score was 8.8. In group II taught by cognitive theory of multimedia, the mean pretest score was 4.2 and the mean post-test score was 13.3. After cross-over in group II taught conventionally the mean test score was 4.0 and the post-test score was 8.9. In group I now taught by cognitive theory of multimedia teaching group mean pretest score was 4.1 and mean post-test score was 13.6.

Conclusion: Postgraduate, first and second-year Diagnostic Radiology residents performed better in assessment once they were taught Physics by use of the cognitive theory of multimedia as compared to when taught by the conventional method of teaching.

Keywords: Didactic lecture, cognitive theory of multimedia, post-graduate residents.

Introduction

Radiological physics is an essential core component of the Post-graduate radiology curriculum. In our teaching institutions, it is generally being taught by radiologists in form of didactic lectures. Students, in general, consider it a difficult and "dry" subject and that also reflects in their performance. The Resident's feedback after didactic lectures reflected dissatisfaction and their apprehension in facing examination. It was observed that post-graduate residents show low grades in physics module assessment and the majority of them fail in the physics component of their FCPS intermediate module examination. No significant work on improving the learning of Radiological Physics was found in the literature review. The cognitive theory of multimedia has generally been used in medical education and undergraduate level to improve memory retention and enhance learning.[1] Objective of this study was to teach postgraduate radiology resident physics by both conventional methods and by using the cognitive theory of multimedia, comparing the results and seeing if there was any improvement in their learning and performance.

Materials and Methods

This comparative study was carried out in the radiology department Benazir Bhutto Hospital Rawalpindi. Ten first-year and ten second-year post-graduate radiology FCPS students with similar attributes were selected from three teaching hospitals affiliated with Rawalpindi medical university. Post-graduate trainees were divided randomly into two groups, each group comprised of 5 first-year and 5 second-year trainees with a similar gender distribution among the groups. They were divided into two groups. First of all, Pretest was taken. After random distribution of study participants in the two groups, two topics of radiological physics which were generally perceived to be similar in difficulty level was chosen for this study. These were Physics of Computerized Tomography and Image intensifier physics.

In the first part of our study, a pretest was taken and group 1 was taught physics of Computerized Tomography using the conventional (didactic) lecture method, and group two were taught the same topic by the use of the cognitive theory of multimedia. Post-tests were taken after the teaching sessions for both groups.

In the second part of our study, group one was taught physics of Image intensifier by cognitive theory of multimedia and post-test was taken and group two was taught physics of Image intensifier by didactic lectures, and post-test was taken. Cross-over was done, Pretest was taken as before. Students who were taught by the conventional method were now taught Image intensifier physics by the use of the cognitive theory of multimedia and the group which was taught by cognitive theory of multimedia was now taught Image intensifier physics through the conventional method. A post-test was taken. Results of both groups were compared and statistical analysis was done using SPSS.

Results

The average age of group one was 27.5 years and of group 2 was 28.4 years. There were 4 males and 6 females in group 1 and group 2 there were 3 females and 7 females. Statistically, these two groups were similar (Table 1).

Table 1: Demographic characteristics of participants

	Average Age in years	*Gender*		*PG Year*	
		Male	Female	First year	Second year
Group I	27.5	4	6	5	5
Group II	28.4	3	7	5	5

At the end of the first round, the mean pretest score in conventional teaching group 1, didactic lecture as a teaching tool, was 4.1, and the mean post-test score was 8.8. In group 2 taught by cognitive theory of multi-media, the mean pretest score was 4.2 and the mean post-test score was 13.3 (Table 2).

Table 2: Round 1

S. No	*Name*	*Age*	*PG Year*	*Group I Conventional teaching*		*Group II taught by Cognitive theory of multimedia*	
				Pre test /20	Post test /20	Pre test /20	Post test /20
1		27	II	6	9	4	14
2		28	II	5	8	4	13
3		26	II	5	10	4	13
4		29	II	4	8	5	14
5		27	II	3	8	5	11
6		26	I	3	9	5	14
7		28	I	5	7	4	12
8		25	I	4	9	4	13
9		29	I	3	11	3	15
10		30	I	3	9	4	14
Total	**275**			**41**	**88**	**42**	**133**
Mean	**27.5**			**4.1**	**8.8**	**4.2**	**13.3**

After cross-over in conventional teaching group II, the mean test score is 4.0, and the post-test score is 8.9. In group, I now taught by cognitive theory of multimedia mean pretest score is 4.1, and mean post-test score was 13.6 (Table 3).

Table 3: Round II

S No	*Name*	*Age*	*PG year*	*Group II Conventional teaching*		*Group I Taught by cognitive theory of multimedia*	
				Pre-test /20	*Post-test /20*	*Pre-test /20*	*Post-test /20*
1		30	II	4	9	5	13
2		28	II	3	8	5	13
3		27	II	3	9	5	14
4		29	II	5	8	4	15
5		28	II	5	10	3	12
6		31	I	5	9	4	13
7		30	I	4	8	5	14
8		25	I	4	9	4	14
9		26	I	3	9	3	14
10		30	I	4	10	3	14
Total/ Mean		**284/28.4**		**40/4.0**	**89/8.9**	**41/4.1**	**136/13.6**

For comparative analysis, four pairs were made. **Pair 1**, Pre-test conventional group I–Post-test conventional group I showed there is improvement in students learning with P-value < .05, which is significant.

Pair 2, Pre-test cognitive Theory of Multimedia, group I–post-test cognitive Theory of Multimedia, group I also showed there is marked improvement in students learning as is shown in table 4 with P value<.05, which is significant.

Pair 3, Pre-test conventional group I–pretest Cognitive Theory of Multimedia. In this group there is no difference in student's performance, showing that the results are similar, therefore P value>.05, as is shown in Table 4.

Pair 4, Post-test conventional group I–post-test Cognitive Theory of Multimedia group I In this group there is improvement in students learning as is shown in table 4, P value<.05, which is significant.

Table 4: Group I

		Mean	*Std. deviation*	*P value*
Pair 1	Pre test conventional group I–Post test conventional group I	-4.70	1.76	.000
Pair 2	Pre test cognitive T. M.M. group I–post test cognitive T. M.M group I	-9.10	1.52	.000
Pair 3	Pre test conventional group I–pre test cognitive T. M.M group I	-.100	1.37	.823
Pair 4	Post test conventional group I–post test cognitive T. M.M group I	-4.50	.97	.000

In group II, for comparative analysis four pairs were made, **Pair 1,** Pre-test conventional group II–Post-test conventional group II. In this group there is improvement in students learning as is shown in table 5, P value<.05, which is significant.

Pair 2, Pre-test cognitive Theory of Multimedia, group II–post-test cognitive Theory of Multimedia, group II, In this group, there is marked improvement in students learning as is shown in table 5, P value<.05, which is significant.

Pair 3, Pre-test conventional group II–pretest Cognitive Theory of Multimedia. In this group there is no difference in student's performance, showing that the results are similar, therefore P value>.05, as is shown in Table 5.

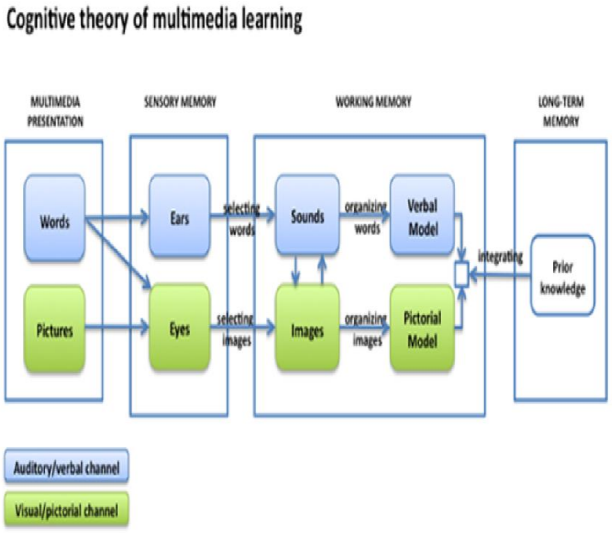
Pair 4, Post-test conventional group II–post-test Cognitive Theory of Multimedia group II In this group, there is improvement in students learning as is shown in Table 5, P value<.05, which is significant.

Table 5: Group II

		Mean	*Std. deviation*	*P value*
Pair 1	Pre-test conventional group II–Post-test conventional group II	-4.90	.994	.000
Pair 2	Pre test cognitive T. M.M. group II–post test cognitive T. M.M group II	-950	1.17	.000
Pair 3	Pre test conventional group II–pre test cognitive T. M.M group II	-.100	1.37	.823
Pair 4	Post test conventional group II–post test cognitive T. M.M group II	-4.70	1.33	.000

Discussion

The cognitive theory of multimedia learning is introduced by American psychology professor Richard Mayer in 1990.[1] It has evolved from Sweller's cognitive load theory.[2] Basic assumption of Mayer's theory is that the **human working memory** has **two sub-components** that **work in parallel** (visual and verbal/acoustic) and that learning can be more successful if both of these channels are used for information processing at the same time.



In the context of medical education, it has been shown that applying multimedia design principles to medical student lectures leads to improved attainment of learning objectives both immediately and long-term.[1] Now multimedia, computer workstations, mobile internet chat groups have all become part and parcel of radiology teaching.

In literature I could not find any study comparing the conventional method of teaching Radiology with teaching by the use of the cognitive theory of multimedia, however, most relevant studies are summarized. Schlorhaufer et al in 2012, published an article, "Implementation of a web-based, interactive polytrauma tutorial in computed tomography for radiology residents: how we do it".[3] In this article, the author analyzed the use of computed tomography (CT) scans in polytrauma cases, and concluded that the images can be read and communicated very quickly. This mode of learning can be utilized for training of Radiology students at the undergraduate level, where X-Ray's films are enough to teach the students.

Muhammad Shamim, in his article published in 2018, "Application of Cognitive Theory of Multimedia Learning in Undergraduate Surgery Course",[4] used this method to teach the students of surgery at the undergraduate level. Images on screen were used in clinical teaching to facilitate learning of operative procedures.[5] Multimedia learning includes learning by pictorial, images, and verbal modes. Verbal learning can be from either written or spoken words and pictorial learning includes either still or dynamic images e.g. videos or animations.[6] According to three principles of cognitive theory of multimedia learning[7]:

1. The learners have separate processing channels for pictures and words.
2. Learners have a limited capacity of working memory for information processing.
3. Learners need appropriate cognitive processing for meaningful learning to occur, e.g., integration with prior knowledge, paying attention, and conceptualization.

"Applying multimedia design principles enhances learning in medical education".[8] This study concludes that, Multimedia design principles are easy to implement and result in improved short-term retention among medical students.

In the cognitive theory of multimedia learning, a model for information processing and learning, which we call memory, is divided into 3 parts: Sensory, consisting of sensory replication of the presentation for a very brief period, working, responsible for the processing of the presented material for a short period, and long-term, representing the already stored knowledge for long periods.[6] Based on these concepts of learning, the role of Cognitive Theory of Multimedia learning in Radiology at undergraduate as well as postgraduate level can be designed.[9]

This study proved that post-graduate students, first and second year of Diagnostic Radiology performed better once they were taught Physics by the use of the cognitive theory of multimedia as compared to when taught by a conventional method. The conventional method is also a useful tool to impart learning, but the cognitive theory of multimedia is the need of the hour (Bechtold, 2017). Physics although being a very difficult and dry subject to teach is included as a core curriculum in the FCPS post-graduate radiology curriculum. By trying unconventional methods and new teaching strategies we can engage students in an active learning process to learn and retain key information in their long-term memory (Maslow, 2007). The words and pictures that we choose for instruction by using a cognitive theory of multimedia are important and impactful on students, thus improving their academic performance (Alt, 2012).

Conclusion

This study proved that post-graduate students, first and second year of Diagnostic Radiology performed better once they were taught Physics by the use of the cognitive theory of multimedia as compared to when taught by a conventional method. The conventional method is also a useful tool to impart learning, but the cognitive theory of multimedia is the need of the hour.[10] Physics although being a very difficult and dry subject to teach, is included as a core curriculum in the FCPS post-graduate radiology curriculum. By trying unconventional methods and new teaching strategies we can engage students in an active learning process to learn and retain key information in their long-term memory.[11] The words and pictures that we choose for instruction by using the cognitive theory of multimedia are important and impactful on students, thus improving their academic performance.[12]

Limitations of the Study

Although the study proved that the cognitive theory of multimedia is a better method to teach Physics to post-graduate FCPS radiology students, the main limitations were sample size, duration and that, only two topics of Physics were taught. The difficulty level of the topics can be a confounder both topics were taught to each group by both conventional methods and by using the cognitive theory of multimedia.

Recommendations

It is recommended that this study should be considered as a pilot study with a follow-up study having a large sample size being taught the physics module in the post-graduate radiology curriculum. Postgraduate radiology teaching hospitals should be approached and collaboration sought and in the end, a final recommendation to the Radiology community be made about teaching Physics by the use of the cognitive theory of multimedia.

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