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EFFECT OF INSTRUCTIONAL MEDIA ON COGNITIVE LOAD OF STUDENTS' IN GENERAL SCIENCE SUBJECT AT ELEMENTARY LEVEL IN DISTRICT MIANWALI

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ABSTRACT

The educational position of any institution is mainly portrayed through the proper use of instructional media in the class room. Within the other factors, instructional media may also be the one determinant of individuals' low or high cognitive load. An attempt in this regard was made to investigate the effect of instructional media on cognitive load f students in subject of general science at elementary level. Male students of 7th grade enrolled in public sector schools in district Mianwali were taken as population of study. 198 students were selected as sample for this experimental research study. The study revealed significant difference in all groups of instructional media and cognitive load.

Keywords: Instructional media, cognitive load

INTRODUCTION

Teaching and learning process being very complex depends on several factors. One of them is instructional media. Instructional media are the tools for transmitting or delivering learning content to the learners for achieving learning objectives.

Use of instructional media may be an important factor to have had a major influence on students' Cognitive load. That refers to total effort of working memory used for formation of new schema and completion of the assigned tasks. Therefore using different instructional media in the classroom may be a source to increase or reduce the cognitive load of learners.

But, the findings of different studies are presenting a sorry figure regarding the meaningful use of technologies in the teaching-learning process for classroom instruction in Pakistani schools. Most of the cases reflect over 90% of teachers are not using any kind of technology

for the instructional benefits. Different types of computer related materials are shun by the teachers in their classes (Saleem et al., 2019)

The key issue is not the introduction of ICT in classroom but the using it in such a way that may assist in reducing cognitive load in addition to enhancing understanding of students (Khurshid et al., 2016)

Among many other challenges faced by students in learning science subject in Pakistan, one is instructional media used by teachers in science teaching at elementary level (Jessani, 2015). The science concepts taught through rote learning in the primary and elementary classes are very difficult to understand .Similarly, Teaching science concepts through rote memorization in the Government Schools can be commonly compared only in face value of science content as recognize (Pell, Iqbal, & Sohail, 2010)

Chen and Yan,(2016) measured cognitive load in reading of general science using computer assisted instructional media showed that it increases learning and reduces cognitive load. Ratminingsih (2016) considered instructional media as a tool used to transmit knowledge to the learners. Therefore, the instructional media not only assist teachers in delivering the content but also facilitate pupils to understand content for achieving the learning objectives. Instructional media has become an influential factor that may have an effect on students' cognitive involvement in addition to their learning progress.

Science is one of the essential subjects in schools and basics for development of any country. Science learning requires use of technology for facilitating students in concept formation to learn science phenomena that is impossible in the absence of proper instructional media. For example; Chen & Yan (2016) studied the impact of instructional media on science learning and retention. Findings of research studies revealed that learners who were taught with the help of animation along with narration performed better than the students who used animation along with on-screen text.

According to Fleck, Beckman, Sterns, & Hussey (2014) technology is penetrating in learners life as they use cell phones, laptops and tablet devices for sharing information and understanding of content material(e.g., YouTube).In this sense, as stated by Huda, Jasmi, Hehsan, Mustari, Shahrill, Basiron, & Gassama (2017) technology based education has following parts, The technology plus content related component. The content related component comprised of instructional videos, text sound or similar. Instructional media in the form of videos are used to teach conceptual knowledge to the learners (Florala & Mayer, 2018).Thus; instructional media in the form of technology introduced the use of videos in teaching. The use of instructional media especially technology based, is enhancing the learning process and helping students to gain knowledge. The research study conducted by Resti & Rachmijati, (2020) on the development of android based instructional media showed it to be valid, practical and effective for elementary students.

Though lot of researches have been done on this topic. Most of the findings are context-specific and have little or no predictive strength outside that context. In this perspective, very little research has been found to be done in Pakistani Context. Keeping in view the belief of many researchers regarding research on instructional media would be highly context bound, it was found interesting to carry out the present study. The study aimed to investigate the effect of instructional media on cognitive load of students. Hopefully the

findings of this study would equip the professionals and parents with the information about instructional media and cognitive load .Specific objectives of the study were:

- To Measure cognitive load of students' in the subject of General Science at elementary level in District Mianwali.
- To Investigate the effect of instructional media on cognitive load of students' in the subject of General Science at elementary level in District Mianwali.

METHODOLOGY

The study was descriptive in nature, so quantitative research approach was used to study the phenomenon under consideration. Students of elementary level enrolled in 7th grade constituted the population of the study. Keeping in view the time and resources constraints, the study was delimited to the Students of District Mianwali.School with maximum strength of 7th grade students(195) was selected to conduct experiment .

To meet the objectives of research, data was gathered by using Cognitive load scale (10 statements)based on 11 pointmetrics, designed by J Leppink, Fred Paas and Jeroen Van Merrienboer (2013) used as Pre-test and Post-test to measure cognitive load of Students.

To gather data, instrument was validated through expert consultation and reliability of the questionnaire was determined through pilot testing on 33 students of class 7th. Alpha Coefficient value ranged from 0.729

DATA ANALYSIS

After gathering and compiling data it was coded in a coding of SPSS 20.0. Then it was analyzed by mean of different tests. One way ANOVA, Post hoc and paired sample t -test was used to see differences in mean scores within and between groups.

Descriptive statistics were carried out to measure cognitive load of students in subject of general science at elementary level. Descriptive statistics for cognitive load of students are given in table 1.

Table 1: ***Cognitive Load Mean score***

	N	*M*	*Max*	*Min*	*Range*	*SD*
Total Cognitive load	195	4.60	8.20	2.80	5.40	.890

Rating based on the 11-point metric (0=Not at all the case to 10= completely the case)

The mean score of the cognitive load of students is given in table 1. The mean score value of students on cognitive load scale was 4.60, with a standard deviation of .890. The maximum score on the cognitive load scale was 8.20 and the minimum score was 2.80. The item responses 0 through 10 were coded so, that the score of 10 received "completely the case", and 0 "Not at all". 1, 2, 3 represented "Mild cognitive load" 4, 5, 6 refers to "Moderate cognitive load" 7, 8, 9 represented "high cognitive load". The mean value of dimension under study is 4.60 which reflect the "moderate cognitive load" response means that students have moderate cognitive load.

Comparison of Cognitive load for different Group of instructional media

Differences in cognitive load based on instructional media

To find out if there was any significant difference in the mean score of cognitive load of groups using different instructional media, a one-way ANOVA was conducted. The result of one-way ANOVA is given in table 2.

Table 2:

		Sum of Squares	***df***	***Mean Square***	***F***	***Sig.***
Cognitive load .post.test.1	Between Groups	16.22	2	8.11	7.96	.000
	Within Groups	195.61	192	1.02		
	Total	211.82	194			
Cognitive load. post.test.2	Between Groups	20.80	2	10.40	14.33	.000
	Within Groups	139.29	192	.725		
	Total	160.09	194			
Cognitive load post.test.3	Between Groups	10.35	2	5.18	8.24	.000
	Within Groups	120.58	192	.628		
	Total	130.93	194			

P<.05

Rating based on the 11-point metric (0=Not at all the case to 10= completely the case).

To find if the difference in mean score is significant a one-way between-groups ANOVA used to determine whether the difference between groups for post test 1, 2 and 3 is significant. Table 2 Shows the result of one-way ANOVA for "Cognitive load" of groups of participants of different instructional media. From one-way ANOVA was found that there is statistically significant difference at the p=.05 level in cognitive load score for the groups .Statistically significant difference was found in means scores of cognitive load for posttest1, *F (2,192) =7.96, p=.000, F (2,192) =14.33, p=.000 for posttest2 and F(2,192)=8.24, p=.000* for posttest3.

Tukey's post hoc test was conducted to determine which three groups relevant to the different types of instructional media were significantly different in participants' intrinsic cognitive load. The post hoc results are given in table 3.

Table 3:*Post hoc Tukey Comparison for cognitive load of groups*

Dependent Variable	(I) groups	(J) groups	Mean Diff	Std. Error	Sig.
Cognitive load.posttest.1	Group1	Group2	.676*	.177	.001
		Group3	.158	.177	.644
	Group2	Group1	-.675*	.177	.001
		Group3	-.517*	.177	.011
	Group3	Group1	-.158	.177	.644
		group2	.517*	.177	.011
Cognitive load.posttest.2	Group1	Group2	.794*	.149	.000
		Group3	.335	.149	.066
	Group2	Group1	-.794*	.149	.000
		Group3	-.459*	.149	.007
	Group3	Group1	-.335	.149	.066
		Group2	.459*	.149	.007
Cognitive load.posttest.3	Group1	Group2	.314	.139	.064
		Group3	.563*	.139	.000
	Group2	Group1	-.3139	.139	.064
		Group3	.249	.139	.175
	Group3	Group1	-.563*	.139	.000
		Group2	-.249	.139	.175

P<.05

Rating based on the 11-point metric (0=Not at all the case to 10= completely the case)

The post hoc Tukey difference of three groups of instructional media for total cognitive load of posttest 1 and post test 2, indicated that group 2(text book) showed statistically

significant difference at *p<0.05*.Except group 1(videos) and group 3(powerpoint) that indicated no significant difference at *p<0.05*.

For pretest 3, cognitive load of Group 1 (videos) and Group 2 (text book) were significantly not different from each other at *p=.05*, similarly group 2 and group 3 (power point) showed statistically no significant differences at *p<.05*for cognitive load on posttest3.

To determine effect size Eta squared values were measured and analyzed in compliance with Cohen's guidelines (1988) and Miles and Shelvin (2001), which are:0.2=small effect size, 0.5=moderate effect size, 0.8= large effect. Eta squared values (Cohen's d) have been calculated using the effect size calculator. For all the effect size, in this case posttest1, .07,posttest2 it was .13, and for posttest3 eta value found.07 , which lies within the range of moderate effect size.

A paired sample t-test was conducted to compare Mean scores of students of group 1 (Text Book) on cognitive load measuring scale for measuring their cognitive load on pretest and post test 1,post test2,and posttest3 for cognitive load mean scores. The results of the t-test for group 1 are given in table 4.

Table 4: ***Cognitive load and Instructional Media (Comparison within videos group)***

Group.1	*Cognitive load*	*M*	*Std. Dev*	*T(64)*	*P*	*r*	*P*	*Cohen's d*
Videos	Pretest	4.52	1.14	-3.26	.002	.697	.000	0.3
	Posttest.1	4.89	1.19					
	Pretest	5.09	1.03	-4.16	.000	.490	.000	0.5
	.Posttest.2							
	Pretest	4.80	.736	-1.59	.118	-.110	.382	0.3
	.Posttest.3							

P<0.05

Rating based on a eleven-point metric (0=Not at all to 10=extremely the case may b)

Table 4:revealed mean comparison in cognitive load of group 1 participants using videos as instructional media. Findings indicated significant mean difference in cognitive load in pretest (M=4.52, SD=1.14) and in post test1 *(M=4.89, SD=1.187)*.Scores were correlated significantly (r=.697,p<.05.The value of Cohn's d was 0.3,0.5 and 0.3.Findings indicated significant mean difference on posttest1 with *t(64)= -3.26, p<.005.*

Findings indicated significant mean difference in cognitive load in pretest ((M=4.52, SD=1.14) and in post test2 (M=5.09, SD=1.025).Scores were correlated significantly(r=-.490 p<. 05).The value of Cohn's d was 0.5

Findings indicated no significant mean difference on posttest3 with t(64)=-1.59,p>0.05. Findings indicated no significant mean difference in cognitive load in pretest (M=4.52, SD=1.14) and post test 3 (M=4.80, SD=.736).Scores were correlated non significantly(r=

-.110, p> .005).The value of Cohn's d was .030(>.20).For mean difference on posttest3 with t(64)= -110 ,p>0.05.

A paired sample t-test was conducted to compare Mean scores of students of group 1 (Videos) on cognitive load measuring scale for measuring their cognitive load on pretest and post test 1,post test2,and posttest3 for cognitive load mean scores. The results of the t-test for group 2 are given in table 5.

Group.2	*Total Cognitive load*	*M*	*Std. Dev*	*T(64)*	*P*	*r*	*P*	*Cohen's d*
Text book	Pretest	4.63	.807	2.84	.006	-.263	.034	0.5
	Posttest.1	4.21	.746					
	Pretest	4.29	.665	2.31	.024	-.198	.113	0.5
	.Posttest.2							
	Pretest	4.49	.823	. 904	.369	-.076	.550	0.5
	.Posttest.3							

Table 5: ***Cognitive load and Instructional Media (Comparison within videos group***

P<0.05

Rating based on a eleven-point metric (0=Not at all to 10=extremely the case may b)

Table 5: revealed mean comparison in Total cognitive load of group 2 participants using Text book as instructional media. Findings indicated significant mean difference in total cognitive load in pretest (M=4.63, SD=.807) and in post test1 (M=4.21, SD=.746).Scores were correlated significantly(r=.-263,p<.05.The value of Cohn's d was 0.5(=.0.5)Findings indicated significant mean difference on posttest1 with t(64)=2.84 ,p<0.05.

Findings indicated significant mean difference in total cognitive load in pretest(M=4.63, SD=.807) and in post test2 (M=4.29, SD=.665) Scores were correlated non significantly(r=.-.198, p> 05).The value of Cohn's d was 0.5(=.50).

Findings indicated no significant mean difference on posttest2 with t(64)=2.31,p>0.05. Findings indicated significant mean difference in total cognitive load in pretest (M=4.63, SD=.807) and post test 3 (M=4.49, SD=.823).Scores were correlated non significantly(r=-.076, p>.005).The value of Cohn's d was .05(=.50).For mean difference on posttest3 with t(64)=.904,p>0.05.

A paired sample t-test was conducted to compare Mean scores of students of group 3 (powerpoint) on cognitive load measuring scale for measuring their cognitive load on

pretest and post test 1,post test2,and posttest3 for cognitive load mean scores. The results of the t-test for group 3 are given in table 6.

Table 6: ***Cognitive load and Instructional Media (Comparison within power point group)***

Group 3	*Total Cognitive load*	*M*	*Std. Dev*	*T(64)*	*P*	*r*	*P*	*Cohen's d*
Powerpoint	Pretest	4.55	.667	-1.09	.278	-.076	.550	0.2
	Posttest.1	4.73	1.05					
	Pretest	4.75	.819	-1.58	.120	.090	.477	0.2
	.Posttest.2							
	Pretest	4.24	.815	2.33	.023	-.082	.514	0.4
	.Posttest.3							

P<0.05

Rating based on a eleven-point metric (0=Not at all to 10=extremely the case may b)

Table 6: revealed mean comparison in total cognitive load of group 3 participants using power point as instructional media. Findings indicated no significant mean difference in total cognitive load in pretest (M=4.55, SD=.667) and in post test1 (M=4.73, SD=1.05).Scores were correlated non significantly(r=.-.076 ,p>.05.The value of Cohn's d was 0.2(=.20)Findings indicated no significant mean difference on posttest1 with t(64)=-1.09,p>.005.

Findings indicated no significant mean difference total cognitive load in pretest (M=4.55, SD=.667) and in post test2 (M=4.75, SD=.819).Scores were correlated non significantly(r=.090 , p> 05).The value of Cohn's d was 0.2(=.20).

Findings indicated no significant mean difference on posttest2 with t(64)=-1.58,p>0.05. Findings indicated no significant mean difference in total cognitive load in pretest (M=4.55, SD=.667) and post test 3 (M=4.24, SD=.815).Scores were correlated non significantly(r=.090, p> .005).The value of Cohn's d was .040(<.50).For mean difference on posttest3 with $t\ (64)=2.33, p<0.05$.

CONCLUSIONS AND DISCUSSIONS

The results in this study suggested that significant mean difference exist between cognitive load of groups using different instructional media .Although The post hoc Tukey difference of three groups of instructional media for cognitive load of posttest 1 and post test 2, indicated that group1 and group 3 indicated no significant difference Likewise group 2 and group 3 showed no significant difference in post test3. Different reasons explain these findings, which run counter to the body of literature that evidenced instructional media either increases or decreased cognitive load(mixed sort of result) Sweller, Ayres, & Kalyuga, 2011; Chen and Yan, 2016; Mason, Tornatora, & Pluchino, 2013; Hung, 2014.

Analysis of within groups comparison for group 1, video using group indicated that significant difference exist between all participants of group 1(videos) in posttest 1and posttest 2. These research findings are similar to the findings of Costley, Fanguy, & Baldwin, (2021). They found a significantly greater cognitive load, $t(24) = 2.56$, $p < .05$: for video group than the no video group. But in posttest 3 ,no significant difference found for participants of group1(videos as instructional media),These findings are similar to the findings of Aalioui,Gouzi & Tricot(2022) .They found no significant effect of videos on the students' cognitive load . Conversely, cognitive load during video lectures has been reduced by interventions helping students to focus their attention, e.g., by signaling essential information or personalization of the oral comments. Moreover after posttest1 and posttest 2 students become familiar with this intervention that helped in reducing cognitive load.

Comparison between participants of group 2(text book) indicated significant mean difference for cognitive load on posttest 1 and 2 but no significant difference for posttest 3. According to Akgün et al(2016) almost half of material presented in the textbook contains cognitive load. Moreover, the textbook also contains some redundancies of information that typically has a negative impact on learning. Most people think that the presentation of the same information in a different way will make understanding is easily obtained. However, learners have to process all redundant information repeatedly, which is a cognitively demanding process that hinders learning .For example; the textbook provides both textual and pictures information that have the same meaning. In this case, adding a picture to a written text or adding a written text to a picture means adding unneeded information. The textbook also contains the material that is incoherence. Actually based on empirical research, adding extraneous information in the form of seductive graphics and stories, or lengthy text can depress learning. In sum, the findings showed that the most appeared ECL in the analyzed textbook are the split-attention (18.43%) and lack of signaling (18.43%).Then, the typing mistake (11.06%), redundant information (3.69%) and incoherence (3.69%). According to the CLT, these might hinder understanding. This suggests that the textbook should be revised by considering the cognitive load may be imposed when students learn it .Moreover, this study also provides teachers with insights into the strengths and weakness of the textbooks, and suggest enable them to make effective decisions about the selection of textbooks. In fact, teachers and the environment may have an influence on the use of text books.

No significant differences found in means of participants of power point presentation group. These findings coincide with the finding (Paul & Seniuk Cicek, 2021) slide reduces the cognitive load on the novice as it includes less unfamiliar or new information. Though this may seem overly simplistic to the instructor, it is appropriate for the novice student. The key takeaway is that instructors should make slides as simple as possible by reducing each slide to one idea, as seen from the *novice's* perspective. Use animation or multiple slides to build to more complex ideas. This will reduce the cognitive load on the students and ensure

improved retention. The Gestalt principle states that humans tend to naturally group visual objects by any obviously similar characteristic such as color, proximity, motion, size, continuity, etc. This grouping reduces cognitive load by making the information easier to reference or access. The key takeaway is that an instructor must consider how the

information on the slide is organized. Using gestalt principles, it is possible to create natural groupings that can reduce the cognitive load on working memory and thus allow the information to be processed and retained more efficiently.

Cognitive load of participants of group 2(textbook) increased with significant difference indicating that text book increases cognitive load.these findings are similar to the research findings of Akgün et al., (2016) who stated that almost half of material presented in the textbook contains cognitive load. Moreover, the textbook also contains some redundancies of information that typically has a negative impact on learning. Most people think that the presentation of the same information in a different way will make understanding is easily obtained. However, learners have to process all redundant information repeatedly, which is a cognitively demanding process that hinders learning. For example, the textbook provides both textual and pictures information that has the same meaning. In this case, adding a picture to a written text or adding a written text to a picture means adding unneeded information. The textbook also contains the material that is incoherence. Moreover, this study also provides teachers with insights into the strengths and weakness of the textbooks, and suggest enable them to make effective decisions about the selection of textbooks. In fact, teachers and the environment may have an influence on the use of instructional media .Accordingly, for earning a more convincing result, further analysis that investigates the relationship between instructional media and cognitive load view to students learning process and their achievement need to be carried out.

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