

## LOCKDOWN AREA OF COVID-19: HOW DOES CARTOON BASED E-CONTENTS EFFECT ON LEARNING PERFORMANCE OF INDIAN ELEMENTARY SCHOOL STUDENTS WITH ADHD

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### ABSTRACT

In the context of the lockdown area of COVID-19, animated and gag cartoon-based intervention has a significant role in promoting students' learning performance at elementary levels. ICT-based intervention on students with ADHD mostly uses in UK, USA, Greece, Iran, and Poland. Still, recent researches are conducting in India, especially in the Northeastern region, to assess its effectiveness. Based on the literature and research questions, the current study aimed to evaluate the effect of animated and gag cartoon-based e-contents intervention on experimental groups' learning performance with those in the comparison group in Silchar town, Assam. 90 students with ADHD were assigned to experimental groups and a comparison group. The experimental group I (n=30, age ranged 10.5-11.5 SD= 11) was exposed to animated cartoon based e-contents instruction, and experimental group II (n=30, age ranged 10.5-11.5 SD= 11) was assigned to gag cartoon based e-contents in Environmental studies. Simultaneously, the traditional approach was used in the comparison group (n=30, age ranged 10.5-11.5 SD= 11). The quasi-experimental design was used to examine the effect of animated and gag cartoon-based e-contents intervention on experimental groups' learning performance with those in the comparison group. It resulted in animated cartoon-based e-contents and gag cartoon-based e-content intervention that significantly affected participants' performance over the comparison group.

**Keywords:** animated cartoon based e-contents; attention deficit hyperactivity disorder, gag cartoon based e-content; learning performance of students

### INTRODUCTION

Recently, the authority of different countries closed the formal elementary schools to stop the infection of deadly corona virus. UNO and WHO also advising the people and the authorities of school and higher educational institutions to stop the informal education system rather continue education through online platforms. In this COVID-19 era, social distancing and using of mask is important to stay safe from outbreak of corona virus. In the last two decades, ICTs is used by the teachers in the teaching and learning process and improved the performance of students in the teaching-learning process (Jena *et al.*, 2017). Literature found that students with Attention Deficit Hyperactive Disorder (ADHD) became normal after being exposed to cartoons or video games. Their performance becomes quite similar to the students without ADHD (Xu *et al.*, 2002), and cartoons reduce distraction and sustain attention for a prolonged time (Arunraj & Blessy, 2015). Similarly, animated cartoon use while teaching encourages the students to learn any complicated subject matter quickly (Mtebe & Twaakyondo, 2012) and grasp the students' attention with ADHD through motion and images (Govindaraj, 2012). Also, Muthuchamy & Arunraj (2013) found from their study that cartoon has a significant positive effect on children as it creates a humorous environment where they are able to learn contents easily, respond to any queries, enjoy classroom situation and can react to any stimuli whether it may be alone or with friends in a small or large group. However, watching cartoons on television reflects a long attention span in children with ADHD (American academy of pediatrics, 2000). It is also found that the maximum number of students with ADHD who have the problem of inattention and other associated behavioral problems have difficulties with a concentration in the classroom. And hinder them in completion of their classwork, homework or any assignments given to them (DuPaul *et al.*, 2008) and as a result of which their performance in tests and exams are deficient, that lead to a lower grade in academic and poor schooling ( Shillingford, *et al.*, 2007; Loe & Feldman, 2007). Moreover, they often show lower performance in reading and calculation (Frazier *et al.*, 2007) and weak written expression (Mayes & Calhoun, 2006) due to their inattentive symptoms (Todd *et al.*, 2002). Similarly, two more studies have revealed that students with ADHD often face difficulty managing and maintaining social relationships, low

social adjustment, and poor communication. ADHD students have lack of interpersonal skills, psychological problems, drug abuse, consuming alcohol, and low self-esteem (Bakhshani *et al.*, 2011; Green & Rabiner, 2016). So, in light of the harmful consequences of ADHD, several findings suggest that the students with ADHD need novel and effective interventions addressed to their academic difficulties (DuPaul, 2007), which may be a cartoon-based e-content intervention.

### **TYPES AND SYMPTOMS OF ADHD**

There are mainly three subtypes of ADHD, according to DSM-V (2013). These are Inattentive Presentation, Hyperactive-Impulsive Presentation, and ADHD Combined Presentation along with their symptoms; these are briefly discussed below.

#### *Predominantly Inattentive Presentation*

The children, including this category, maybe characterized by difficulties with concentration, inability to focus, and pay attention. They also face problems organizing tasks and time management and often forget and lose the materials necessary for any activities. The children belonging to this category don't listen to others while spoken to them directly and often avoid engaging in any activities that require mental effort such as homework, school work, etc.

#### *Predominantly Hyperactive/Impulsive Presentation*

The children under this category often have difficulty awaiting their turns, blurting out answers too quickly before the questions have been completed, disruptive classroom behavior, interrupt others' conversation, activities, rejection by classmates, and often talks excessively. They usually run and climb excessively in which it is inappropriate and frequently fidgets with hands or feet.

#### *Predominantly Combined Presentation*

The children under the predominantly combined presentation this category show both inattention and hyperactivity-impulsive behavior.

### **REVIEW OF CARTOON BASED E-CONTENTS AND LEARNING PERFORMANCE OF STUDENTS WITH ADHD**

To carry out the present study, the researcher reviewed more than 50 literature related ICTs in general, and cartoon-based intervention applied explicitly to students with ADHD (Arunraj & Blessy, 2015; DuPaul *et al.*, 2008; Mautone *et al.*, 2005). It is found that there has a significant relationship between using cartoon based e-content approach and the academic performance of students with ADHD (Govindaraj, 2017; Muthuchamy & Arunraj, 2013). Most of the studies were evaluated the effects of ICT on the learning performance of students with ADHD, and those were mainly conducted in UK, USA, Greece, Iran, Poland, and other parts of nations. However, few researches were undertaken research on the cartoon based intervention in India, especially in the North-Eastern region (Andreou *et al.*, 2016; Christina *et al.*, 2004; Mautone *et al.*, 2005; Shaw & Lewis, 2005). Two case studies were conducted in Tamilnadu, India found that the use of cartoon in learning environment provides the opportunity for active participation in children with ADHD, which helps them improve difficulties of attention and construct their knowledge meaningfully and permanently (Arunraj & Blessy, 2015). Whereas another study indicated, Animated Learning Package for Mathematical subjects helps students with ADHD enhance their learning, achievement, and reduction of ADHD symptoms (Govindaraj, 2012). Similarly, Eker & Karadeniz (2014) found that cartoon can be used in teaching practices that provide significant improvement in academic achievement and reduce anxiety and tension in students of the experimental group. Moreover, two more research findings indicated that the application of cartoon in the teaching-learning process helps create a learning environment by giving the students the freedom to explore their creativity (Al-Rabaani & Al-AAMri, 2017; Ross, 2012; Mtebe & Twaakyondo, 2012). Animation content improved mathematical abilities in students far better than the traditional approach (Rohendi, 2012). Also, animated cartoon could be used to help children with ADHD gain various skills, several visual and spatial reasoning tasks, and communication with parents, teachers, siblings, friends, or others (Srinivasalu, 2016). As most children favor cartoons, the images are well absorbed in the eye and the brain (Ozay, 2013). So, to enhance the level of attention and to improve academic achievement, cartoon can be used in teaching Environmental Studies among students with ADHD, particularly

(Jena & Gupta, 2019). The researchers assessed the cartoon-based intervention's effect on students' learning performance with ADHD in Environmental Studies at elementary schools in Silchar Town, Assam, India.

### GLOBAL NOVELTY OF THE STUDY

Based on the literature reviewed, most of the studies found that ICTs has a significant impact on the academic improvement of students over the conventional approach (Andreou, Riga, & Papayiannis, 2016; Jena, 2015; Riga & Andreou, 2018; Stern *et al.*, 2016). A question arises whether the animated cartoon is significant compared to the conventional approach to students' learning performance with ADHD. In the last four decades, various commissions have emphasized on joyful learning. In support of these ideologies, the National Curriculum Framework (NCF) 2005, and New Education Policy 2019 were highly emphasized on learning by the activity-based approach incorporated with ICT. Yet, no policy has especially been developed for students with ADHD. The researcher is trying to share the study findings through different policy decisions; those can be reflected in curriculum and instruction. Moreover, the Government of India approved to establish ICT or technology-enabled classroom in government schools, and cartoon based instruction can be implemented only with ICT. So, the policymaker, curriculum framer, and stakeholders should keep keen attention to develop e-contents in support of cartoons in Environmental Studies. Besides, different orientation programs, conferences, workshops, etc. should be organized at the primary and secondary level to train the teachers on how to operate cartoon based instruction and how to develop cartoon based e-contents. The authors examined the effectiveness of cartoon based e-contents on students with ADHD in Environmental Studies at the elementary level in Silchar, Assam.

### RESEARCH QUESTION

In this study, we compared the effect of animated and gag cartoon-based e-contents intervention on the experimental group's learning performance with those in the comparison group in Silchar town, Assam. There are contradictive results about the effects of simulations on students' conceptual understanding and inquiry skills. Although some of them (e.g., Al-Rabaani & Al-AAmri, 2017; Christina, *et al.*, 2004; DuPaul & Weyandt, 2006) found that animated and gag cartoon based e-contents intervention provided a significant impact on knowledge and inquiry acquisition. Some others reached and found that the traditional approach gave better outcomes than animated and gag cartoon based e-contents intervention simulation-based instruction (Loe & Feldman, 2007). Most of these studies claim that the effectiveness of animated and gag cartoon based e-contents intervention in science education depends on the topic taught by the animated and gag cartoon based e-contents intervention, the learners, and the science teachers. In the current study, we used the same animated and gag cartoon based e-contents intervention to teach the Environmental lessons for elementary school to the students with ADHD backgrounds in the practical classes. In this way, we tried to investigate the animated and gag cartoon based e-contents intervention over the conventional approaches. The following research questions were investigated in the study:

- Whether the cartoon-based e-contents intervention is effective for students with ADHD on their learning performance in Environmental Studies belonging to Assam's elementary schools?

### OBJECTIVE

To assess the effect of animated and gag cartoon-based e-contents intervention on the experimental group's learning performance with those in the comparison group in Silchar town, Assam.

### HYPOTHESIS

Animated and gag cartoon-based e-contents training students with ADHD in association with those in the comparison group, will demonstrate better in their Environmental Science learning performance.

### METHODOLOGY

#### *Participants*

The study examined the effect of cartoon-based e-contents on the learning performance of students with ADHD. For that purpose, the authors selected three English medium schools affiliated to CBSE and the students with ADHD of Class V in Silchar town, Assam, India. The study participants were 90 students with ADHD who were assigned to two experimental groups and a comparison group. The experimental group I (n=30, age ranged

10.5-11.5 SD= 11) was exposed to animated cartoon based e-contents instruction, and experimental group II (n=30, age ranged 10.5-11.5 SD= 11) was assigned to gag cartoon based e-contents in Environmental studies. Simultaneously, the conventional approach was used in the comparison group (n=30, age ranged 10.5-11.5 SD= 11).

*Design of the study*

We used a quasi-experimental design while all the participants of three groups were assigned to the pretest. After a four-month intervention with cartoon-based e-contents, participants were again assigned to posttest. Animated cartoon based e-content intervention was exposed to the experimental group I (n=30) and experimental group II (n=30) who were treated with gag cartoon based e-contents but a conventional discussion approach was assigned to the comparison group (n=30). Moreover, for minimizing extraneous variables, equivalent group design, and statistical technique (ANCOVA) was used.

**Instrumentations**

1) *ADHD Diagnostic Teacher’s Rating Scale*

By following the guidelines of the Diagnostic Statistical Manual of Mental Disorder-5 (2013) of APA, the researchers developed an ADHD diagnostic teacher rating scale to recognize the symptoms of ADHD among students. The scale comprised 18 statements (having 0-3 score) consisting of four options, namely Never, Occasionally, Often, and Very Often. The scale was categorised into three core subtypes of ADHD i.e. predominantly inattentive presentation included 1-9 statements, predominantly inattentive/hyperactivity presentation included 10-18 statements and the combined presentation included the statements from both mentioned subtypes. The test-retest reliability and Cronbach’s Alpha of *ADHD Diagnostic Teacher’s Rating Scale* were .99 and .98. It took maximum of 20 minutes to respond to the complete statements of the rating scale.

2) *Achievement Test in Environmental Studies*

An achievement test in Environmental Studies for class V affiliated to CBSE schools was developed by following the standard guideline of test construction. After discussing with the school administration, the contents were selected, and accordingly, the blueprint was prepared with proper domain and weightage to the test items (see box1). Fifty multiple-choice items having four options were prepared to examine students’ learning performance with ADHD in Environmental Studies. The content validity ratio of the Achievement Test in Environmental Studies was (.81). Simultaneously, the test-retest reliability and Cronbach’s Alpha was .88 and .87 respectively was estimated, and a maximum of 15-17 minutes required to respond to the whole items.

Box-1 contents of Environmental Studies for Class V

Class	Chapter	Name of the chapter	Concepts
V	I	Supersenses	Has this ever happened to you, Why so?, Sound send message, Sloth,
	II	A Snake Charmer’s story	I am Aryanath, Dadaji remember
	III	From Tasting to Digesting	Different tastes, Straight from the heart, Nitu was given a glucose drip, Story-A stomach with a window
	IV	Mangoes Round the Year	Biji returned the bread, Summer treat- Mamidi tandra
	V	Seeds and Seeds	Plants which hunt, Wandering seeds, Who came from where?
	VI	Every Drop Counts	Customs related to water
	VII	Experiments with Water	What float- what sinks? Dead sea, Dandi march
	VIII	A Treat for Mosquitoes	Blood test, Anaemia-What’s that?, Baby mosquitoes
	IX	Up You Go!	Mountaineering camp, A funny incident, A special guest, Camp in the snow
	X	Sunita in Space	Straight from the heart, Talking with Sunita,

## PROCEDURE OF EXPERIMENT AND DATA COLLECTION

We assessed the animated cartoon-based e-contents intervention's effectiveness on students' learning performance with ADHD in Environmental Studies. ADHD Diagnostic Teacher's Rating Scale was applied to select the students with ADHD of Class V of three schools were assigned to experimental groups and comparison groups randomly. After identifying and assigning to the particular group, they were pretested. After six months of intervention, post-tested was assigned to assess the effectiveness of cartoon based e-content intervention over the conventional approach.

### ***Activity I: Animated cartoon based e-contents intervention to students with ADHD***

Before the beginning of lockdown due to COVID-19, ADHD Diagnostic Teacher's Rating Scale was used to identify the participants with ADHD, allocated to the experimental group I for gag cartoon based e-contents intervention. After a few days, lockdown enforced in the country, and the online instruction was provided to the students. Before providing the intervention, the participants were assigned to a short duration of training on the animated cartoon based e-contents intervention for its familiarization (*see supplementary material 1- series of cartoon clips of "Tasting to Digesting"*) through Google meet. Before the actual intervention, the participants were pretested and assessed to know their previous knowledge through an online achievement test. After three months of intervention, a posttest was administered to evaluate their learning performance in Environmental Studies and the effectiveness of animated cartoon based e-content intervention.

### ***Activity II: Gag cartoon based e-contents intervention to students with ADHD***

Before the beginning of lockdown due to COVID-19, ADHD Diagnostic Teacher's Rating Scale was used to select the participants with ADHD who were assigned to school II allocated to experimental group II for animated cartoon based e-contents intervention. After a few days, lockdown enforced in the country, and the online instruction was provided to the students. Before the intervention, a short duration of training on the animated cartoon based e-contents was provided for their familiarization. Before the actual intervention, the participants were online pretested to assess their previous knowledge through an achievement test. According to the course and contents, animated cartoon based e-contents were prepared and visualized with proper feedback. (*see supplementary material II- the cartoon clips*). After the intervention, posttest was administered to assess their learning performance in Environmental Studies and assess the effectiveness of animated cartoon-based e-content intervention.

### ***Activity III: Conventional discussion approach to the students with ADHD***

Similar to two experimental groups, ADHD Diagnostic Teacher's Rating Scale *also used* to identify the students with ADHD of Class V in school III and assigned to the comparison group. The traditional intervention was provided to students for four months to teach the contents prescribed in the syllabus and the textbook of class V. Before instruction, pretest, and after instruction, posttest was administered to assess the learning performance in Environmental Studies.

## ANALYSIS AND RESULTS

We assumed earlier that animated and gag cartoon-based e-contents training students with ADHD will demonstrate better in their Environmental Science learning performance over the comparison group.

*H1: Animated and gag cartoon-based e-contents training students with ADHD, in association with those in the comparison group, will demonstrate better in their Environmental Science learning performance.*

Table 1 descriptive statistics of experimental group I, II and comparison group

Group	Intervention	N		Pretest	Posttest
Experimental Group I	Animated cartoon based e-contents intervention	30	Mean	9.60	37.03
			SD	1.276	2.553
Experimental Group II	Gag cartoon based e-contents intervention	30	Mean	9.77	28.53
			SD	1.251	5.002
Comparison Group	No cartoon based intervention	30	Mean	9.70	21.47
			SD	1.179	1.349

Table 1 reveals the estimate of animated cartoon based e-contents intervention; gag cartoon based e-content intervention with the comparison group of participants. The pretest means and SD of Animated cartoon based e-contents intervention and Gag cartoon based e-content intervention groups, and comparison group participants was  $9.60 \pm 1.276$ ,  $9.77 \pm 1.251$ , and  $9.70 \pm 1.179$ , respectively. The average post-test performance of the participants of animated cartoon based e-contents intervention group was (mean= 37.03 & SD = 2.553) while Gag cartoon based e-content intervention group was (mean=28.53 & SD=5.002). However, the posttest learning performance of the comparison group (mean= 21.47 & SD= 1.349) was lower than both animated cartoon based e-contents intervention and gag cartoon based e-content intervention group.

Figure 3 Histogram of pretest posttest score of experimental group I, II and comparison group

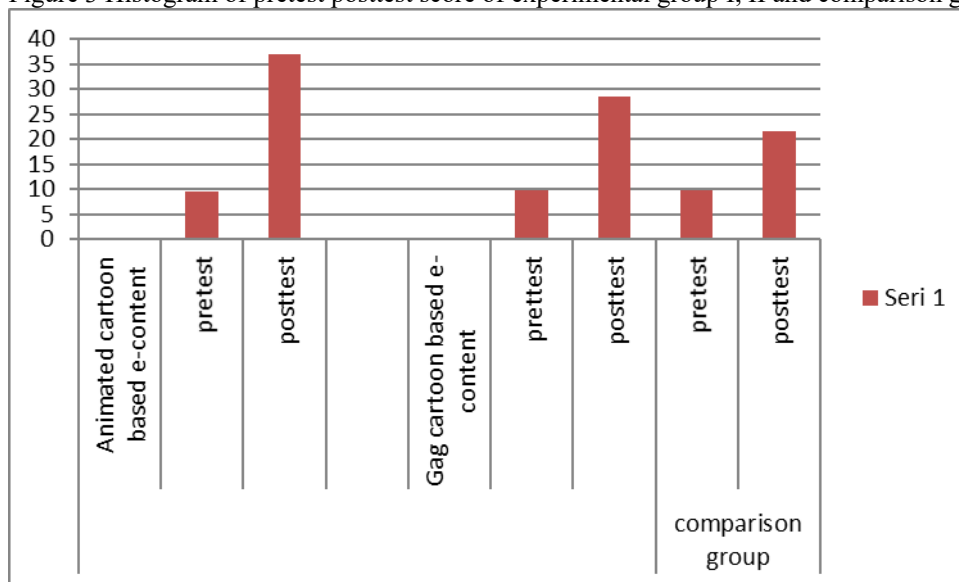


Figure 3 interprets the mean of pretest, posttest score of animated cartoon based e-contents, and gag cartoon based e-content intervention over the comparison group. It was shown that the distribution in the histogram on the same ordinate axis, the posttest scores of animated cartoon based e-contents and Gag cartoon based e-content intervention was higher than the conventional approach of teaching. Y-axis represents the mean posttest score of animated cartoon-based e-contents intervention group, gag cartoon-based e-content intervention, and the comparison group (37.03, 28.53 & 21.47).

Table 2 Univariate factorial ANCOVA for Dependent Variable: posttest score and covariate: pretest score

Source	Type III Sums of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4206.237	5	841.247	70.197	.000	.807
Intercept	1349.505	1	1349.505	112.608	.000	.573
Group	.000	0	.	.	.	.000
Intervention	.000	0	.	.	.	.000
pretest score	9.320	1	9.320	.778	.380	.009
Group * Intervention * pretest score	11.645	2	5.822	.486	.617	.011
Error	1006.663	84	11.984			
Total	79001.000	90				
Corrected Total	5212.900	89				

Table 2 reveals the effects of animated cartoon based e-content intervention and Gag cartoon based e-content intervention over the comparison group. The ANCOVA results reported through univariate analysis tests found a significant impact of the animated cartoon-based e-content intervention and gag cartoon-based e-content intervention on participants' learning performance over the comparison group. The ANCOVA results of the pretest score of three groups was not significant [ $F(2, 89) = .778.111, p > .000$ ], while the learning performance in posttest among the participants of three groups was significant [ $F(2, 127) = 35.005, p = .000$ ]. The partial Eta Squared value indicated that the effects of animated cartoon based e-content intervention and Gag cartoon based e-content intervention over the comparison group is high (0.807). Hence, the alternative hypothesis was accepted. Animated and gag cartoon-based e-content training students with ADHD, in association with those in the comparison group demonstrated better in their Environmental Science learning performance.

Table 3 scheffe test post hoc tests

(I) Intervention	(J) Intervention	Mean Difference (I-J)	SDError	Sig.
Animated cartoon based e-content intervention	Gag cartoon based e-content intervention	8.422	.896	.000
	No cartoon based intervention	16.648	.895	.000
Gag cartoon based e-content intervention	Animated cartoon based e-content intervention	-8.422	.896	.000
	No cartoon based intervention	8.226	.895	.000
	Animated cartoon based e-content intervention	-16.648	.895	.000
No cartoon based intervention	Gag cartoon based e-content intervention	-8.226	.895	.000

Table 3 indicated that the number of errors was significantly higher in the animated cartoon based e-content intervention condition ( $M = 8.422, SDE_{Error} = .896$ ) over gag cartoon based e-content intervention than in the other two learning conditions (animated cartoon based e-content intervention and comparison group) combined ( $M = 16.648, SD_{Error} = .895$ ). The average number of errors was significantly higher in animated cartoon based e-content intervention vs. gag cartoon based e-content intervention. However, the number of errors was significantly similar in gag cartoon based e-content intervention vs. animated cartoon based e-content intervention, and comparison group performance ( $M = 16.648$  &  $SD_{Error} = .895, p = .000$ ) indicated significant.

Table 4 Univariate test where posttest is the dependent variable

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	4146.615	2	2073.308	173.005	.000	.805
Error	1006.663	84	11.984			

Table 4 shows the univariate test, where posttest is the dependent variable. The F test [ $F(2, 84) = 173.005, p = .000$ ] was significant (see table 4). However, the partial Eta squared value indicated that the effects of animated cartoon based e-content intervention and gag cartoon based e-content intervention over the comparison group was high (0.805).

Table 5 Levene's posttest of equality of error variances of the dependent variable

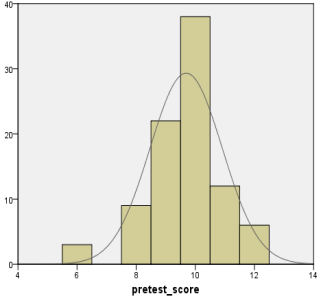
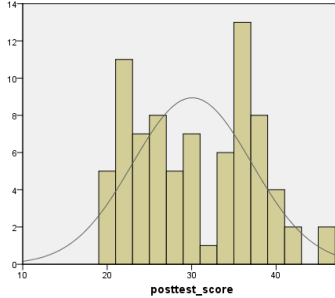
F	df	df2	Sig.	Pretest score	Posttest score
	1				
.664	5	84	.651		
As $p > 0.05$ , equal variances can be				The residuals are normally distributed	

Table 5 showed Levene's posttest when the pretest of animated cartoon based e-contents intervention and gag cartoon based e-content intervention was significant over the comparison group was included in the model as a covariate. Levene's test resulted in  $.665 > .651$  was not significant, indicating that the group variances were equal, and the homogeneity of variance was found.

Table 6 Estimated marginal means of posttest score

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental Group I	36.979	.634	35.719	38.239
Experimental Group II	28.558	.633	27.298	29.817
Comparison Group	20.332	.632	19.075	21.589

Table 6 shows the adjusted means (i.e., controlling for the covariate 'posttest') for each group. This simply means that the effect of 'intervention' has been statistically removed. From these adjusted means, it is clear that experimental group 1 was best after adjusting with covariate of pretest. Table 5 shows that Levene's test showed homogeneity compared with the estimated marginal means in table 6. It showed that the lowest score was achieved by the comparison group (20.332) compared to Experimental group I and II (mean=36.979, 28.558, respectively).

**DISCUSSION**

The study was initiated to conduct in the Silchar town of Assam before the lockdown era of COVID-19 and during the restriction of COVID-19, schools were closed and students and parents were banned to entry into the campus. During this period, students with ADHD were identified by following the ethical and medical guidelines. It was positive for us that our study involved with online learning. So we continued experiment through online platforms, collected data, prepared report and submitted to this journal. We claimed there was a significant effect of the animated cartoon-based e-contents intervention and gag cartoon-based e-content on participants' performance in environmental Science over the traditional approach. The study area was restricted to Silchar Town, Assam, where Class V of elementary schools were affiliated to CBSE was selected for the experiment. We provided cartoon based e-contents and assessed its effectiveness in the teaching and learning process at elementary levels. In this context, for conducting the experiment, the researchers randomly assigned cartoon based e-contents intervention to experimental groups and convention discussion method to Class V students of elementary schools in Silchar Town. In this lockdown area of COVID-19 phenomena, it was found that the impact of animated and gag cartoon based e-contents intervention has a significant role in promoting the learning performance of students with ADHD in Environmental Studies at elementary levels. This was the first study in Northeast India teachers using e-contents especially, both animated and gag cartoon based e-contents in Environmental Studies for the students with ADHD at elementary schools. However, the study's findings were supported with a few earlier researchers (Arunraj & Blessy, 2015; Andreou, Riga, & Papayiannis, 2016; DuPaul,



Stoner, O'Reilly, 2008; Muthuchamy & Arunraj, 2013; Srinivasalu, 2016). However, the schools in Silchar town, Assam, India, by not wholly technology supported. Therefore, the researcher undertook the study and applied animated and gag cartoon-based e-contents instruction on the internet or online platform by taking consent from these schools' concerned authorities. After four months of instruction through gag and animated cartoon based e-contents instruction, the learning performance of students with ADHD was found much better than the conventional approach. After assessing their retention capacity of six months, various extraneous variables viz. memory, history, maturation, mortality, etc. were minimized using statistical analysis. Cartoon based animated model can improve the standard of education (Al-Rabaani & Al-AAmri, 2017; Ross, 2012; Govindaraj, 2012; Mtebe & Twaakyondo, 2012; Rohendi, 2012). However, based on the present study's findings, we can say that the application of animated cartoon in Environmental Studies lessons has significantly improved students' learning performance with ADHD over the gag cartoon-based e-contents instruction and conventional approach. As a result, cartoon helps create an active learning environment as soon as these students start to look at the images and learn from there. Moreover, it is observed that there was a significant change in conversation or interaction of these students with their peers and teachers, which was quite improved than earlier.

## CONCLUSION

The use of cartoon in the educational field during the COVID-19 pandemic has a greater significance at the infancy stage. For upgrading the distance mood of learning in extreme situations, cartoon-based e-contents can be applicable to formal learning during the vacation or in lockdown situations in elementary schools. A lot of schools affiliated to CBSE board in India, especially in Assam has adopted ICT tools in the teaching-learning process during the lockdown era of COVID-19 and therefore, research carried out to assess the effectiveness of cartoon among students with ADHD at the elementary level. In this present COVID-19 phenomena, the cartoon based e-contents instruction strengthens the performance of learning in Environmental Studies among students with ADHD irrespective of their gender, personality, intelligence, socioeconomic status, etc. This cartoon instruction helps the teacher make them competent concerning the content and pedagogical approach required for Environmental Studies. This will help the teachers to improve the quality of teaching and useful learning condition at this level. However, it is also revealed that various stakeholders favored using cartoon for elementary school children with ADHD despite having some disadvantages viz. developing cartoon-based e-content and teacher expertise in using these e-contents. Besides the above findings, it was recommended that appropriate application is mandatory since the proper use of cartoons can further the inclusion of the students with ADHD in innovative educational environments. In this way, both the teachers and students will benefit from developing their content knowledge and having a clear concept about the subject matter. The current study's findings provide awareness to the teachers, parents, and guardians of students with ADHD.

The educational implications of the study are as follows:

- 1) The study's findings reveal that the cartoon-based e-contents instruction may prove useful but not the panacea for students with ADHD.
- 2) Teachers may download the cartoon and animation videos from YouTube for the teaching-learning process.
- 3) The study's findings may be used to develop the tendency of practices, trial, and error habits in ADHD students.
- 4) The study's outcome showed that cartoon-based e-contents instruction might improve these students' cognitive processes.
- 5) The study's result revealed that the cartoon and animated based e-contents might be useful in making teachers aware of considering them as an effective teaching-learning material.
- 6) Various educational institutions may be created such type of cartoon and animated videos and upload on various web portals for users. These videos are helpful as a teaching-learning material to improve the performance of these students.

However, the following are the recommendations put forwarded by the researchers.

- 1) The present study investigated the effect of the cartoon-based e-content intervention on students' learning performance with ADHD. Still, it needs further research on how cartoon-based instruction influences cognitive development, social skills, problem-solving skills, anxiety, etc. of students with ADHD.
- 2) It requires further study of how cartoon applies to upper primary and secondary level.
- 3) It needs to investigate the effect of cartoon-based e-content on the learner's attention, memory, impulsive, and hyperactivity behavior of the students.
- 4) It requires investigating the impact of cartoon based e-content on the learning performance of non-ADHD students.

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**Supplementary material I**

Fig1- series of cartoon clips of “Tasting to Digesting”



**Supplementary material II**

Fig 2 series of cartoon clips of Super senses A Snake Charmer's story From Tasting to Digesting Mangoes Round the Year Seeds and Seeds Every Drop Counts Experiments with Water and A Treat for Mosquitoes

