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LINEAR DESIGN VS. BRANCHED DESIGN OF DIGITAL STORYTELLING IN A WEB BASED DISTANCE LEARNING COURSE: DOES IT HAVE EFFECTS ON STUDENTS' KNOWLEDGE ACQUISITION AND CREATIVITY THINKING SKILLS?

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The current research aims at investigating the comparative effect of two types of Digital storytelling design: Linear Vs. Branched of sequencing events/episodes on knowledge acquisition (KA) and creative thinking skills (CTS) in web based distance learning. The problem statement was that a deficiency in students' performance was noticed in "Computer in Instruction" Course at Al-Aqsa University, and a need for discovering the effect of two designs of Digital Storytelling (DS) on KA and CTS. The developmental research methodology and a two experimental groups design with Pre-Post Tests were selected and a sample of (30) students divided randomly in two groups of 15 each. So, the researchers developed: design standards of DS, a list of CTS, and two validated versions of DS (Linear and Branched) using Elgazzar (2002) ISD model, two approved research tools (KA and CTS). Experimentation was carried out by the first author at distance during the first semester of 2011–2012. The pre – post tests of KA and CTS were administered. Pre, post, and gain scores were considered in testing five research hypotheses. Statistical procedures include descriptive, t-tests, and One-Way ANCOVA. Results have revealed that both Branched DST design and Linear DST design are found to be effective in developing KA and CTS. Linear DST design is found to be superior to Branched DS in gain scores of (KA), while there are no significant differences found in gain scores of CTS, post-test of CTS, and post-test of KA. In conclusion, the answer to the main question is that an effect is found only on gain scores of KA favouring the linear DST design over the Branched Design of DST, and no such comparative effects found on the other variables of KA and CTS in a web based Distance Learning course.

Keywords: Digital storytelling design, Developmental research, elgazzar ISD Model, web-based distance learning course, Knowledge acquisition, Creative thinking skills.

Introduction

Digital storytelling (DST) is considered as one of the innovative developments in e-learning technology and distance learning today. Storytelling is around for many years, either in its earlier formats or in its digital formats, and considerable number of researchers have documented its effectiveness. However, there is a need for further research on its design variables, learning outcomes, different learners, and delivery systems. There is a fact that children as well as adults enjoy storytelling in their interactions and communications. We all know that this tendency and potential of ST start as early as we can remember our mothers' stories in childhood. As a view, these massive concerns and findings that support the effectiveness of DST in e-learning are interpreted, may be, there is a mental storytelling (ST) function in our human cognition that works in performing our daily activities, see Figure 9. That is, Individuals may operate several internal mental storytelling (ST) functions in order to perform these actions. That is, in theory, while a person makes decisions, designs, meta-cognitions, evaluations, mange business, solve problems, planning for something, etc., he/she is actually experiencing internal mental storytelling (ST) functions of many procedures of "how to or what if" for all these activities. As a result of that mental ST function, human learning outcomes are enhanced if there is a match between the design of the delivery system as DST and human internal cognition functions, while any mismatch between them may result in inactiveness of this potential inside learners' cognition and results in low learning outcomes – let us call it "Match Theory". We think that developing of KA and CTS may depend on such internal STs since the delivery system is digital storytelling (DST), i.e., there is a match. So, it is important to find out if there is a casual of learning through DST on KA and CTS. Consequently, one should ask: what is going to happen to learner's cognitive performance of KA and CTS if the delivery system in his e-learning environment is DST?. This research aims at discovering possible effects of utilizing two types of designing DST in knowledge acquisition (KA) and creative thinking skills in a distant web-based eCourse.

Digital storytelling (DST) came to existence since the late 80s of the last century by Joe Lambert and late Dana Atchley when they established the Center of Digital Storytelling a non-profit, community arts organization in Berkeley, California, USA (Rubin, 2008, 222; Norman, 2011, 2). Since then, many developments have taken place in the technology and applications of DST from single medium on PCs, multimedia on PCs, to multimedia on the Web, to multimedia on virtual learning environments. Interactions between DST and learners has been also changed from merely receiving or listening to full control to learners on its sequence of events/episodes through interactive linear and interactive branching designs of DST. So, interactivity is the most important feature of DST design for enhancing active learning from DST as a delivery system of learning and instruction. In learning, based on scholars (Salmons, 2006; Norman, 2011), DST is basically an e-learning system or a learning environment based on the interaction of learners with appropriate digital resources such as text, pictures, graphics, animation, animated characters, videos, and along with human narrators to convey a story events/episodes to achieve learning objective (or objectives) and learning outcomes to learners. Advances in digital resources and software of developing DST have made it easy to develop DST, but still the major part relay on its design for various types of learners and learning outcomes. So, in view, DST design continue to call for research on its design variables for various types of learning and learners. This research is an attempt in this track to discover the effects of two design of DST, namely, interactive linear design and interactive branched design on both KA and CTS.

Linear DST Design Vs. Branched DST Design:

It is worth mentioned here that Phelps (2004) has discovered seven shapes of digital storytelling that writers of digital media ST have used in publishing their stories. She conducted structural analyses of

various CD-ROMS and hyper-fiction websites. She considers these seven digital story shapes as possible path structures stories can take within digital media. These shapes are Linear, Interactive Linear, Multi-Linear, Braided Multi-Linear, Nested Funnel, Tree-Branching, and Non-Linear. Based on those seven story shapes, two modified shapes are the main concern of this current research to fit the academic context: the first is the interactive Linear DST and the other is the interactive Branched DST. Basically, these two DST designs are mentioned elsewhere as design variables. The interaction in these two designs are close to Puentedura (2008) interactions in his five stage model of integrating digital media and storytelling. Puentedura asked a very strong question expressing the need of finding alternative approaches to the construction of the storytelling that could match different storytelling goals, especially in the academic arena. In the same concern, Puentedura raised another question about ways of breaking storytelling into chunks to insert interactions and how these narrative chunks be assembled into multiple coherent narrative. In this research, an attempt to answer Puentedura's questions about chunking and assembling storytelling in academic context of eLearning. Actually, in designing interactive Linear DST design and interactive Branched DST design with same content but different sequencing (linear Vs. Branching) was the most challenging issue!.

This issue was solved here by the following rules:

(1) The course or unit of instruction should be analysed into main objectives (MOs) and each MO should be analyzed into sub-objectives (SOBs). The course or unit in turn restructured in modules (Ms) for MOs.
(2) Chunking should be based on sub-objectives (SOBs), each SOB should have an episode (EP) of DST, and each EP ends with inserted interactive activity/activities (IACT). So, each chunk is a triple (EP, SOB, IACT).
(3) Linear DST design of the course or unit has Modules (Ms) and MOBs and in turn each Module M has fixed logical order of chunks of the triples (SOB, EP, IACT). So, Interactive Linear DST design is a fixed sequence of chunks (SOB, EP, IACT) as in Figure (1).
(4) Branched DST design of the course or unit has Modules (Ms) and MOBs and in turn each Module M has chunks of the triple (EP, SOB, IACT) that are sequenced by learners under their choice. So, Interactive Branched DST design is a learner's choice based sequence of chunks (SOB, EP, IACT) as in Figure (2).
(5) This process continues until all Course or Unit modules completed.

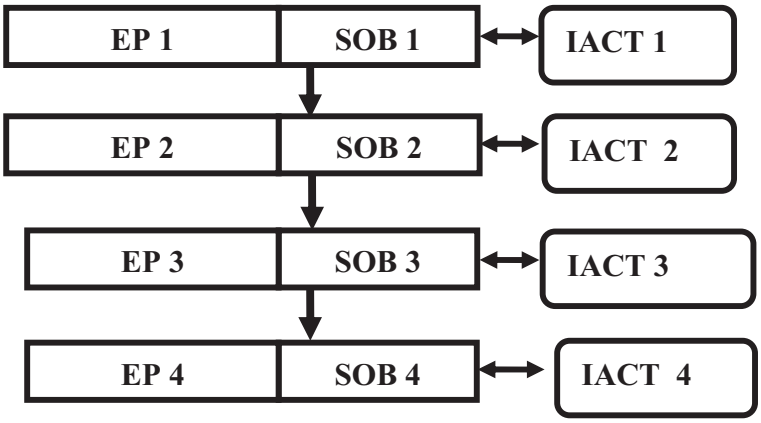

Figure 1. Flowchart and Layout of Linear DST Design.

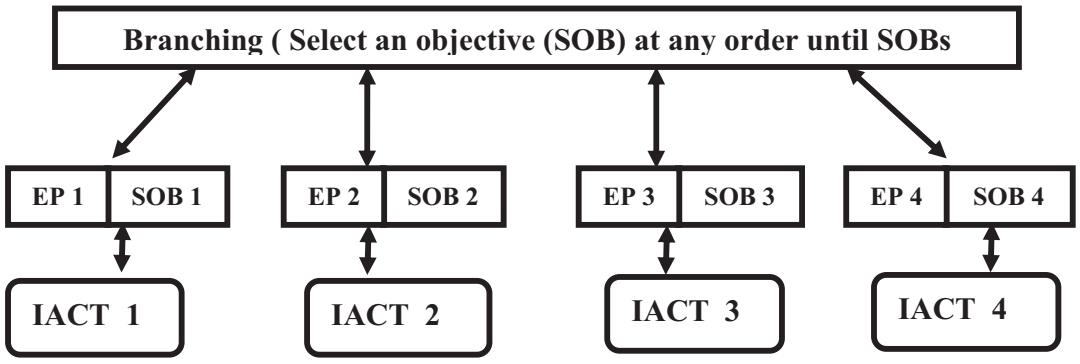

Figure 2. Flowchart and Layout of Branched DST Design.

Literature Review

Norman (2011,1) makes a point that digital storytelling is a process of using digital multimedia technologies for authoring DST and sharing stories without mentioning its classification according media. While Ohler (2005) points out classifications of DST based on its content presentation and narration into three forms: audio, visual, and written forms. Phelps (2004) presents seven shapes of digital storytelling: Linear, Interactive Linear, Multi-Linear , Braided Multi-Linear, Nested Funnel, Tree-Branching, and Non-Linear. In addition to educational use of storytelling. There are many areas of using digital storytelling as presented by McLellan (2006) to include: personal stories, digital story archives, memorial stories, vocational stories, digital storytelling of medicine and health. Digital storytelling can be considered, as mentioned earlier, as a source of excitement in learning, as it contains a variety of media that make the mind of learners alert and active to the end of the course of the learning process. Digital storytelling (DST) enriches learners' imagination and develop their abilities for creation and innovation and provide them with pleasure and benefits at the same time. Rubin (2006) mentions that teachers created DSTs may also use them as a method of understanding the impractical and abstract content. Several studies (Norman, 2011; Xu et al., 2011; Barret, 2006; Mosa and Salama, 2004; Al-Zahrani, 2008; Sadik, 2008; figg and Mccartney, 2010; Wang and Zhan, 2010; and Yuksel et al., 2010) have recommended the use of digital storytelling in different areas of education. The course “Computer in Instruction” that is taught within the program of preparing Ed. Tech. Students, Faculty of Education, at Al-Aqsa University contains units that can be characterized as being impractical, historical, and abstract. So, students consider it less interesting and boring, consequently, their scores aren’t as good as compared to their performance in other practical courses. Since Digital storytelling is an example of technology that offers richer learning environment, constructive learning experiences, active learning, more creative, and exciting learning experience for learners could help these students not only in knowledge acquisition but also developing creative thinking skills. In the other, DST lets Ed Tech students experience learning from a technology based environment, that improves their professional development. More details on defining research problem and formulating research questions are presented in the following paragraphs.

Research Problem and Questions

The research problem can be stated that there is weaknesses among the student teachers of the Faculty of Education at Al Aqsa University in the course "computer in Instruction" in their performance; this raised a need to implement distance learning through DST in two designs (Linear vs. Branched) and to discover their comparative effects on both knowledge acquisition KA and creative thinking skills CTS. So, the main question was proposed to be answered: Are there effects between Linear DST and Branched DST on developing both: knowledge acquisition KA and CTS among students of educational technology?

This main question was analyzed into the following sub-questions:

1. What digital storytelling DST design standards for web-based distance learning to knowledge acquisition KA and creative thinking skills CTS?
2. What are the two digital storytelling (Linear, Branched) web-based distance e-learning to develop knowledge acquisition KA and creative thinking skills CTS using Elgazzar ISD model (2002) according those standards?
3. What are the effects of DST design (linear, branched) on both: knowledge acquisition KA and creative thinking skills CTS?
4. What are the effects of the Linear DST design on both: knowledge acquisition KA and creative thinking skills CTS?
5. What are the effects of the Branched DST design on both: knowledge acquisition KA and creative thinking skills CTS?

Research Hypotheses

Researchers formulated five main hypotheses:

(1) There are significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in posttest scores of KA and CTS for the branched DST design.
(2) There are significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in posttest scores of KA and CTS for the branched DST design when controlling the pretest scores.
(3) There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST and branched DST in gain-scores of KA and CTS for the branched DST design.
(4) There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST pre-posttest of KA and CTS for the posttest.
(5) There are significant differences at level ($\alpha \leq 0.05$) between the two means of the branched DST pre-posttest scores of KA and CTS for the posttest.

Research Methodology

The Developmental Research Methodology (AECT, 1994; Seels & Richey, 1994; Richey, Klein, & Nelson, 2004; Richey, & Klein, 2005; Elgazzar, 2002, 2010, 2012) was used in this research. Within this methodology three different methods were used:

(1) Descriptive research methodology implemented in students' characteristic analysis, course content analysis, resources analysis, and establishing design standards list of the DST designs,
(2) Systems Development Methodology in terms of implementing Elgazzar ISD Model (2002, 2010) in developing the two designs of DST of the web-based distance learning course, and
(3) Experimental research methodology in the research experiment to investigate the comparative effects of the two designs on students' knowledge acquisition AC and critical thinking skills CTS.

Research Delimitations

This research is delimited to:

(1) Students of Ed. Technology major, Faculty of Education, Al-Aqsa University.
(2) Selected course is "Computer in Instruction" and selected topic is "Developments of using computer in instruction".

(3) Implementing Elgazzar ISD model (2002) in phases: Analysis, Design, Production, and Formative evaluation; accepting DST designs according to design standards.

Terminology

The following are some terminology as used in this research:

(1) Digital Storytelling (DST): DST as it is used in academic settings as in this research refers to an e-delivery system of instruction on the Web to learners utilizing digital multimedia and resources that includes texts, pictures, motion pictures, graphics, 2D/3D characters, sounds, and along with human narrators, in a systematic way of presenting events/episodes that cover instructional objectives through a real story or non real story in a certain design of sequencing that involves learners' interactions for active learning to achieve pre stated instructional objective/objectives.
(2) Branched DST Design: In the context of this research, Branched DST design refers to the type of e-delivery system on the Web. that lets learners to select the events/episodes or to select objectives in a non-sequential way of episodes. Each event/episode/objective is followed by a leaner interaction. Then he selects next events/episodes/objective until all event/episode/ objectives learned and DST ends. Operationally, branched DST design refers to the first type of independent variable of the eCourse.
(3) Linear DST Design: In the context of this research, Linear DST design refers to the type of e-delivery system on the Web that lets learners interact with the DST events/episodes/objectives in a sequential way. Each event/episode/objective is followed by a leaner interaction before moving to the next event/episode/objective until DST ends. Operationally, linear DST design refers to the second type of independent variable of the eCourse.
(4) Knowledge Acquisition (KA): KA is used here to refer to learners' achievement of the content delivered to them through DST's factual information, concepts, cognitive skills, and events/episodes. Operationally, KA is measured by the KA test scores and gain scores of KA.
(5) Creative Thinking Skills (CTS): CTS is used here to refer to learners' cognitive actions and responses to situations or questions that are open to multiple answers, problems with expected multiple solutions, expected multiple relations, imaginary solutions, and creating multiple new relations that are covered by the content delivered through DST's . These actions, responses, and answers should be characterized by originality, fluency, flexibility, and elaborations or details. Operationally, CTS is measured by the CTS test scores and gain scores of CTS.

Research Procedures

(1) Content Analysis of "Computer in Instruction" Course

Researchers started with conducting content analysis of this course within the delimitations of this research and following the some requirements of the selected Elgazzar ISD model (2002). The 1st author carried out this part with help from the instructor of this course. An initial analysis of the mentioned Unit on "Developments of using computer in instruction" to find out types of KA and situations of CTS resulted in: (6) topics (modules), (47) instructional needs for sub-objectives, (14) to remembering, (10) to understand, (12) to interpret, (11) to analysis, and (30) to CTS. These analyses were subjected for refereeing from experts. The final most agreed upon analyses became: (6) topics (modules), (40) instructional needs for sub-objectives, (9) to remember, (10) to understand, (10) to interpret, (11) to analysis, and (25) to CTS. So, the first research question was answered and resulted in: (40) types of KA and (25) of CTS.

(2) Developing DST design Standards

Based on extensive literature reviews, eLearning standards, DST designs, the nature of Linear DST design and Branched DST design, analyses of learning content in (1), and phases of Elgazzar ISD Model, the theoretical bases for standards were derived. Based on these theoretical bases, an initial list of DST design standards contained (15) standards and (130) of their indicators were formulated. These standards and their indicators were subjected for refereeing from experts. The final most agreed upon standards and their indicators became (18) standards and (139) of their indicators. So, the second research question has been answered with having standards and indicators that controls the design and production of the two designs of DST thru the ISD Model for those KAs and CTS.

(3) Developing the Branched DST and Linear DST Designs

A very lengthy details of developmental tasks were done on applying Elgazzar ISD Model(2002) in Figure (3) until the two DST designs approved by the list of designing standards. In the analysis phase of this ISD, students academic characteristics and resources were analyzed. So, instructional needs from content analysis for KA and CTS as in (1) , students characteristic, and resources analyses were completed as stated in design standards (2) and ready to enter design phase of the model. In design phase of ISD, steps started with task "Driving instructional objectives ..." and ended with the task "Building Learning/Teaching ..." were carried out for both the DST designs. In the first task "Driving instructional objectives ...", Six main objectives (MOB) and six titles were designed to form six modules for DST. Based on instructional needs of KA and CTS in (1), Four sub-objectives (SOB) were derived from clustered instructional needs to each main objectives (MOB) in the six modules. Six DSTs were designed for the six modules. Each DST in each module were divided into four episodes (EP) for its four sub-objectives (SOB), i.e. four pairs of (EP, SOB) covered in each module. Interactive activities (IACT) were designed to follow each pair of (EP, SOB) to make sure that its sub-objective (SOB) achieved to form a triple of (EP, SOB, IACT). Then, the Linear DST design and the Branched DST design sequences were designed to each module. In the linear DST design, the triples (EP, SOB, IACT) were set in a fixed sequence as in Figure (4).

In the branched DST design, the triples (EP, SOB, IACT) were put in parallel for the learner's choice until all choices completed as in Figure (5). The rest of tasks in the design phase of the ISD model completed. All outputs from this design phase were approved in meeting standards (2) and ready for production phase of the ISD Model.

In production phase, the production task of DST started with " Accessing/Obtaining available media ..." and ended with the task "Program authoring ..." were carried out for both DST design. More production tasks were also done to prepare the VLE of Moodle for both DST designs. Three Communication tools for students with both course's Instructor and 1st author that included: Chatting Rooms, Questioning and Announcements, were designed in the Moodle VLE. Figure (6) is depicting a unified home page for both designs on the Moodle VLE. Figure (7) is depicting Linear DST design (one DST) on right (R) and branched DST design (four DSTs) on left (L). Both DST designs were subjected for refereeing by experts to make suitable improvements to meet design standards (2) for both DST designs on the VLE. As a result of referring, all the most agreed upon modifications from experts were done on the Web on the VLE. The final approved eLearning of DST designs were ready for Evaluation phase as of the ISD model. As stated in the delimitation section of this research, the application of the ISD model ended by the task of formative evaluation for both DST designs. In this formative evaluation, one module from the two designs were applied on (6) female students, (3) for each design. Minor modifications were done on both designs as demanded from students. By then, the two designs Linear DST design and Branched DST design were fully developed through Elgazzar ISD model (2002) and were ready for research experiment as in (7).

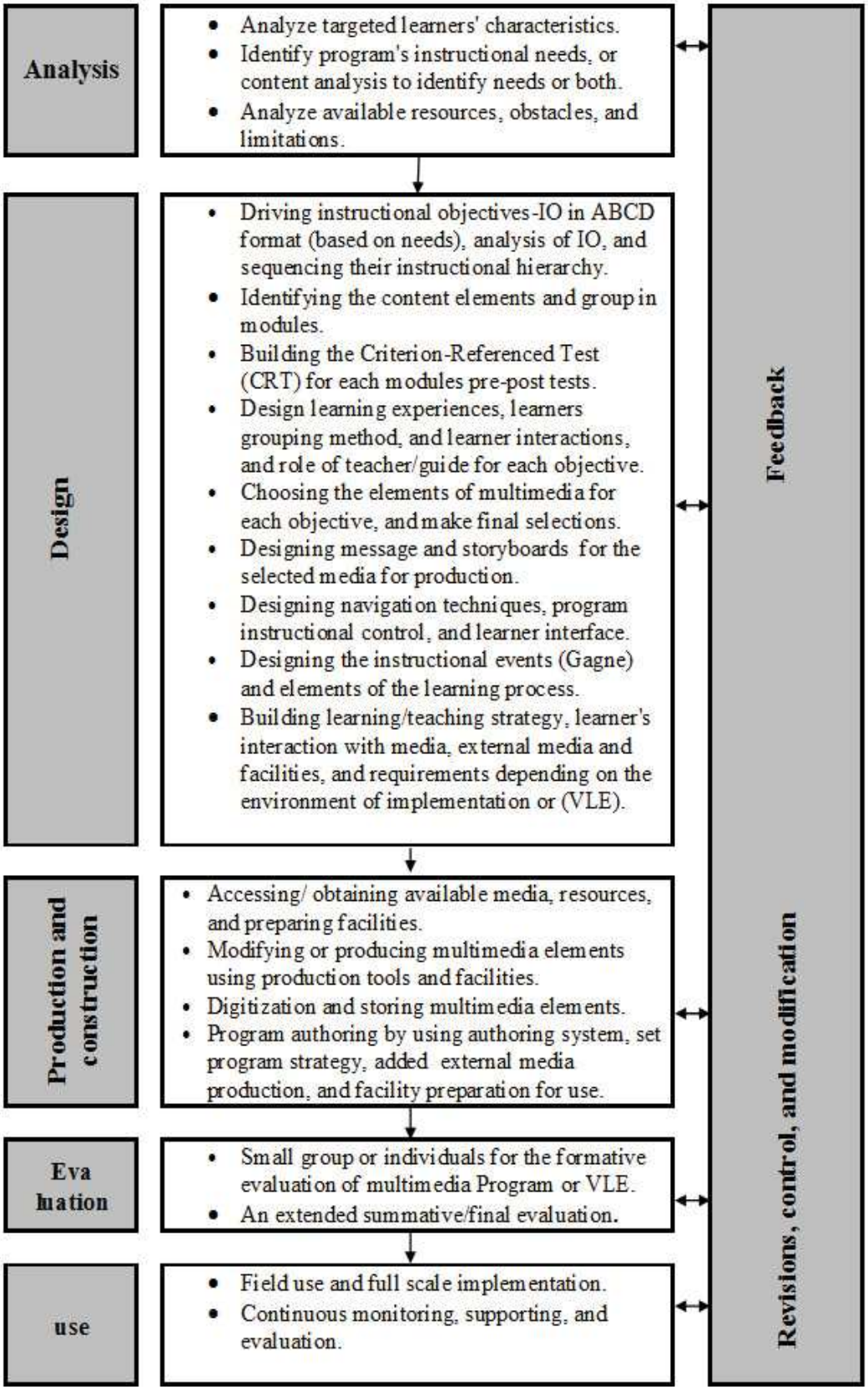

Figure 3. Elgazzar ISD Model (2002) for Multimedia Computer Based Instruction.

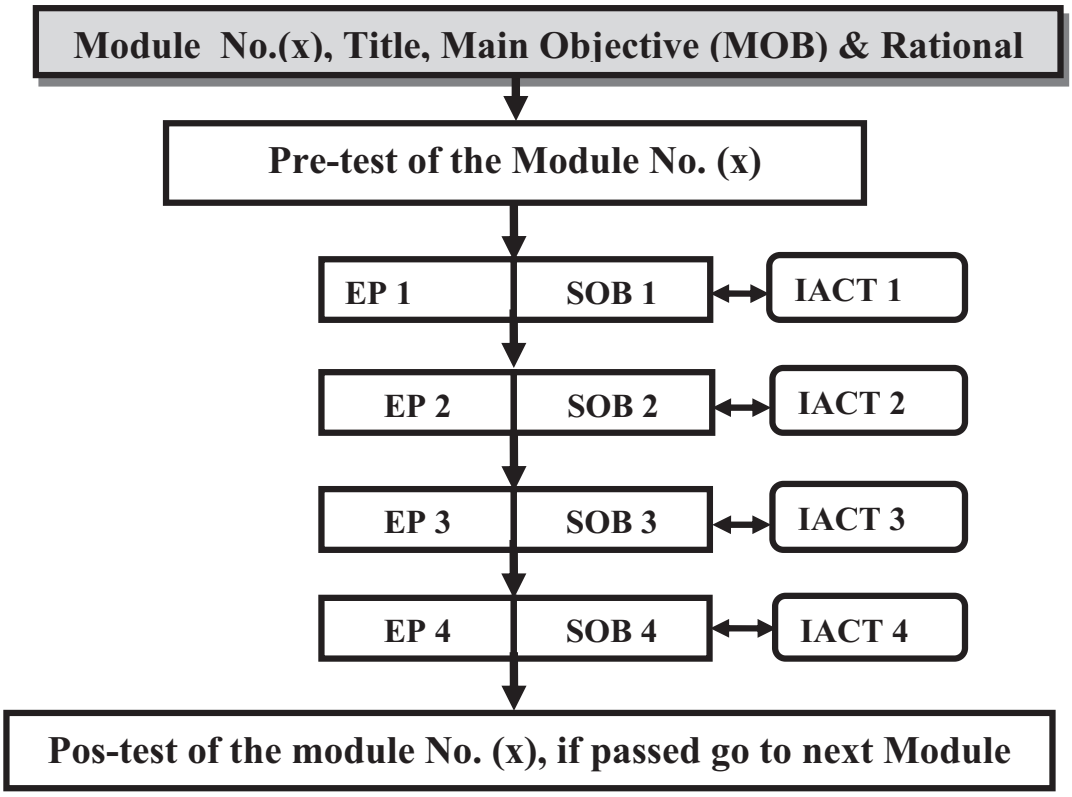

Figure 4. Flowchart and Layout of Linear DST Design for Module No (x).

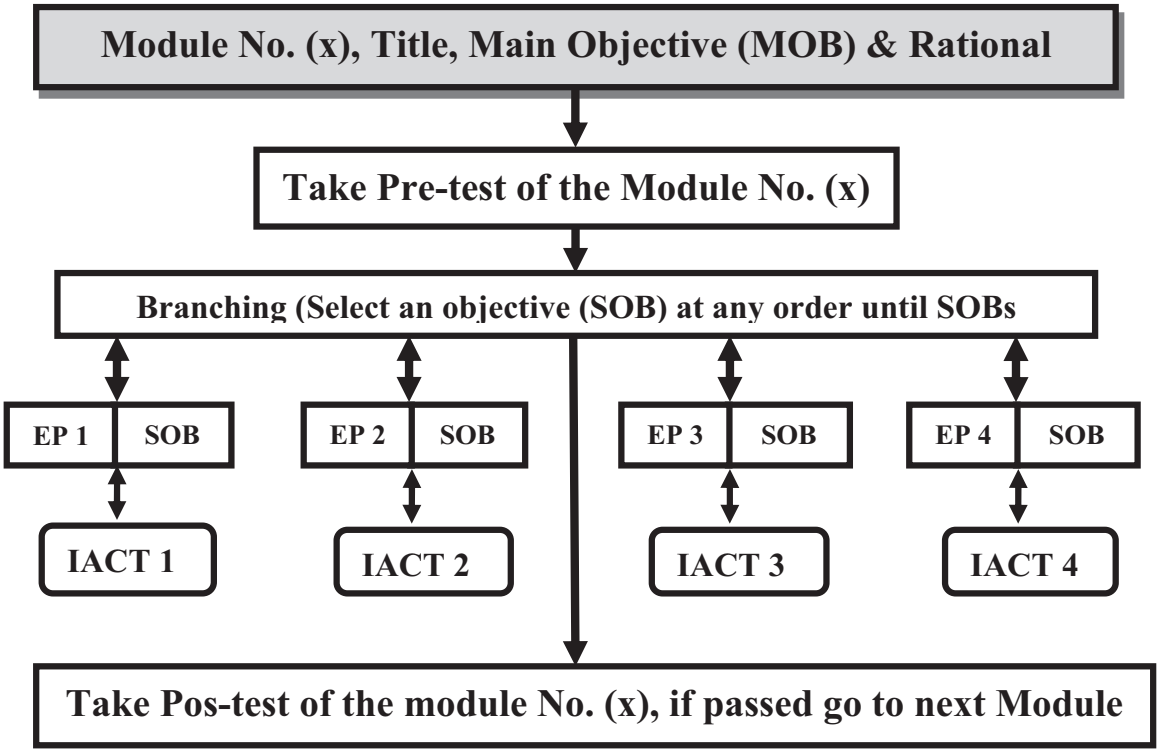

Figure 5. Flowchart and Layout of Branched DST Design for Module No (x).

Figure 6. Unified Home Page for both DST designs on the MOODLE's VLE.

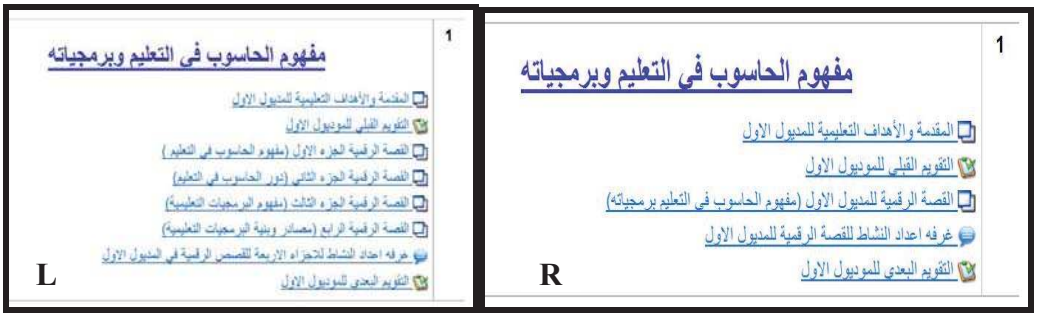

Figure 7. Branched DST (L) and Linear DST (R) on the MOODLE's VLE.

(4) Participants

Participant sample of this research was a purposive sample. It was consisted of (30) of volunteers female students of Educational Technology major of the faculty of Education at Al-Aqsa University. This sample was divided randomly into two groups of (15) students each. The independent t-test was conducted to see if there were differences between means ot both the pretest of KA and CTS as in Table (1). The t-value (2.152) of the two means difference of KA (7.103, 5.717) at df (28) is significant at (0.05) since the computed significance ($0.040 \leq 0.05$), so, the two groups were not equivalent. While the t-value (0.135) of the two means difference of CTS (4.019, 4.082) at df (28) is not significant at (0.05) since the computed significance ($0.894 > 0.05$), so, the two groups are equivalent. However, ANCOVA was considered in testing the difference between the means of posttests of KA and CTS.

Table 1. Independent t-test results of means differences between Linear DST and Branched DST of the pretest scores of KA and CTS.

Group		N	Mean	Standard Deviation	t- value	df	significance
Pretest KA	Branched	15	15.200	7.103	2.152	28	0.040
	Linear	15	10.133	5.717			
Pretest CTS	Branched	15	4.019	0.908	0.135	28	0.894
	Linear	15	4.082	1.556			

(5) Experimental Design

The two experimental group with pretest – posttest Quasi-Experimental Design was used without control group. So, pretests and posttests of both KA and CTS wre implemented as shown in Figure (8) of the experimental design.

Groups (G)	N	Pretest (O)	Treatment (X)	Posttest (O)
Experimental Group(1)	15	Pretest of: KA and CTS	Branched DST Design	Posttest of: KA and CTS
Experimental Group(2)	15		Linear DST Design	

Figure 8. The two Group Qusi-Experimental Design.

(6) Research Tools

Researchers developed two research tools:

(1) *Knowledge Acquisition (KA) Test*: The goal of this test was to measure student's achievement of types of knowledge of the course (Computer in Instruction), that consists of information, concepts, procedural knowledge, decisions, and facts, as resulted from course content analysis in (1). The initial form of the KA test was consisted of (47) items in the form of multiple choice (MCQ) of one mark for correct answer. These items were adjusted in terms of table of specifications. Its validity was done by specialists in the field of educational technology and the KA test was modified according to their notes and the final form consisted of (40) MCQ items. Then the KA test was then put on the virtual learning environment (VLE) of MOODLE on the website http://www.digitalstory.ps. The reliability of KA test was carried out on its posttest data. Cronbach's Alpha (α) coefficient of KA pottest data. The calculated value of Alpha ($\alpha = 0.849$) has confirmed the KA reliability. So, it is shown that the KA is valid and reliable test for the purpose of this research.

(2) *Creative Thinking Skills (CTS) Test*: The CTS test was developed to measure students' skills in the four components of creativity: Fluency, Flexibility, Originality, and Elaborations or details to fit the course's situations of Computer in Instruction and Ed. Technology field. So, the initial items of CTS test were similar to those of Torrance Verbal Form that was Arabized (Egyptian Edition) by A. Soliman and F. Abu-Hatab (1992). The initial CTS test was consisted of eight (8) main questions that had sub open ended (26) items. These items were specified to be: open to multiple answers, problems with expected multiple solutions, expected multiple relations, imaginary solutions, creating multiple new relations, and etc.. Four rubrics of scoring: fluency, Flexibility, originality, and elaborations (details) were added to the initial form of the CTS test. After some peer revisions, this initial CTS form along with the four rubrics were subjected to validations by refereeing of specialists from Ed. Tech. and cognitive psychology. Modifications, reordering, as well as several adjustments were received from referees and have taken place on the CTS initial Form. The most agreed upon final CTS test was still consisted of eight (8) main questions and (26) sub-question items. To confirm reliability and inter-correlations of CTS test, correlations among the four components and the total CTS scores of the posttest data showed positive highly significant ($\alpha \leq 0.05$) correlations ranged between (0.83 – 0.93), and the split-half resulted in high reliability coefficient (0.93). So, the CTS test has proven to be reliable and internally correlated as well as refereed validity.

(7) Experiment of the two DST Designs

The 1st author carried out the implementation of the two DST designs with help and co-ordination of the course Instructor during the 1st semester of the year 2011 - 2012. Participants were briefed about the objectives and what they are supposed to do at distance learning from the Website (www.digitalstory.ps) in this new method of self learning and remote support and guidance. Students were also provided with information to access the website at home or computer lab and every one took his manual. Student were randomly assigned to the two DST designs and authorization to get access to it in the VLE. Pretests of both KA and CTS were administered to both groups as planned in research experimental design in Figure (8). Schedules were set for those who cannot access home. All students get the access information to the website at lab or at home. Students started studying the unit modules according to the assigned DST design linear or branching. Students enjoyed studying from the Web module after module taking modules pre-post tests through the VLE until finishing. This process of studying the modules was guided by the 1st author as co-Instructor and VLE administrator. After making sure that all participants of both groups studied every module separately, a date for meeting was issued for them for applying posttests of both KA and CTS in the lab. The number of who completed the experimentation tasks were (15) female students in each experimental group totaling (30) of both groups. The experiment lasted about one month, from Oct 31 to Dec 1, 2012. Post-tests of both KA and CTS were administered collectively in the lab.

Results and Discussions

Data collected from all research tools were coded into SPSS for processing and analyses. Researchers applied descriptive statistics procedures using SPSS statistical procedures to compute means and standard deviations for the two Digital storytelling designs: linear DST design and branched DST design to get a preliminary look at data as in Table (2). It is so clear from data that students in linear DST design scored in means better than branched DST design students in both posttest and gain scores of KA and CTS. This noticeable difference is not as expected in all hypotheses. However these difference among means might not be significant. On the other hand, both designs are effective on developing both KA and CTS as noticeable between pretests scores and their posttests scores.

Table 2. Means and standard deviations for the two DST designs of research variables.

Research variables	Digital storytelling design			
	Branched design N = 15		Linear design N = 15	
	Mean	Standard Deviation	Mean	Standard Deviation
Posttest of KA	31.733	11.354	36.066	5.020
Pretest of KA	15.200	7.103	10.133	5.717
Posttest of CTS	9.532	0.723	9.730	1.245
Pretest of CTS	4.019	0.908	4.082	1.556
Gain of KA	16.533	12.670	25.933	8.302
Gain of CTS	5.513	1.233	5.648	1.712

In the following section, results of testing research hypotheses are presented as outputs from SPSS.

Hypothesis (1): There are significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in posttest scores of KA and CTS for the branched DST design.

To test this hypothesis (1), the independent samples t-test was applied to test the significance of two means of the posttest scores of KA as well as the posttest scores of CTS. So for the posttest scores in Table (3), the t-value (1.352) of the two means difference of KA (31.733, 36.066) at df (28) is not

significant at (0.05) since the computed significance (0.187 > 0.05), so, the null hypothesis is not rejected. The t-value (0.531) of the two means difference of CTS (9.532, 9.730) at df (28) is not significant at (0.05) since the computed significance (0.600 > 0.05), so, the null hypothesis is not rejected . So, the null hypothesis, there are no significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in posttest scores of KA and CTS is accepted.

Table 3. Independent t-tests results of means ' differences between Linear and Branched DST of post-tests scores of KA and CTS.

Test scores	Group	N	Mean	Standard Deviation	t-value	df	significance
posttest of KA	Branched	15	31.733	11.354	1.352	28	0.187
	Linear	15	36.066	5.020			
Posttest of CTS	Branched	15	9.532	0.723	0.531	28	0.600
	Linear	15	9.730	1.245			

These results clearly show that linear and branched DST designs are both effective on postests' scores of KA and CTS. This is my be because that both linear DST and branched DST were systematically developed according to accepted design standards. However, this is may be because that the effect of the pretests' scores of KA and CTS were not controlled.

Hypothesis (2): There are significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in posttest scores of KA and CTS for the branched DST design when controlling the pretest scores.

Researchers applied one – way ANCOVA to test this hypothesis as the pretests scores were kept as co-variants for both KA and CTS. Table (4) and Table (5) show results of both tests. From Table (4), the F-value (1.685) of the main effect of between designs (linear, branched) at df (1,27) is not significant at (0.05) since the computed significance (0.859 > 0.05), so, the null hypothesis is not rejected for the variance for KA. From Table (5), the F-value (0.256) of the main effect of between designs (linear, branched) at df (1,27) is not significant at (0.05) since the computed significance (0.617 > 0.05), so, the null hypothesis is not rejected for the variance for CTS. So, the null hypothesis, there are not significant differences at level ($\alpha \leq 0.05$) between the two means of linear DST and branched DST in posttest scores of KA and CTS when controlling the pretest scores is accepted.

Table 4. One-Way ANCOV results of posttest of KA with pretest of KA as covaiate.

Source Of Variance	Sum of squares	df	Mean Squares	F Value	significance
Pretest of KA	2.567	1	2.567	0.032	0.859
DTS designs	134.482	1	134.482	1.685	0.205
Error	2155.300	27	79.826		
Total	36775.000	30			

Table 5. One-Way ANCOV results of posttest of CTS with pretests of CTS as covaiate.

Source Of Variance	Sum of squares	df	Mean Squares	F Value	significance
Pretest of CTS	0.817	1	0.817	0.782	0.384
DTS designs	0.268	1	0.268	0.256	0.617
Error	28.232	27	1.046		
Total	2812.219	30			

These results revealed that both linear DST and branched DST designs were effective even after controlling the effects of the pretests' scores of KA and CTS as covariates in the ANCOVA model. This clearly supports the proposed " match Theory" since both the delivery systems were DST regardless of their designs. These important results raise the issue that another factors that are being involved such as students characteristics and the content nature and characteristics.

Hypothesis (3): There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST and branched DST in gain-scores of KA and CTS for the branched DST design.

To test this hypothesis, the independent samples t-test was applied to test the significance of the difference the two means of the gain scores of KA as well as the gain scores of CTS. Table (6) shows results of both tests. So for the gain scores of KA in Table (6), the t-value (2.403) of the two means difference of KA (16.533, 25.933) at df (28) is significant at (0.05) since the computed significance ($0.023 < 0.05$), so, the null hypothesis is rejected for gain scores of KA. The t-value (0.247) of the two means difference of CTS (5.513, 5.648) at df (28) is not significant at (0.05) since the computed significance ($0.807 > 0.05$), so, the null hypothesis is not rejected for gain scores of CTS . So, Hypothesis (3) is partially accepted, there are significant differences at level ($\alpha \leq 0.05$) between the two means the linear DST and branched DST in gain scores of KA for linear DST design, but for the gain scores of CTS is accepted.

These results revealed an interesting point of concern that linear DST design was superior to the branched DST design of developing KA which was not expected. One of the most acceptable reason my be due to the nature of the content of the course "Computer in Instruction" that is linear historic events and its KA is a linear process. Besides, the branched DST design couldn't overcome that linear structure of that course content. On the other hand, results showed no differences in CTS between the two DST designs. So, the "Match Theory" is still partially supported.

Table 6. Independent t-tests Results of means ' Differences between Linear and Branched DST of Gain KA and Gain CTS.

Test scores	Group	N	Mean	Standard Deviation	t- value	df	significance
Gain of KA	Branched	15	16.533	12.670	2.403	28	0.023
	Linear	15	25.933	8.302			
Gain of CTS	Branched	15	5.513	1.233	0.247	28	0.807
	Linear	15	5.648	1.712			

Hypothesis (4): There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST pre-posttest of KA and CTS for the posttest.

To test this hypothesis (4), the paired sample t-test was applied to test the significance of two means of the pretest and posttest scores of KA as well as the posttest scores of CTS of the linear DST design. Table (7) shows the two tests. For the pretest and posttest scores of KA, the t-value (12.098) of the means difference of KA (2.593) at df (14) is significant at (0.05) since the computed significance ($0.000 < 0.05$), so, the null hypothesis is rejected for KA. For the pretest and posttest scores of CTS, the t-value (12.775) of the means difference of CTS (5.648) at df (14) is significant at (0.05) since the computed significance ($0.000 < 0.05$), so, the null hypothesis is rejected for CTS also. So, the null of hypothesis (4) is rejected, There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST pre-posttest of KA and CTS for the posttest is accepted.

Table 7. Paired t-tests Results of pre-postests in Linear Design DST group of KA and CTS.

Test scores	Mean	Differences		T-test's value	DF	significance
		Mean	Standard Deviation			
Posttest of KA Pretest of KA	36.0667 10.1333	2.593	8.302	12.098	14	.000
Posttest of CTS Pretest of CTS	9.7300 4.0820	5.648	1.71223	12.775	14	.000

Hypothesis (5): There are significant differences at level ($\alpha \leq 0.05$) between the two means of the branched DST pre-posttest scores of KA and CTS for the posttest.

To test this hypothesis (5), the paired sample t-test was applied to test the significance of the two means of the pretest and posttest scores of KA as well as the posttest scores of CTS of the linear DST design. Table (8) shows the two tests. For the pretest and posttest scores of KA, the t-value (5.054) of the means difference of KA (1.653) at df (14) is significant at (0.05) since the computed significance (0.000 < 0.05), so, the null hypothesis is rejected for KA. For the pretest and posttest scores of CTS, the t-value (17.311) of the means difference of CTS (5.513) at df (14) is significant at (0.05) since the computed significance (0.000 < 0.05), so, the null hypothesis is rejected for CTS also. So, the null of hypothesis (5) is rejected, There are significant differences at level ($\alpha \leq 0.05$) between the two means of the linear DST pre-posttest of KA and CTS for the posttest is accepted.

Table 8. Paired t-tests Results of pre-posttests in Branched Design DST group of KA and CTS.

Test scores	Mean	Differences		t-test's value	df	significance
		Mean	Standard Deviation			
Posttest of KA Pretest of KA	31.7333 15.2000	1.653	12.67093	5.054	14	.000
Posttest of CTS Pretest of CTS	9.5327 4.0193	5.513	1.23347	17.311	14	.000

Results of testing both Hypothesis (5) and Hypothesis (6) are clearly show that both linear DST design and branched DST were effective on developing KA and CTS. These results also gave a firm support to the proposed "Match Theory" since both delivery systems were DST regardless of their designs and were matching the proposed internal mental ST in learners' cognition.

Final Results, Conclusions, and Recommendations

Results have revealed that both Branched DST design and Linear DST designs are found to be effective in developing KA and CTS. Linear DS design is found to be superior to Branched DS in gain scores of (KA), while there are no significant differences found in gain scores of CTS, post-test of CTS, and post-test of KA. Then, the answer to the main question is that effect is found only on gain scores for the linear DST design of Digital Storytelling over the Branched Design of DST in Distance Learning course. These findings of the effectiveness of both DST designs on both KA and CTS may be due to the nature of the learners' interactions with DST, and extensive use of digital multimedia on the VLE on the Web. Moreover, these findings can be interpreted by the authors' proposed "Match Theory" mentioned in the introduction of this article. This "Match Theory" can be understood in view of the contention of Gagne's theory of Instructional/Learning Events (1977). In this proposed "Match Theory", as in Figure (9), there

are two variables in the e-Learning environment: (1) Internal variable which is a mental storytelling (ST) function in the learner cognition, (2) External variable which is the delivery system outside the learner, and, (3) there is a relation between these two variables; learning outcomes are to be enhanced if the delivery system matches in the external variable matches the internal variable, i.e. in this research, the internal mental storytelling (ST) matches the DST delivery system in the external variable. This match between the internal (ST) and the external DST as a delivery system will enhance learning outcomes: KA and CTS. Results of this research, in general, supported this proposed "Match Theory".

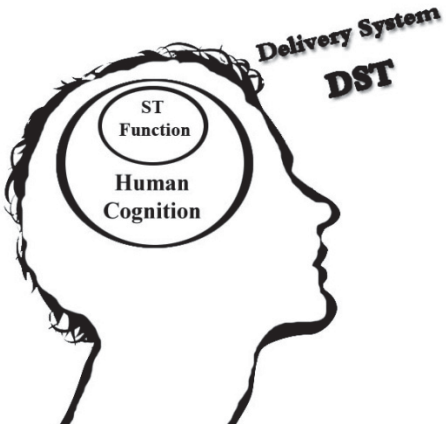

Figure 9. Storytelling (ST) Function in Human Cognition and Delivery System (DST).

This means that students' learning outcomes in both KA and CTS were enhanced as a result of this match between the design of the delivery system and human internal cognition functions. So, our mission as educational technologists, designers, and developers of leaning environments should use such potentials of learners to facilitate learning. This research is an attempt of this mission, as using these two designs (Linear, Branched) of DST as delivery systems to communicate the students' internal ST function of cognition for knowledge acquisition (KA) and creative thinking skills (CTS) as learning outcomes.

In sum, the view of the "Match Theory" calls for more research in DST in eLearning in educational technology. This view might be true also for learning in general, i.e., learners construct their learning though operating their internal mental storytelling (ST) function before they express their learning outcomes or what they have learned. It is suggested here that this contention of internal mental ST function in human cognition can be utilized in learning in at least from two sides. The first side, educators are encouraged to utilize this internal ST function of human cognition by giving learners opportunities to learn while building stories – ST builders - through any delivery system; direct face to face teaching, individual instruction, self learning, co-operative learning, or collaborative learning. And from the second side, educators are encouraged to utilize this internal mental storytelling (ST) by giving learners opportunities to learn through DST to communicate this internal mental (ST) function for enhanced learning outcomes. This view of using ST function of human cognition and the "Match Theory" call as mentioned earlier more research. So, based on this research results and findings, some recommendations and future research were driven:

1. Digital storytelling (DST) designs (Linear or Branched) are effective and should be used in eLearning particularly when governed by acceptable design standards.
2. Chunking procedures for interactive digital storytelling (DST) explained and implemented in this research are effective and should be used in designing DST in eLearning.
3. Future research that considers large sample sizes of both females and males as well as different courses' contents should be conducted for generalizing these research findings.

4. Instructional Designers should utilize DST in order to enhance learning outcomes in both ways: (1) DST to help learners as story builders, and (2) DST as delivery system for other learning outcomes.
5. Future research should be done that considers learners' characteristics and variables such as cognitive/learning styles, modalities, and age levels.
6. Future research should be done on investigating possible effects of the interactions between DST (Linear/ Branched) designs and cognitive styles such as (Reflective/Impulsive) styles on KA and CTS.
7. Future research should be done on investigating possible effects of the DST (Linear/ Branched) designs in different content types such as Mathematics, Science, Arts, and Technology on KA and CTS, as well as different learning outcomes.
8. Future research and views are invited to investigating the possible existence of a mental storytelling (ST) function in human cognition that works in performing individuals' daily activities and learning and the proposed "Match Theory".

In conclusion, the answer to the main question is that an effect is found only on gain scores of KA favouring the linear DST design over the Branched Design of DST, and no such comparative effects found on the other variables of KA and CTS in a web based Distance Learning course. Moreover, results of the effectiveness of DST in this research supported a proposed "Match Theory".

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