CHAPTER II: REVIEW OF RELATED LITERATURE

A detailed study of articles and publications encompassing all areas of the topic of research brought to light many avenues and possibilities thought about and discussed in earlier studies. Though nothing exactly was found to have been tried in the pursued topic of research, i.e., Animation as an effective tool of communication in primary education in Karnataka, many related themes like use of digital tools for communication, effectiveness of ICT in education and use of multimedia in learning; had been pondered upon, studied and concluded. Most of the studies related to use of animation in teaching and learning are in the context of developed western countries. A few most important topics among them have been chosen and evaluated, which is helpful to analyse the current research topic.

Advent of IT tools had significant impact on the communication and education in 21st century. Several researches from US, UK, Australia show that the uses of ICT tools has a positive influence on childhood and suggest that children’s early literacy and play experiences are shaped increasingly by electronic media. These technologies, and the activities that children may engage in with them, have the potential to extend learning in new and exciting ways and strengthen everyday literacy teaching and learning in early childhood classrooms (Waller 42). In this context, learning is not only fun but also encourages children actively construct their own meaning and make sense of the world in their own ways. It is in direct contrast to much of the traditional literacy practice, where the learner is often passive and the teacher acts as the conductor of content and actions.
As Centero observes, “Although the computer was used for educational purposes from the very beginning, the fact is that the necessities as to their capacity for calculation processes and, above all, graphical presentation of the computer-based teaching-learning systems have caused the practical application of computer science to education” (3). Activities of traditional class room can now be complemented with different experiences that have been made possible with the new digital and online technologies. These technologies, and the activities that children may engage in with them, have the potential to extend learning in new and exciting ways. New technology such as ‘talking books’, multimedia and ‘talking word processors’ could allow children far more independence from the teacher in literacy tasks and free the teacher to focus teaching on the distinctive features of reading and the written process. In addition, the use of digital cameras and multimedia composing tools has the potential to transform children’s storytelling and writing.

As seen, throughout the educational technology literature, many people are convinced of the capacity of digital technologies to make education more flexible, fluid, and ultimately more empowering for the individual learner. For many scholars, it therefore no longer makes sense to retain “pre-digital” models of organizing learning through institutions that are focused on the rigidly hierarchic mass delivery of static content. Instead, people are now beginning to question how best to develop forms of learning that can be negotiated rather than prescribed and discovered rather may be delivered. More often than not, digital technology seems to provide a powerful means of supporting education that is driven by individual learner’s needs and based on learners taking control of managing and accessing knowledge for themselves (Facer and Green 49). Several theorists suggest that, students who have grown up with digital technology have a fundamentally different way of thinking than previous generations.
There is a developing body of research evidence indicating that ICT will make children learn to read if used in the right way. As mentioned in the book ‘ICT in the Early years’ researches of Medwell, Lewin Underwood, examined the use of ‘talking books’. They suggested that using talking stories increases children’s word reading accuracy, both in the context of the story and out of context; improves children’s understanding of the stories and supports children’s reading by offering them access to the meaning of the stories and the way sentences work. They also pointed out that these programs are more effective for boys who seemed to show greater increases in word accuracy than girls when using talking stories (Waller, 46). Talking books are not only accessible and highly motivating but also: ‘have the potential to develop reading skills by giving children an overview of the story prior to reading it, by supporting children’s independent reading through sounding out unrecognized words and by encouraging collaborative reading. De Jong and Bus in their investigation of electronic storybooks, also found the CD-ROMs combined multimedia with interactive additions supported literacy within the story.

Marshall by reviewing many studies related to use of ICT tools in education concluded that certain applications in certain settings can be shown to have supported learning in a quantitative sense. Some of the studies reviewed by Marshall were related to the computer applications; others deal with video. The author makes many strong claims on the effectiveness of use digital tools in education. He says, “Historical evidence suggests that technology can, and did teach and more than 50 research studies addressing voice, video, and computer-based learning provide conclusive evidence that students can, and do, learn from educational technologies” (qtd in Mollenda & Sullivan 15).
In both learning and e-learning, ICT tools cultivated and strengthened the relationships among students and their teachers inside and outside the classroom. Use of ICT in classroom was able to motivate students for learning. ICT was also useful for interaction with other students, and for research. The e-learning environment changed the style of communication, not only between teacher and student but also among co-learners. Garrison and Shale declared that educational technology has a vital role, which intermediates in order to achieve a two-way communication between teachers and learners (12).

Robert Taylor in his book *The Computer in the School: Tutor, Tool, Tutee*, had put forward the idea that, at school, digital technologies could play three different roles: tutor, tool, and tutee. It’s clear that each of these roles depends on the kind of dialogue established between the computer, intended as a teacher, and the student. Whenever technologies are employed, the roles of teachers and students change.

According to Chizmar and Walbert, technology allows the teacher to move from the “sage on the stage” to the “guide at the side”. When technologies are infused into the curriculum, the teacher’s role shifts from, being primarily, an information source to a facilitator, a coach, a guide, and a co-learner (252). Prensky says, “Presenting information through the medium of ICT allows teachers to speak the right language and to encourage students to exert greater effort to understand the concepts they are presenting”. Jones, Valdez, Nowakowski, and Rasmussen outlined the way in which these teacher roles are enacted in technologically rich classrooms. They contended that teachers are facilitators when they provide environments and opportunities for students to work collaboratively and solve authentic problems. When they act as a guide, teachers mediate, model, and coach. Teachers model when they competently demonstrate the use of technology. They coach by giving hints and encourage
students to refocus and practice their skills. The computer and its ability to provide access to the information highway have the potential to alter the type of assignments that are developed, the form in which the assignments are presented, the type of learning that will occur, the kinds of problems, both behavioral and technological, that will be remediated, and the way teachers will respond.

Papert argues that computer can help even young children to think (qtd in Bowman, Donovan & Burns 229). In a study, preschoolers who used computers scored higher on measures of metacognition. They were more able to keep in mind, number of different mental states simultaneously and had more sophisticated theories of mind than those who did not use computers.

Fine and Thornbury (22) think that in the twenty-first century the computer probably inspires the most by arousing and respect from young children. Though it is as visual as television, engagement with the computer is not passive. A link with the world beyond school, the computer’s presence in the classroom reflects the seriousness with which the school regards their education. It offers access to the learning for children who are unable to profit from more convergent traditional teaching and it holds out the promise, for all children, that their education is relevant and is concerned with the life. If this promise is to result in educational gains, then the use of the computer must be more than instrumental.

He supports this argument by quoting a research study: In a case study conducted in a group consisting of 30 children the children were able to sit as a class group and view the digitally projected computer screen with comfort. Nevertheless, this was not a straightforward delivery model of learning; the children were encouraged to read together
menu items on the screen and direct where the teacher should click the mouse to produce a particular outcome. This gave the learning a social context. It encouraged the children to listen and co-operate in a structured group situation. They were learning the need to control impulses and understand the need for rules in a whole class learning environment.

The study also observed that teachers were much more willing to use ICT in their subject teaching if they have access to a digital projector or whiteboard. The teacher was also planning to provide challenging opportunities for children whose ability and understanding were in advance of their language and communication skills’. It also provided different tools for experimentation, providing for those who may not work easily in other classroom media. A great advantage of this arrangement was, the provision for the children to practice their newly observed skills immediately following the demonstration, reinforcing their memory of the instructions.

Same students were exposed to another experiment and they had to do painting using specific software related to drawing, which was controlled by students. In this painting case study, the children were listening intently to instructions from the teacher and to each other as they experimented. The computer also offered the revelation of story, where the children controlled the pace and interact with text, graphics, animation and sound. At a more creative level, the computer offered children the means of making their own stories and text. The CD-ROM has also changed the way in which children can access stories, exploratory games and rhymes in the early years of classroom. Based on this study, Fine and Thornbury came to the conclusion that “giving access to sound, graphics, animation and video to excite them and motivate students reading and language development. With the computer growing in
importance as a resource for language and literacy the evaluation of software becomes a necessary pedagogical tool in a class room”.

Waller also asserts that there is a strong justification for using ICT in early literacy activities (40). ICT tools provide the motivation for some children who find reading and writing difficult. In addition, there is a growing of research evidence that demonstrates benefits of ICT for teaching and learning. ICT tools encourages a ‘playful approach’ to the learning, they place problems in ‘meaningful’ contexts and they lend themselves to collaborative work and discussion. They are also stunning in their ability to engage children’s interest and commitment (Whiteboard 102). This is one of the real strengths of the adventure computer game format. By placing everything in the context of a compelling fictional world, these games are able to offer children ‘off the peg’ problems but in a way which makes them real and living.

Researches show that use of ICT tools also enhances communication in education. In a study conducted by Karampotsios, Kardaras, and Papathanassiou (232), to investigate the role of e-learning in supporting communication among students and lecturers in Athens University of Economics and Business (AUEB) several interesting factors were revealed. As per the Study done among 438 students of the sample, 56.9% believed that e-learning contributes positively or strongly positively to the continuous guidance from lecturer to student. Electronic media can be used in order to follow students’ performance and allow the lecturers to be better informed and appropriately lead their students to the solution they mostly need. With regard to the feedback from lecturers, most of the students answered that e-learning has positive contribution to immediate feedback (61.8%). A question expressed by
a student can be quickly answered with no need for following a tight schedule of contact
hours or for arranging meetings that suit both lecturers and students.

This study indicates that 49.5% of students share the opinion that e-learning enables
students to communicate with lecturers through the Internet and approach their supervisor
during the development of a project or any other assignment. This is not a very strong
positive stance in favor of e-learning, since slightly more than half of the sample does not
endorse e-learning value. Only 39.6% of students in the sample express the belief that e-
learning improves lecturers’ encouragement to students. Instead, 43.1% do not accept that e-
learning can have a positive impact. This study indicates that students rather perceive
encouragement as a matter of a direct in-person communication. E-learning provides the
means of communication in case of well-structured and more regular issues. The percentage
of students, who believe that e-learning is a positive factor for effective instructors’
immediacy (40.9%) is almost the same to the percentage of students who believe that e-
learning do not affect instructor’s immediacy (40.4%). Effectiveness in communication needs
direct communication. Hence, the study suggests electronic means can be seen as a valuable
supplement to effective communication.

Most of the studies uphold the argument that use of ICT tools can enhance young student’s
abilities in learning. However, some researches are very skeptical about the benefits of young
children’s use of computers. Healy raises concerns that ICT will cause harm to children’s
development because computers may replace traditional play activities and increase the
possibility that they become social isolates (qtd in Hayes & Whitebread 40).
Bransford, Brown, and Cocking argue that technology is not an educational panacea: Technologies do not guarantee learning but ineffective use of technologies can hinder learning—for example students may spend most of their time picking fonts and colors for multimedia reports instead of planning writing and revising ideas (206). And everybody knows how much time students can waste on surfing the Internet. Another researcher, Postman (121) reminds us that creativity can be lost by using computers. He writes, “We know that doctors who rely entirely on machinery have lost skill in making diagnoses based on observation’. Perhaps our greatest commitment to the next generation is to enable children to control the new technologies rather than to be controlled by them”.

Besides, use of computer in education can also affect communication process in classroom. Short, Williams, and Christie noted that the lack of nonverbal cues like, facial expression, posture, gesture, proximity, would limit the richness and scope of communication in computer mediated communication environment. Computer mediated communication was thought to be an ‘impoverished means of communication’, giving little chance to gather an important information about the context, the commonly shared rules of conduct and their influence on communication, all of which foster uninhibited speech and flaming. Moreover, as anonymity, which is a frequent feature of online interactions, reduces these control indicators, communication would be more de-individualized and de-personalized, and that would have different and unpredictable consequences on the various speech contexts. Lacking nonverbal indicators, computer mediated communication was seen to be characterized by a very low level of social presence, and it was thought that this feature could invalidate the learning purpose (Manca 121).
Researchers have given divergent views on the use of ICT tools in education. Whether the use of digital tools in education is a boon or bane—the question is still debatable. But they have made a broader point on the issue of ICT that, despite the ICT revolution over the past five years, there has been no detectable decrease in the use of face-to-face classroom instruction, whereas there is an evidence that technology based Internet and intranet delivery is steadily gaining momentum (Mollenda & Sullivan 4). Hence, one could conclude that technology based training is not replacing traditional training but rather supplementing it.

Mayer made a distinction between technology centered and learner centered approaches in education (32). For an effective instructional communication we have to understand the difference between two. In this sense, growing numbers of authors are now discussing the value of what Jonathan Edson terms “user-driven education” – i.e., allowing learners to take an active role in what they learn as well as how and when they learn it. It also presents a fundamental challenge to the concept of the formal educational establishment as a whole. All of these ideas and arguments imagine a radically different education system – one where “learners are active participants or co-producers of knowledge rather than passive consumers of content and learning is seen as a participatory, social process supporting personal life goals and needs.” The use of animation in education which is essentially a major tool of ICT can turn the students into active participants and co-producers of knowledge and enhance learning abilities of students in modern classroom set up.

There are several studies which throws light on the importance, use and effectiveness of animation in education. Cox, in a study, found a difference in reading and learning when children used CD-ROMs with clear bold text uncluttered by pictures. When comparing children using different talking books she observed that children looked at the words and
played with the animation of one particular talking book, but with another they tried to read. Cox evaluates the impact of the CD-ROMs on children’s reading: “The illustrations, animations and sound effects in talking books give meaning to the story and encourage children to look at books, which makes them particularly important for reluctant readers. But while the words are being read and highlighted, no animation should be playing. Talking Books had helped children to make sense of the texts and provided words that fitted the sentences meaningfully and grammatically. They did not however pay greater attention to the way the words looked and sounded” (Cox 6). This finding suggests that talking stories support children’s reading by offering them access to the meaning of the stories and the way the sentences work.

But the same can’t be said in other situation. There are large numbers of mathematically focused computer mediated games on counting, matching, sorting, sequencing and shape recognition for children. Watching children playing some of these games made researchers wonder whether the reinforcement they provide adds to their mathematical knowledge. For example, the task which requires the children to match the number 4 to four objects does not prove that they can count to 4 or understand the symbol. It is a drill and practice task which has historically been carried out with cardboard and pictures in nursery classrooms and to which the computer can add sound, animation and feedback. The computer adds to this reinforcement ‘a mode of learning’ which is novel in the early year’s classroom. It supports the children’s independent work and offers feedback without the presence of an adult. But the learning may simply be in the successful completion of the task, not in the understanding of numbers. Children are taught to match letters of the alphabet to pictures by dragging the picture until they get the sound (and the reward in points), but when questioned afterwards
the link between the initial letter and the word identifying the picture had not been understood at all (Fine and Thornbury, 30).

A study by Baylor and Ryu comparing the static images and animated versions of a learning agent, found that, the animated versions were rated as being more ‘engaging and credible’ (qtd. in Rogers 295). Using animation enables expressions, emotions, and other lifelike qualities to be depicted more effectively. Generally, learning companions have been designed to encourage reflection, articulation and to increase a learner’s motivation. Typically, they appear in an animated cartoon form as part of the computer interface. An example is ‘Herman the Bug’ who was designed to help the students learn about biology. In particular, it was designed to be a talkative, quirky insect that flew around the screen and dived into plant structures to provide problem-solving advice to students. When providing an explanation, it inhibited a range of animated activities, including walking, shrinking, flying, expanding, swimming, acrobatics and teleporting. Studies of Herman have shown it to be effective at directing children’s attention to relevant information, sustaining their interest in the course material and helping them to vary out online activities (qtd. in Rogers 293). They appear to do so by motivating and maintaining interest.

Yvonne Rogers in his research, attempted to find out the reasons behind efficacy of animation in supporting the learning process when children interact with animated agents and the possibility of different output in the result, when animated agents are used as learning companions versus when they are used as virtual characters in an interactive narrative (294). In both the instances, it appeared that the use of animated agents results in a highly engaging user experience, enabling children to more readily understand what is being said, acted out and being asked for. The animation used to represent the agents, is virtually compelling and
this turned out to be the major factor in motivating the students to learn or infer the motives and intentions of the character in their interaction with other characters on the screen.

Betrancourt & Chassot, in their study on instructional uses of animation, found that animation promotes better understanding due to its visualization and it also can be used a tool to convey dynamic information. They studied by focusing on cognitive psychology, where a large body of research has been done to find out whether widespread enthusiasm for the use of graphics in instructional material can be supported by empirical evidence as to their effectiveness in promoting learning. Most of the research in this area had compared text alone and text with pictures to assess the subject’s performance on retention and inference tests. The finding largely support the claim that graphics benefit learning, with most of the studies indicating that graphics improved memory for the illustrated information and comprehension of the situation described in the text. More recently, studies have investigated the conditions under which graphics are beneficial to memorization and comprehension.

Various reasons have been advanced to explain the beneficial effects of graphics. Some of these reasons are associated with the effective role that graphics can fulfil. For example, graphics may be aesthetically appealing, humorous, attention-attracting or motivating. However, animations may also confer benefits by fulfilling a cognitive role. According to the dual-coding theory, by conveying information in both verbal and pictorial mode, a double track is provided for the processing, encoding and retrieval of this information. Finally, the proponents of the mental model theory assert that, ultimately, readers form a mental representation which is structurally analogical to the situation described. From such mental models, new information can be inferred, missing information can be completed, and contradictions are resolved. Providing an analogical visualization
through a graphic is considered to facilitate mental model construction by offering an external representation that supports an internal representation, by partially offloading information from working memory and increasing available processing capacities. (Betrancourt & Chassot 142-143).

Usually by providing multiple perspectives on complex concepts an animation can facilitate a deeper learning. An animation has the capacity to present the dynamic aspects of an issue directly and explicitly. In other words, it can be also said that animation is another way of presenting multiple perspectives to a learner by effective verbal explanation and visual illustration of complex procedures, dynamic processes etc. Hansen, Narayanan & Hegarty, in their studies have found that, students learn algorithms and other complex concepts effectively from interactive visualizations presented in the form of animations integrated with hypertext explanations than from classroom lectures or textbooks. They also discovered that, learning is negatively impacted when animation is removed from the multiple representations. It is also proved that the multiple representations may not always lead to successful learning. Lowe, had undertaken a study in this regard and found that novices viewing weather animations in his experiment, focused more on perpetually salient aspects than on thematically significant aspects. The reason was when multiple representations were presented to the learners, they chose not to use all available information available in the representation due to lack of sufficient knowledge to identify and attend the important aspects of animation (qtd. in Younger & Narayanan 237).

Schnotz and Rasch argue that animated pictures can also direct the observer’s attention to important aspects of display, convey procedural knowledge, demonstrate the dynamics of subject matter and allow explanatory learning through manipulating a displayed
object (92). Furthermore, animations can have a supplementation effect by which they help learners to pre-form a cognitive process that they could not otherwise perform without this external support. Schnotz and Rasch, through their research attempted to analyse functions of animation in comprehension and learning from the perspective of cognitive load theory. In their research, several aspects such as cognitive load in learning from animation, effect of enabling and facilitating functions of animation in learning and comprehension abilities, comparison between static and animated pictures based on empirical study on them and concept of cognitive load within the framework of Vygotski’s zone of proximal development have been studied.

According to them, “recent models of multimedia are based on the assumption that human cognitive architecture includes different subsystems, various sensory registers, a working memory and a long-term memory”. According to these models, information from the environment enters the cognitive system through sensory organs and is briefly stored in a sensory register. Information is then transmitted through different sensory channels from the sensory registers to working memory, where it is further processed together with the information from long-term memory i.e., prior knowledge to construct different kinds of mental representations such as propositional representations and mental models. The process of constructing these mental representations in working memory is referred to as ‘comprehension’. When comprehension and other kinds of cognitive processing leads to changes in long-term memory, these changes are termed as ‘learning’ A bottleneck in processing of information is the limited capacity of information storage and processing by the human working memory. Because the human working memory is limited, all kinds of information from external world will impose a cognitive workload on human memory.
According to Sweller, Van Merrienboer and Paas, there are different kinds of workload such as; intrinsic load, extraneous load and germane load”.

They explained further- the ‘intrinsic load’ is determined by the complexity of the instructional content or the task to be performed relative to the degree of expertise of the learner. So, in any learning situation, intrinsic load cannot be manipulated. In contrast, ‘extraneous load’ is determined by the instructional format rather than the nature of the content. More specifically, it is generated by an inappropriate instructional format; in the manner the instruction is structured and presented to the learner. Thus, the instructional design should aim to decrease extraneous cognitive load. The ‘germane load’ reflects the efforts of detecting the relevant regularities and of forming appropriate schemata or content during the process of learning. Here, individuals should be encouraged to engage in cognitive processing that facilitates schema construction and increases individual’s level of expertise. Thus, in contrast to the extraneous load, germane load should not be reduced but rather be increased provided that the total cognitive load stays within the limits of working memory capacity.

As per Schnotz and Rasch, animation can have different functions regarding the cognitive workload on working memory, i.e., an enabling function and facilitating function. The enabling function means process becomes possible due to reduction of cognitive workload, which otherwise would have remained as impossible. The facilitating function means due to reduction of cognitive workload process which was already possible becomes easier with a great deal of mental effort (94).
Scnotz and Rasch after doing many other studies related to animation came to the conclusion that, “animated pictures provide an additional information that seems capable of having different functions with respect to the learning. On the other hand, animations can enlarge the set of cognitive processes and thus, allow the learner to perform more processing than he would be able to perform with static pictures. This is enabling functions of animation. On the other hand, animations can trigger a dynamic cognitive schema that makes specific cognitive processes easier. This is the facilitating function of the animations”.

They said, “Different kinds of the animated pictures seem to fulfil different functions for learning. Animations can be used to generate and display a large number of static pictures and show different states or show a subject matter from different perspectives. Such animations seem to have primarily an enabling function. They enable a learner to perform more cognitive processing than he would be able to do with the static pictures. On the contrary, animations allowing the display of dynamic processes seem to have primarily facilitating function. These animations can provide an external support for corresponding mental simulations and thus, make these mental processes easier to perform. Individuals with high learning pre requisites seem to benefit primarily from an enabling function, whereas individuals with low learning prerequisites seem to be affected primarily by the facilitating function of the animation”.

According to them, both the enabling and facilitating function of animation can be considered as providing base for the reduction of cognitive load. However, the facilitating function of the animation can also be harmful, when learners who would already be able to perform the mental simulations on their own nevertheless make use of the available but unneeded external support. Animation can keep the learners from doing the relevant
cognitive processing not only due to increased task difficulty but also due to an inappropriate facilitation of the task.

Schnottz & Rasch are of the opinion that different kinds of animations can have different functions in teaching and learning. Manipulation pictures seem to have primarily an enabling function, whereas the continuous simulation pictures seem to have primarily a facilitating function. Manipulation pictures seem to be primarily beneficial for answering time-difference questions. Learners can use such pictures to generate various time states of the earth in order to extract the information about time differences and this was obviously helpful for answering time-difference questions. This function seems to be especially pronounced when students have higher learning prerequisites because these learners have sufficient resources available to use these possibilities. Continuous simulation pictures seem to affect primarily the answering of circumnavigation questions.

However, for the learners who are able to perform the mental simulation on their own, the external support offered by a continuous simulation picture could prevent them from performing learning-relevant cognitive processes by themselves. In this case, the facilitating function is beneficial for processing, but not for learning. Step-wise simulation pictures provide less of this facilitating function. They allow learner to control and more possibilities for self-directed cognitive processing with deeper conceptual analysis of the subject matter than continuous simulation pictures. Less facilitation seems to be more beneficial for learning in this case.

There is also an argument that, the continuous simulation pictures increased extraneous load. Though it sounds logical and in the study conducted by Schnottz & Rasch,
learners were able to perform the mental simulations on their own (100-105). Thus, simulation pictures provided the process information, which was in fact no longer required by the learner and therefore redundant. In the opinion of Kalyuga, Chandler & Sweller, providing redundant information usually increases the extraneous load because learner must process unnecessary information. Redundancy can result in an expertise reversal effect when individuals with higher learning pre requisites perform better without, rather than with, additional information. However, this pattern does not fit the results of the experiments presented by Schnotz & Rasch because the negative effects of the animation were found primarily when students had low- learning prerequisites rather than high pre-requisites. Therefore, it seems, it may have the negative facilitating effect which is different from the expertise reversal effect.

Thus, the use of animation in multimedia learning environments seems to be beneficial only under some circumstances. Adequate use of animation will only be possible on the basis of a sufficient understanding of the interplay between animated displays and the functioning of the Learner’s perceptual and cognitive system (Schnotz & Rasch 110-111). Animation can sometimes shorten learning times by illustrating changes in the operation or state of things; showing dangerous, rapid, or rare events; or explaining abstract concepts. Animation increases interest and holds attention better than text or audio, and the resulting learning seems to be retained (Mishra & Sharma 4-5).

In a study conducted by Thompson and Riding found that, animation is beneficial to learning as it conveyed the information that static graphics did not. For example, Thompson and Riding used an animation to explain the Pythagorean Theorem to the junior high school students that incorporated rotation and translation to depict equivalence in length and area.
They found that students studying the animation have outperformed the students who were studying static graphic or a series of graphics depicting important steps. In such cases, animation is assumed to be beneficial because it conveys additional information that is crucial to the process of constructing a satisfactory mental model of the subject matter.

Yvonne Rogers has conducted a study on comparison of how animation has been used to support formal, informal and playful learning to facilitate comprehension, understanding and reflection in different ways (286). A well-known benefit of using animation in an instructional context is its ability to visually depict the changing information, which is usually imperceptible, in a variety of abstracted and simplified ways. The trajectories of objects and dynamical processes, especially those that cannot be seen by naked eyes, are visually depicted in ways that explicitly show how something happens or works. For example, processes that very rapidly or slowly can be animated to appear in slow motion (e.g., a bullet being fired) or speeded up (e.g., a plant growing).

But there are a few studies which say use of animation may not be beneficial for learning. Morrison and Tversky, have compared animated graphics, static graphics and text alone for teaching the permissible paths of people or vehicles. Graphics produced better performance than text alone, but animated diagrams provided no benefits compared to the single static diagrams (qtd. in Betrancourt & Chassot 145). Hegarty and Narayanan (236-240) also found no difference in learning outcomes between those who viewed animations and those who viewed static graphics. A conclusion that can be drawn from such studies is that animation is not the only one type of graphic that can lead to “runnable mental model” of the subject matter.
Mayer says “Learning with animation poses serious challenges to human information processing system. Animation need not be superior to static images always in promoting learning (33). The effectiveness of animation often depends on how it influences on the learners cognitive processing. Cognitive theory of multimedia indicates that learning ability of the students depends on the way in which information is transferred to human brain”.

Many studies conducted by Mayer and his colleagues shows that, the poor knowledge level students particularly get benefit from the addition of text to diagrams. Mayer compared the performance of two groups of students, low and high knowledge group, in learning a physics system either through the diagram alone or through the combination of diagram and text. His study showed that the high knowledge learners were somewhat successful in understanding the systems from diagrams alone, low knowledge learners scored higher on retention tests when they received both text and diagrams (Mayer 32-35).

Schnotz and Rasch also in their research compared the static and animated pictures. The rationale for the study was as follows: If animated pictures enable the learner to perform an additional cognitive processing, learner’s total amount of time required for additional processing also increases (96-100). So, the enabling function of animation should also lead to an increase of learning time, when it is compared with the static pictures. It is also essential for an enabling function to be more effective, the learner should have high learning prerequisites such as high cognitive ability, prior knowledge etc. With high learning prerequisites, learner will be able to use the possibilities of animations more extensively. On the other hand if animated pictures facilitate cognitive processing, the learner needs lesser time to learn from animated than static pictures because as per the facilitating functions of animation, it expected to reduce cognitive load to an extent that is easier to cope up with.
For the purpose of the study, forty university students were chosen and tested for their intelligence and prior knowledge about the topic. Both the variables were combined into joint variables of learning prerequisites. A hyper linked text about time and date differences on the earth were presented before the students, both in animated as well as static forms. After the learning phase, the participants completed a comprehension test which consisted of 12 items referring to the time differences between different places of the earth. The result of the study showed that, “students with high learning prerequisites spent more time on animated pictures than on static pictures. However, students with low learning prerequisites spent less time for animated pictures than for static pictures”. Thus, the results supported the assumption that the enabling function of the animation applies to the students with higher learning prerequisites, whereas the facilitating function applies to students with lower learning prerequisites.

The Study results also had pointed out at the fact that students with animated pictures outperformed the students with static pictures in answering time difference questions. However, students with low learning prerequisites answered circumnavigation questions significantly better after learning with static pictures than animated ones. So animations didn’t have such a deep positive effects on answering these questions.

Another observation made on the basis of the results obtained in this study is that facilitation can also have a negative effect on learning. If individuals are perfectly capable of performing such mental stimulations by themselves, external support can lead to a decrease in productive processing. Accordingly, student invests less cognitive effort in learning from animation than when learning from static pictures. From the perspective of cognitive load theory, animation can unnecessarily reduce cognitive load associated with deeper meaningful cognitive processing. Most of the students obviously had sufficient skills for mental
stimulations without external support, but students with lower cognitive prerequisites were apt to accept unneeded external support.

According to Richard Lowe, despite the increasing popularity of animations in technology-based learning materials, a growing body of the research suggests that they may not be necessarily superior to static depictions (49). In some cases, potential educational benefits from animation’s capacity to depict dynamics explicitly could be outweighed by the perpetual and cognitive processing costs of comprehending animated presentations. Here ‘user-controllable animations’ appears to address the issue of this potential mismatch. Because control over presentation rate, direction and continuity seems to offer learners opportunities for dealing with animation’s processing challenges.

As shown in the research conducted by Palmer & Elkerton, it is also expected by many developers of educational materials that, the interactivity available with user-controllable animations will lead to learners engaging in a deeper form of processing (qtd. in Lowe 52-53). Unfortunately, this expectation is difficult to be realized in practice. For effective user-controllable animation, learner interrogation needs to target those aspects that are very relevant to the concurrent learning task. One of the important interrogation requirement for leaning from static depictions is learner must be able to locate and identify the relevant aspects as they explore the picture space. In case of domain novices, strategic exploration even in static pictures might become difficult due to lack of background knowledge in guiding them to relevant material. However, these problems are compounded with user controllable animations also because learner must be able to search and correlate both, picture space and temporal space which constitutes the sequence of animation. Further, animation’s transience also poses challenge to the analytical process as learner should be able
to divide the display into appropriate parts prior to mental model constructions. Thus, user
controllable animation used in the studies by Lowe (53-54), had pointed out that, in the
context of rising demands of dealing with highly complex dynamic information, learners had
only limited success even with user-controllable animations.

In an experimental study conducted by Hegarty and Kriz, students studied the operation
of the flushing cistern; using single static diagram, a series of three static diagrams showing
the three different stages of the operation and an animation (15). Twenty students were
assigned to each group, based on their paper folding test scores to ensure that all groups had
even numbers of high and low participants. The study revealed that, the performance of the
students who learned from only one static image very low. But there was no significant
difference between the results of, other two groups, who learnt from three static images and
from an animation.

Most of the researches on the concept of learning with animation have been carried
out through laboratory experiments involving university students. There have been relatively
few experimental studies investigating the effect of animated visuals with primary or
secondary school students. In an audio visual research that has been conducted by a few
researchers such as Gibbons, Anderson, Smith, Field and Fisher found that preschool
children, aged around 4 years, remembered actions better when they were conveyed visually
than when they were described by a narrator, but the difference disappeared in older and
younger children. Both of them produced more elaborations with the visual presentation than
with the audio alone and remembered dialogue better. It was hypothesized that visual
representation would supplement and complement developing verbal abilities, thus
facilitating construction of a mental model of referent situation. Moreover, children as young
as 4 years showed unexpectedly good comprehension of cinematic montage conveying implied actions, character perspective, spatial relationships and simultaneity of actions. Such audio visual research provided evidence that young children have the ability to process animated visual information effectively and derive complex information from it.

Rieber & Hannafin have conducted a study on “effectiveness of animation on learning”. They have designed computer-based lessons to teach Newton’s law of motion to elementary school students. In some studies, a positive effect of animation was found. But in other studies, animation was not superior to static graphics. However, animation was found to positively influence continuing motivation. In a free choice situation, children studying animated instruction were more inclined to return to the instruction than children studying static graphics or text instruction (qtd. in Betrancourt & Chassot 146).

In traditional primary and secondary education, the emphasis tends to be on verbal material as the main vehicle for presenting to-be-learned information, whereas depictive information is too often merely used for attracting and motivating students. A study by Holliday, confronted this issue by designing an instructional situation in mathematics in which graphics conveyed the critical information. He found that children studying the graphics alone outperformed those children studying graphics in association with text. Holliday in his study, concluded that children in school situations in which text and graphics are presented together, tend to ‘under process’ the graphic information because they think that the most critical information is conveyed by text (qtd in Betrancourt & Chassot 147).

In contrast, a study by Kalyuga, Chandler and Sweller have revealed that, providing a combination of verbal and pictorial material improved learning performances for novices
trade apprentices compared with pictorial information only. However, as learners became more experienced, the pictorial material alone was more beneficial than the verbal-pictorial combination. Although these studies do not conflict with the positive general multi-media effect found in numerous studies, they do provide evidence that ‘more can be less’ when learners poses sufficient prerequisites to take advantage of a single representational format.

Lowe, has come up with a phenomenon called ‘underwhelming’ where there will be a negative effect on learning from animated graphics due to insufficient processing of pictorial information. Such effect could appear if animation induces an ‘illusion’ of understanding due to visualisation of whole chain of events in such animation but does not result in comprehension of the functional and casual relationships involved (qtd in Betrancourt & Chassot 148). Comprehension of an animated presentation may also be compromised if learners lack the conceptual and strategic skills required to extract the relevant information.

In a research by Betrancourt and Chassot on a multimedia environment that offered both text and animation, information in two representational formats (i.e., both text and animation) were displayed separately and organised in a weak linear structure (149). He tried to understand the question whether the learners favour text or animated information by using an experimental study in which 7th grade students were asked to study a multimedia document explaining the retrograde motion of the planet Mars as seen from the Earth. Two conditions were compared. Participants in the assessment condition were told that at the end of the study period, they would be tested on what they had learnt. For those in the no-assessment condition, there was no mention of a subsequent test. The test was based on 2 assumptions, First assumption was that the students in the assessment condition would use more systematic strategy to study the material and more often go back to the piece of information already
explored. Secondly, students in the assessment condition would pay more attention to the text than to animation because in primary and secondary education, formal assessments traditionally give more emphasis to the verbal than to depictive information.

The results of the study had shown that despite the age factor, most of the students adopted a systematic strategy while exploring the multimedia document. Most of the students did not use the strategies that would allow complementary text and graphic information to be processed conjointly as a requirement to understand the explanation fully. It is also worthy to note down a fact that about fifteen percent of the students, have chosen to ignore the text information completely. Given the explanative and computational power of the visualization, children’s attraction towards visualization is potentially beneficial for learning; provide that appropriate guidance is given in the instructional material. In particular, the material should indicate clearly that verbal and pictorial information are both necessary to fully understand the information and so should be processed conjointly. In practical design terms, it means that the verbal information should be provided in a way that it cannot be avoided or overlooked. If the instructional material provides a navigation panel, the spatial layout should clearly indicate the order in which the pieces of information need to be studied, regardless of aesthetic or artistic issues (Betrancourt and Chassot 153-162).

Lowe, in his research found that a fundamental determinants of the potential animation to positively affect multimedia learning is that the learner’s capacity to process the animated information successfully. He also found in his previous studies that, novice learners tend to apply ineffective strategies when interrogating the complex, interactive animation. However, the research also provided evidence that adults’ explanatory behaviour were systematic rather than random with a number of distinctive search patterns being exhibited.
There are different techniques to create animation. It can be generated by computer, recorded on video from a real scene or be formed from a mixture of real and computer-generated features. But the technology should not, in itself, change the way animation is cognitively processed, the kind of information that is conveyed from the temporal nature of animation, is critical to learning. Lowe distinguished three kinds of information: first, Transformation, that involves form changes in graphic depicted items (shapes, colour, texture). Second, Translation, which involves the movement of whole items relative to the reference frame or relative to each other. Third, Transition, that involves the partial or complete appearance/disappearance of items due to temporal evolution.

Using animation when none of these three kinds of information is required to understand the subject matter is probably inadvisable. In appropriate use of animation may not merely fail to provide benefits, it may even be harmful to the learning process. However, animation has the following possible uses in education:

Supporting the Visualization: Animation can be used to visualize dynamic phenomena that are not easily perceptible (space and time scale), impossible to realise in practice (too dangerous or too expensive), or not inherently visual (representation of abstract concepts such as forces).

Inducing a ‘cognitive conflict’: Animations can be used to visualize phenomena that are not spontaneously conceived in the correct fashion. Research has revealed that in physics, naïve conceptions often dominate over the scientific conceptions even amongst advance d
students. In such cases, using correct and incorrect animations of the phenomenon could help learners to make their conceptions explicit.

*Enabling learners to explore a phenomenon:* Animation can be used to provide a suitable interactive learning experience that encourages learner to generate hypothesis and test them by manipulating the depiction’s parameters. In this case, animation becomes a stimulation that is used in a discovery-learning approach (Betrancourt & Chassot 143-145).

A major uncertainty facing developers of multimedia learning material has been a lack of principled guidance on how various elements of such material should be designed in order to facilitate comprehension. In 1998, Narayanan & Hegarty have developed a five-stage processing model for guiding multimedia design that addresses the issue of dealing with dynamic subject matter. They suggest that people comprehend an external representation of a dynamic system on the basis of a mental model constructed to internally represent its component parts and their relations (qtd. in Lowe 50).

Mayer argues that successful learning requires students to perform five actions - learner should be able to select relevant words from the presented text or narration, he/she should be able to select relevant images from the presented illustrations, organize the selected words into a coherent verbal representation, organize selected images into a coherent visual representation and finally. Integrate the visual and verbal representations with prior knowledge; which has direct implications for the design of effective multimedia instruction. Learning with animation is not an easy task. Use of animation in education can pose several challenges. Mayer has identified ten ways to overcome the challenges posed during learning from animation, which broadly achieved in three ways by - reducing extraneous overload, managing essential overload and fostering generative processing (33-45).
He believes that in the classroom when students learn with animation, images that are not related to the theme of the lesson, sounds that are distracting, narration that contain excess information may harm the communication and affect their learning. He has identified five principles which will help to reduce the extraneous overload in learning with animation - the coherence principle, the signaling principle, the redundancy principle, the spatial contiguity principle, and the temporal continuity principle.

**Coherence principle:** If an animation contains too much of extraneous material, it may affect learning. When an instructional designer prepares animation teaching material, he may get tempted to add interesting video clips, background sounds, colorful texts or instrumental music tracks, but it may not help to understand the lesson. Coherence principle indicates that people learn better when extraneous material is excluded.

**Signaling principle:** If it is not possible to eliminate extraneous material from a narrated animation, to reduce the extra cognitive load cues can be added in order to guide the learner what to attend and how to organize it. Signaling principle suggests that students learn better when cues are provided that highlight the organization of the animation or narration.

**Redundancy Principle:** According to redundancy principle people learn better from animation and narration than from animation, narration and on screen text alone. When an animation is presented with narration, information will be efficiently processed through both visual and auditory channels, which enhances students learning process.

**Spatial contiguity principle:** Confusing layout forces learner to engage in extraneous processing. Spatial contiguity principle advocates that students learn better from a good
layout, when corresponding elements of narration and onscreen text are presented near other than far from each other on screen.

*Temporal contiguity principle:* According to temporal contiguity principle, people learn better when corresponding animation and narration are presented simultaneously rather than successively. If a learner listens to explanation and simultaneously views animation depicting the explanation, he understands better as he gets two separate exposures to explanation.

Second way to overcome from the challenges in learning from animation, is managing essential processing, by focusing on the situations in which learners may face difficulty in learning with animation because sometimes, material to be learnt may be intrinsically complex thereby requiring high levels of essential cognitive processing. If an information involving animation is provided at the faster pace that is not under the control of learner, such narrations may become problematic and results in “essential overload”. There are three principles to manage such situations of ‘essential overload’, they are- Segmenting Principle, Pre- Training Principles and Modality Principles

*Segmenting Principles:* Segmenting Principles, in simple terms refer to breaking down the narrated animation into meaningful segments and allow the learner to control the onset of each one. For example, a lesson on how a lightning storm develops could be broken into 16 segments, each describing one major event. After a segment is presented, he learner can get the next segment by clicking on the continued button. This Segmenting Principle is that people learn better when a narrated animation is presented in earner-paced segments rather than as a continuous unit.
**Pre-Training Principles:** Other technique to manage essential overload is to make sure that learner knows the names and characteristics of the main components depicted in a narrated animation. For this it is necessary that learner must engage in two learning tasks: ‘building component model’ i.e., knowledge of possible states of components and ‘building a casual model’ i.e., knowledge of how change in one component may lead to change in another component or idea of cause-and-effect chain.

The logic behind it is if the learner already knows the names and the possible states of components, then the learner can devote more time and cognitive resources. The Pre-Training Principle is that people learn better from a narrated animation when they have had training in the names and characteristics of the main concept.

**Modality Principle:** Using modality principle, a multimedia lesson consisting of animation and concurrent on-screen text being presented at a faster pace makes the visual channel of the learner more complex and overloaded. This is because the learner’s eyes must pay attention to the material in the animation and text simultaneously. One way to manage such essential overload is to off-load some of the essential processing from the visual channel to the auditory channel by presenting the words in spoken form. Here, the visual channel can be used for processing the animation and the auditory channel may be used for processing the words. The Modality principle is that people learn better from animation and narration than from animation and on screen text. So the instructional implications of this principle are to present words as narration rather than as on-screen text when they accompany an animation.

The third and the last way to overcome from the challenges in learning from animation is - fostering generative processing. It refers to selecting relevant portions of the animation and
narration, mentally organizing such material into pictorial and verbal models and integrating
models with each other having prior knowledge. Such process results in deep understanding.
In order to foster the generative processing it is necessary to build a sense of social
partnership between the learner and computer-based instruction lessons.

*Personalisation Principles:* The Personalization principle is that people learn better when
narration is in conversational style rather than formal style. For example, using
conversational style of communication replacing ‘the’ with ‘yours’ or using first and second
person constructions will render the message more effectively.

*Voice Principles:* The Voice principle is that people learn better when the narration is
spoken in a standard-accented human voice than in a machine voice or foreign-accented
human voice. Because when the narrator’s voice is machine stimulated or has heavy accent,
learner is less likely to accept the lesson as social conversation. So a standard-accented
human voice promotes a sense of social conversation.

Mishra & Sahrma argue that computers in themselves do not automatically change the
nature of teaching and learning. It is the way in which their use is integrated into classroom
activity that produces educational benefits for students (28). The reason for this lack of
impact is seen to lie not with the attributes of the technology itself, but rather with the ways
in which the technology has been implemented in learning contexts. More specifically, it is
the educators’ knowledge, assumptions, and perceptions regarding the technology and its
implementation in the specific learning context that will determine its implementation and, its
effectiveness. The same can be said in the context of use of animation in education too.
Several researchers found that the use of animation is effective for learning, but some had
argued that use of animation may not be necessarily useful always. On the basis of reviewed literature it is evident that effectiveness of animation largely depends on the design of animation of content, the way of presentation or the use of instructional materials, and the knowledge, skills of teachers and students.