

A Review of Multimedia Learning Principles: Split-Attention, Modality, and Redundancy Effects

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Abstract: This study aims to present a literature review on three principles of multimedia learning including split attention, modality, and redundancy effects with regard to their contribution to cognitive load theory. According to cognitive load theory, information should be presented by considering excessive load on working memory. The first principle states that attending to two distinct sources of information may impose a high cognitive load, and this process is referred to as the split-attention effect (Kalyuga, Chandler & Sweller, 1991, 1992). The second principle, Modality effect claims that on-screen text should be presented in an auditory form instead of visually when designing a multimedia environment (Moreno & Mayer, 1999). Using more than one sensory mode augments forceful working memory that produces progressive effects on learning. The third principle redundancy effect occurs when information presented repeatedly interferes with learning. This study provides guidance how to create more effective instruction with multimedia materials for instructional designers.

Key Words: “Split attention”, “modality effect”, “redundancy effect”, “cognitive load theory”, “multimedia learning”

Özet: *Multimedya ile Öğrenme İlkelerinin İncelenmesi: Biçem, Aşırılık, Dikkat Bölünmesi Etkileri.* Bu çalışma üç temel multimedya tasarım prensibinin, dikkat bölünmesi (split-attention), biçem etkisi (modality effect) ve aşırılık etkisi (redundancy effect), bilişsel yük teorisine katkısı üzerine bir literatür taraması sunmayı hedeflemektedir. Bilişsel yük teorisine göre (cognitive load theory), bilgi, çalışan bellekteki (working memory) aşırı yüklenmeyi göz önünde bulundurularak sunulmalıdır. İlk prensibimiz, dikkat bölünmesi, bilgi birden fazla kaynaktan uzaysal olarak bağlantılı bir biçimde sunulmadığında ortaya çıkmaktadır (Kalyuga, Chadler, & Sweller, 1999). İkinci prensibimiz, biçem etkisi, çoklu ortam tasarımı yaparken, ekranda yazının görsel olarak sunulması yerine işitsel olarak sunulması gerektiğini savunmaktadır (Moreno & Mayer, 1999). Birden fazla duyuşsal kanal kullanımı çalışan bellekteki etkiyi arttırmaktadır. Üçüncü prensibimiz aşırılık etkisi, bilgi aşırı halde sunulduğunda öğrenmeyi olumsuz yönde etkileyerek açığa çıkmaktadır. Bu çalışmada bir öğretim tasarımcısının multimedia öğrenme ortamlarını daha etkili tasarlayabilmeleri için bir rehber sunulmaktadır.

Anahtar Sözcükler: “Dikkat bölünmesi”, “biçem etkisi”, “aşırılık etkisi”, “Bilişsel yük teorisi”, “çokluortamla öğrenme”

Introduction

Educational technology materials have often failed to support learning activities of the new technology intervention (Cuban, 1986). Multimedia learning tools have also shown ineffective implementation in terms of their efficiency on educational value, like many other educational technology materials designed without any guidance. Hooper and Reinartz (2002) defined the multimedia as, “*Multimedia is a combination of two or more media into a single coherent message.*” and “*Multimedia refers to software that contains combination of text, graphics, animation, video or other audio* (p.308).” Several problems emerged with multimedia use in learning, for that reason, theorists and practitioners have questioned their educational value (Hooper & Reinartz, 2002). According to Mayer and Moreno (1998), one way to avoid such claims regarding new educational technologies, such as multimedia learning environments, involves the effective use of instructional technology with guidance of a research-based theory to follow the students’ progress.

The flexibility and interactivity of the elements of the multimedia may cause confusion and increase cognitive load in learners’ mind. Multimedia learning theory claims that information should be presented to learners in multi-mode, including words, pictures, and audio, in order to enhance learning (Mayer, 1997). Therefore, multimedia design learning principles need to be considered when designing instruction that would use such technologies. This study aimed to revise three multimedia design principles, the split attention, modality effect, and redundancy effect. These three multimedia design principals will be explained in light of the background of cognitive load theory. The research method consisted of reviewing articles on the effects of multimedia, particularly the split attention, modality, and redundancy effect of

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multimedia learning principles theory, on performance of the learners. The researcher searched the studies articles published between the period 1991-2012 using Web of science, ERIC, and PsycINFO databases specifying the keywords such as “split-attention”, “modality effect”, “redundancy effect”, “cognitive load theory”, and “multimedia design principles.”

Cognitive Load Theory

Human cognitive architecture consists of working memory and long-term memory. People have difficulty keeping information, which contains more than seven chunks of elements because working memory is limited (Miller, 1965 cited in Garner, 2002). Additionally, working memory can keep the information active for a few seconds under conditions where rehearsal is limited (Peterson & Peterson, 1959 cited in Pociask & Morrison, 2004). Working memory limitations affect learning and when information exceeds the working memory capacity, cognitive load increases significantly (Sweller, 1993 cited in Yeung, Lee, Pena, & Ryde, 2000). For that reason, researchers in various fields look for parallel processing of information necessary to reduce cognitive load. In education, cognitive load is one of the important factors that needs to be considered when designing instruction (Yeung, Lee, Pena, & Ryde, 2000).

Cognitive load theory is concerned with instructional design and message design methods, which enable individuals to manage the limited processing capabilities of working memory and capitalize on the extensive capabilities of long-term memory by trying to promote schema formation and improve intellectual learning and performance of complex cognitive tasks (Sweller, 1988 cited in Pociask & Morrison, 2004). Moreover, Cooper (1998) defined cognitive load (CL) as the “total amount of mental energy imposed on working memory at an instance in time” (p. 10). According to Sweller, van Merriënboer, and Paas (1998), this “total” cognitive load has three subcomponents, intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL).

Intrinsic cognitive load refers to complexity of the information to be processed by the learners’ working memory (Sweller & Chadler, 1994). Mental demand of tasks determines the intrinsic cognitive load. It should be noted that a heavy intrinsic cognitive load comprises tasks with a high degree of interactivity (Garner, 2002). According to the literature, ICL supports indirect manipulation of intrinsic cognitive load by incorporating, sequencing, and layering strategies into the instructional design process and learning tasks (Pollock, Chandler, & Sweller, 2002).

Extraneous cognitive load is affected by the design of the information process. Extraneous cognitive load affects learning negatively because it relates directly to holding the information in mind when searching the connection between text and pictures. Pociask and Morrison (2004) stated, “High ECL equates to a reduction in working memory resources available for learning, while low ECL equates to an increase in working memory resources available for learning” (p.707). Learners need to hold verbal information in their minds while searching relevant pictorial information, when the learning materials are presented in split-source format. This process of split attention leads to extraneous cognitive load (Cierniak, Scheiter & Gerjets, 2009).

Germane cognitive load “Germane cognitive load is a load imposed by cognitive processes directly relevant to learning” (van Merriënboer, Schuurman, de Croock, & Paas, 2002, p.12). Garner (2002) stated that in an instructional design, if extraneous cognitive design is kept to a minimum and the intrinsic cognitive load is too high, there may be an unused working memory available; therefore, using appropriate instructional design, learners can use germane cognitive load to help in the construction of schemata in particular domain of interest.

Deleeuw and Mayer (2008) focused on measuring cognitive load, which is a fundamental challenge in cognitive load theory. They designed experiments according to the three kinds of cognitive processes, intrinsic, germane, and extraneous, which can contribute to the cognitive load. These processes involve mental work, which is irrelevant to the learning goal and consequently wastes limited mental resources, intrinsic processes, which involve complexity of material, and germane or generative processes, which involve engaging in deep cognitive processing related to the prior knowledge. In this study, the participants learned low domain knowledge from a multimedia lesson on electric motors. Participants’ cognitive load was measured using self-report scales (mental effort ratings) and response time to a secondary visual monitoring task. A difficulty rating scale was completed at the end of the lesson. The results revealed low correlations among the three measures. The results showed that the response time measure was most sensitive to manipulations of extraneous processing created by adding redundant text. Effort ratings were most sensitive to manipulations of intrinsic processing created by sentence complexity. Finally, difficulty ratings were most sensitive to indications of germane processing reflected in transfer test performance. As

an important practical implication, researchers implied that when the goal is to assess the level of extraneous cognitive load, response time to a secondary task appears to be most appropriate.

Factors that should be considered when designing instruction include the principles of multimedia learning. Although there are many multimedia design principles, in this paper, the researcher presents a research-based review of split attention, modality, and redundancy effects of multimedia design. This study reviews research on split attention, modality, and redundancy effects. These three effects and related studies will be explained in the following parts. First, the next part will explain the split attention on multimedia learning. Split-attention effect can be explained when students must split their attention between multiple sources of information, which results in a heavy cognitive load.

Split Attention

Attending to two distinct sources of information may impose a high cognitive load, and this process is referred to as the split-attention effect (Chandler & Sweller, 1991, 1992, Owens & Sweller, 2008). Split attention effect relates to instructional design issues and is observed when texts and pictures used spatially separated rather than spatially integrated in a learning material (Owens & Sweller, 2008). In a study, Florax and Ploetzner (2010) compared learning from spatially presented text and picture integrated format using text segmentation and picture labeling. The participants who received spatially integrated text and picture were more successful compared to participants who received continuous text (not in bullets or numbered text format) and unlabeled picture. The results also showed that the participants who received the segmented text and the labeled picture were more successful than those who received continuous text and unlabeled picture group.

Young, Jin, and Sweller (1997) gave an example of split attention, showing that when a student reads a story and encounters an unfamiliar word, given a separate glossary, the student leaves the text and turns to the vocabulary list. Learner temporarily stores its meaning and then reverts to the text and tries to incorporate the word meaning into the passage. This can be an example of split attention. This effect occurs when learners must integrate and split their attention between multiple sources of information mentally. According to researchers, this has been shown to be a primary problem with some instructional designs (Chandler & Sweller, 1991, 1992; Sweller & Chandler, 1994; Sweller, Chandler, Tierney, & Cooper, 1990; Ward & Sweller, 1990).

Liu, Lin, Tsai, and Paas (2012) investigated split-attention and redundancy effect on mobile learning in physical environment. They created three learning conditions, including text with pictures embedded in the mobile device, text embedded in the mobile device and real learning object, and text and pictures embedded in the mobile device and real object. The researchers hypothesized that because of the split attention effect with various sources of information, learners exposed to intervention with text and picture presented on Tablet PC would show higher comprehension performance and learning efficiency compared to learners exposed to intervention with text presented on Tablet PC and learning object. However, in the study, the results showed that the distance between two sources of information, including information on Tablet PC and the learning object outside of the mobile device, did not concern learners' comprehension and learning efficiency.

The results of the studies done by Tarmizi and Sweller (1988) and Ward and Sweller (1990) are congruent with the cognitive load hypothesis. The results of their studies showed that worked examples, which require learners to split their attention between multiple sources of information, were not more effective compared to problem solving and may even be less effective. The researchers hypothesized that worked examples, which may reduce or eliminate split attention, may be effective because of reduction in cognitive load, since through this process, learners do not search for relevant referents but mentally integrate worked example. For example, mental integration is no longer necessary by physically integrating geometry statements with the diagram. In order to enhance learning, the cognitive load involved in mental integration should be eliminated (Chandler & Sweller, 1991).

Modality effect

Modality effect is related to the cognitive load theory, which has limited capacity for multimedia learning (Mayer, 2001). Modality effect claims that learning will be enhanced if textual information is presented in an auditory rather than the usual visual format, such as visually based information in the form of a picture, graph, or animation, for instance. Generally, modality effect asserts that on-screen text should be presented in an auditory form instead of visually when designing a multimedia environment (Moreno & Mayer, 1999). Modality has been defined using different perspectives. First, according to Paivio's dual coding theory (Paivio, 1988), human memory has different subsystems when processing verbal and non-verbal

information. Learners will remember information best when text and picture enter working memory simultaneously. Therefore, Pavilio suggested a referential link that could lead to a richer memory trace. Presenting text and picture in different modalities is the best way to put both of them in the working memory simultaneously. This means that the modality effect is the effect of an optimum combination of information-elements while preventing split-attention. An alternative view follows that modality effect occurs when information is presented in a visual and auditory mixed mode. This effect claims that using mixed mode is more effective than using a single mode when presenting the same information. The logical relation between the two modes is crucial. If the two sources of information are presented in isolation, neither effect is attainable (Low & Sweller, 2005).

According to Moreno and Mayer (1999), if learners keep words in their auditory working memory and keep pictures in their visual working memory, than the learners can spend their attention mostly on the construction of the relationships between verbal and visual materials. It can be said that spending learners' attention on construction of this relationship means using working memory effectively. Therefore, using working memory effectively prevents extrinsic cognitive load capacity.

Mousavi, Low, and Sweller (1995) investigated the use of auditory and visual mode of presentation in terms of geometry worked examples. The research underlined the split-attention effect and the effect of presentation modality on working memory. The split-attention effect increases a heavy cognitive load. This effect occurs because students split their attention between multiple sources of information. In addition, regarding presentation-modality effects, Mousavi et al. suggested that working memory has partially independent processors for handling visual and auditory material. They conducted six experiments to test the effect of split attention and modality effects. They hypothesized that effective working memory may be increased by presenting material in a mixed rather than a unitary mode. Their experiments results supported this hypothesis. Thus, the research concluded that the negative consequences of split attention in geometry ameliorated by presenting geometry statements in auditory rather than visual form.

Tindall-Ford, Chandler, and Sweller (1997) showed that instructional materials using dual-mode presentation techniques, such as auditory text and visual diagrams, were more effective than single-modality formats, such as visual text and visual diagrams. This modality effect may be attributed to an effective use of working memory. The authors conducted three experiments using various instructional materials. In the study, participants who studied using materials that incorporated audio text and visual diagrams or tables outperformed students who studied using a conventional, visual-only format.

Plass, Chun, Mayer, and Leutner (2003) investigated the role of the cognitive load in multimedia learning. They specifically examined the effect of cognitive load on processing verbal and visual information among learners with different cognitive abilities. The learning material was presented in an interactive multimedia format in the form of a short story. The story comprised German words; some of them were presented using different types of multimedia annotation. While verbal annotation consisted of a text translation of the word, visual annotations consisted of a photo or a short video clip. The function of these annotations was to aid in the selection of relevant information rather than organization or integration of mental representation. Thus, students received no annotation, verbal annotation, visual annotation, or both for these words. Plass et al. found that recall of word translations was worse for low-verbal and low-spatial ability students than for high-verbal and high-spatial ability students when they received visual annotations for vocabulary words. However, students did not differ in the recall of word translations when they received verbal annotations. The visual image annotations, when presented alone, may have introduced confusion, especially for words that were difficult to depict visually, such as "irritated" or "instruct". In addition, according to their results, text comprehension was worst for all learners when they received visual annotations. The results are consistent with a generative theory of multimedia learning and with cognitive load theory, which assumes that multimedia learning processes are executed under the constraints of limited working memory. Plass et al. argued that the visual annotations imposed a high cognitive load because students had to select the relevant information from the image to understand the vocabulary words.

Redundancy effect

Redundancy effect suggests that redundant materials interfere with learning. These materials include the same but unnecessarily elaborated information presented in multiple forms. According to cognitive load theory, redundant information increases working memory load; therefore, it affects learning negatively. Redundancy effects refer to "eliminating redundant material results in better performance than when the redundant material is included" (Kalyuga, Chadler, & Sweller, 1998). Researches presented below investigated this principle.

Chandler and Sweller's (1991) research study titled "Cognitive Load Theory and the Format of Instruction" is one of the first that investigated and supported the redundancy affect. In the study, six experiments were conducted to test the consequences of split-source and integrated information in electrical engineering and biology instructional materials. The first experiment was designed to compare conventional with integrated elementary electrical instructions. The experiment conducted in an industrial training setting lasted for 12 weeks and the subjects comprised 28 apprenticeships. The materials consisted of two conventional but modified sets of introductory instructional notes. The results suggested that integrated instructional formats are superior to conventional split-source format. The purpose of the second experiment was to investigate the possible differences between conventional and integrated instructions. The period and the subjects were the same as in Experiment 1. The results of the experiment 2 suggested that integrated instructions were less effective compared to split-source information in such areas. The results of experiments 3, 4, and 5 showed that the introduction of seemingly useful but unnecessary explanatory material, such as a commentary in a diagram presented in an integrated format, could have destructive effects. The results of the last experiment indicated a need for physical integration of the materials if individual materials could not be understood.

Young, Jin, and Sweller (1997) investigated split attention and redundancy effects on reading comprehension with explanatory notes. They conducted five experiments to examine the effects of cognitive load management using explanatory notes on reading comprehension among readers with different levels of expertise. The result of the first experiment supported the superiority of explanatory notes at high level of processing, i.e., comprehension. However, the results did not support low level processing, i.e., vocabulary learning using an integrated format. The results of the second experiment supported that vocabulary definitions integrated within a passage rather than on a separate vocabulary list enhanced 5th graders' comprehension while reducing vocabulary learning. The third experiment conducted with adult readers found that an integrated format reduced comprehension while it enhanced vocabulary learning. The efficiency of instruction depends on the extent to which it imposes an extraneous cognitive load. The same presentation format may facilitate performance or interfere with performance through either split-attention or redundancy effects, depending on learners' expertise.

Kalyuga, Chadler, and Sweller (1999) investigated the redundancy effect as an alternative to split attention instructional designs. The researchers hypothesized that any increase in cognitive resources, which required participants to process split-attention materials, decreases the resources available for learning due to a limited working memory capacity of learners. The researchers conducted two experiments. The first experiment aimed to improve split-attention effects using computer-based instructional material consisting of diagrams and text. This effect was realized by increasing effective working memory size by means of presenting the text in an auditory form. The results showed that auditory presentation of text was more effective compared to visual-only presentation. However, when the text was presented in both auditory and visual forms, it did not prove superior to visual-only presentation. In that case, the visual form forced a cognitive load that obstructed learning. The second experiment aimed to improve split-attention effects by using color-coding, which would reduce cognitive load by inducing search for diagrammatic referents in the text. In both experiments, the results showed that alternatives to split-attention instructional designs were effective because of reductions in cognitive load.

Mayer, Heiser, and Lonn (2001) investigated the redundancy effects on multimedia learning when presenting more material leads to less understanding. The researchers conducted four experiments. In these experiments, college students viewed an animation and listened to concurrent narration explaining the formation of lightning. The first two experiments assessed redundancy effects and the other two concerned coherent effects. While in the first experiment, the narration accompanied concurrent on-screen text, in the second experiment, narration was duplicated. According to the results, students in the second experiment performed worse on tests of retention and transfer than did students who received no on-screen text. This research measured the redundancy effect, which is consistent with the dual-channel theory of multimedia learning in which adding on-screen text can overload the visual information-processing channel. In two studies, learning a scientific explanation from a narrated animation was compromised by the addition of on-screen text that contained the same words as in the narration. The detrimental effects of redundant on-screen text were found both when the on-screen text was an exact copy of the corresponding narration and when it was a summary with the same words as the corresponding narration. This finding reflects a redundancy effect, which suggests that adding redundant on-screen text to a narrated animation detracts from multimedia learning. When presenting a multimedia lesson with spoken words and pictures, adding words in the form of printed text did not improve learning.

Craig, Gholson, and Driscoll (2002) conducted two experiments to explore the integration of animated pedagogical agents into multimedia environments in the context of Mayer's (2001) cognitive theory of multimedia learning. Agent properties produced no significant effects. Researchers explored the effects of three types of materials, printed text, spoken narration, and spoken narration with the printed text, to investigate the effects of redundancy in a multimedia environment that included an agent. The spoken-narration-only condition outperformed the other two groups, printed text and spoken narration with printed text. The results showed no differences between printed text and printed text with spoken narration. Craig et al. (2002) found a significant effect in the retention data. Students in the agent spoken only condition significantly outperformed those in the agent printed-only condition. When comparing the agent spoken-plus-printed condition with the agent spoken-only condition, the difference was in the direction predicted by the redundancy effect. A significant effect in the matching data was also found. Students in the agent spoken-only condition significantly outperformed those in the agent spoken-plus-printed condition. The matching data were clearly in line with predictions made based on the redundancy effect. The presence of printed text along with spoken text significantly interfered with performance. A significant effect in the transfer data was also found. Students in the agent spoken-only condition significantly outperformed those in both the agent printed-only and agent spoken-plus-printed condition. It seems consistent with the claim made by Mayer et al. (2001), who suggested that in multimedia learning environments, "presenting words as text and speech is worse than presenting words solely as speech" and that this conclusion holds when a pedagogical agent is also part of the environment (p. 187).

Mayer and Johnson (2008) hypothesized that adding on-screen labels to narrated graphics would improve performance on tests of retention. In addition, on-screen labels would not obstruct performance on tests of transfer. In the study, undergraduate students viewed a short multimedia PowerPoint presentation. Two experiments were conducted. The first aimed to determine the cognitive consequences of adding short, redundant on-screen text to a multimedia lesson. The second experiment was conducted to validate the first experiment. Students were assigned to redundant and non-redundant groups. For the redundant group, each slide also contained 2–3 printed words that were identical to the words in the narration. These words described the main event in the narration, and they were placed next to the corresponding part of the diagram. For the non-redundant group, on-screen text was not presented. The results revealed that the redundant group had better performance compared to the non-redundant group; however, only on a subsequent test of retention but not on transfer.

Conclusion

In this review, the researcher introduced basic research on the split attention, modality, and redundancy effects, although there are many other principles of multimedia learning. Split attention is related to presenting multiple source of information in spatially integrated format rather than disconnected format (Chandler & Sweller, 1991, 1992). Modality effect indicates that the verbal information should be presented narratively rather than in the screen mode in terms of effectiveness of multimedia learning environment (Moreno & Mayer, 1999). Redundancy effect indicates that removing the redundant text from the learning material is more likely to improve performance than learning materials with redundant information presented on the screen (Mayer, 2001).

Three types of cognitive load form the overall cognitive load caused by limited capacity of working memory. These types are intrinsic cognitive load, related to complexity of information; extraneous cognitive load, related to the design of the information; and germane cognitive, related to hard task learning process. These three types of cognitive load are related each other and cause overall cognitive load. Intrinsic cognitive load is the amount of the information and extraneous cognitive load is the design of information causes to have more effort for working memory. Therefore, extreme effort leads germane cognitive load.

Split attention effect occurs when the designer uses the text and pictures separately in a learning material. Therefore, according to the results on split attention, the designer should use the text and picture mode in spatially integrated position in learning materials. However, practically it is not always feasible, especially not if the text instructions are very prolonged. Erhel and Jamet (2006) suggested that using pop-up windows might be helpful in these situations. Modality effect is an alternative way of struggling with split attention effect. While the modality effect claims that people learn better from a multimedia message when the words are spoken rather than printed, the redundancy effect claims that removing rather than including redundant material improves the outcome. The three multimedia design principles are complementary each other, because when the designers want to use the materials in verbal and audio formats, they should consider the redundancy effect near the modality effects. Although this situation

applies to other principles, this review preferred specifically these two principles. The redundancy effect has implications for the design of multimedia instructional messages. When making a multimedia presentation consisting of a narrated animation, studies do not recommend adding on-screen text that duplicates words that are already spoken in the narration. Redundancy effect holds for situations in which the animated narration runs at a fast rate, if there is no learner control of the presentation.

In practicality, teachers should consider the three multimedia design principles simultaneously when they design the instruction. For example, when a teacher uses two modes multimedia materials including audio and visual he should consider the split attention principle when he wants to give extra instruction by himself. He needs to consider the correct time in order to wary of split students' attention, during the presentation. On the other hand, the teacher can reduce students' cognitive load by presenting the information from two channels. For example, the teacher can explain the graph verbally rather than presenting the text format. The information on the text format cause cognitive load when the student is searching the connection between the text and graphic. The other principle shows that presenting the same information in two different channels causes students' excessive cognitive load. Therefore, teachers should reduce the channels which present the same information. To some up, teachers, instructional designer, or multimedia designer should be consider these three main principles as well as the other multimedia design principles in terms of reducing the cognitive load on learner when they design the learning environment.

This review showed that instructional designers should be sensitive to limitations of learner's working memory capacity. For example, learner's cognitive capacity can be exceeded if the narrated animation does not contain sufficient interacting concepts that are presented too fast. Previous studies have shown that modality effect relates to design of narrated animations containing many interacting concepts. In addition, modality effect would be useful when using narrated animation rather than animation with onscreen text (Mayer, 2005). Studies in this review were primarily short laboratory experiments. However, future studies should be conducted in more realistic educational settings to increase the generalizability.

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Genişletilmiş Özet

Eğitim teknolojileri materyalleri, hareketli resimlerden bilgisayar temelli materyallere kadar yanlış uygulamalardan dolayı hayal kırıklığı yaratan bir geçmişe sahiptir (Cuban, 1986). Edison'un "hareketli resim eğitim sistemimizde devrim niteliğindedir ve birkaç yıl içinde kitapların yerini alacaktır." açıklaması bu argümana bir örnektir. Günümüzde benzer güçlü iddialar multimedya öğrenme ortamlarının potansiyeli

için de yapılmaktadır. Ancak, eğitimde multimedya araçların kullanımı ile ilgili öğrenme güçlüğü yaratacak bazı sorunlar ortaya çıkmıştır. Bu nedenle eğitim teknolojileri teorisyenleri ve uygulayıcıları bu araçları eğitimsel açıdan sorgulamaktadırlar (Hooper & Reinartz, 2002). Mayer ve Moreno (1998)'ya göre, multimedya öğrenme ortamları gibi yeni eğitim teknolojilerine ilişkin bu tür sorunları önlemek amacıyla, araştırma temelli teorilere dayanan bir rehber ihtiyacı duyulmaktadır. Bu rehber yardımıyla öğretim teknolojilerinin etkin kullanımının öğrenci gelişimi takip edilerek uygulanabilmesi gereklidir. Multimedia tasarım ilkeleri, öğretim tasarımcılarına yönelik eğitimsel aksaklıkları çözmeye yönelik ve öğrenmeyi geliştirmek amaçlı hazırlanmış bir klavuzdur.

Bu çalışmada, multimedya tasarım ilkelerinden, dikkat bölünmesi (split-attention), biçem etkisi (modality effect), ve aşırılık ilkesi (redundancy effect) öğrenci performansları üzerine etkisini araştıran çalışmalar incelenmektedir. Akademik çalışmalar 1991-2012 yılları arasında Web of science, ERIC, and PsycINFO very tabanlarında “redundancy effect”, “modality effect”, “cognitive load theory”, ve “multimedia design” anahtar sözcükleri ile taranmış hakemli makaleleri oluşturmaktadır. Birçok multimedya öğrenme prensipleri olmasına rağmen, bu çalışmada yalnızca üç temel prensip olan dikkat bölünmesi, biçem etkisi ve aşırılık etkisi ilkelerine değinilmiştir.

Bilişsel yük teorisine göre (cognitive load theory), bilgi, çalışan bellekteki (working memory) aşırı yüklenme göz önünde bulundurularak sunulmalıdır. Bilgi birden fazla kaynaktan uzaysal olarak bağlantılı bir biçimde sunulmadığında multimedya tasarım ilkelerinden biri olan dikkat bölünmesi, ortaya çıkar (Kalyuga, Chadler, & Sweller, 1999). Öğrenci, uzaysal olarak bağlantılı olmayan kaynaklar arasındaki bağlantıyı ararken, bilgiyi çalışan bellekte tutması gerekir. Bu işlem bilişsel yüke sebep olur. Bir diğer multimedya tasarım ilkesi olan biçem etkisi, multimedya tasarımı yaparken, ekranda yazının görsel olarak sunulması yerine işitsel olarak sunulması gerektiğini savunur (Moreno & Mayer, 1999). Bu ilkeye göre, birden fazla duyusal kanal kullanımı çalışan bellekteki etkiyi artırır. Biçem etkisi bilgiyi çoklu ortam materyalleri ile sunarken, kelimelerin yazılı olarak sunulması yerine sözlü olarak sunulduğunda insanların daha iyi öğrendiğini savunurken, aşırılık prensibi aynı bilgiyi sunan iki kanalın birden verilmesi yerine tek bir tanesinin kullanımının öğrenmeyi olumlu yönde etkilediğini savunur. Tindall-Ford, Chandler ve Sweller (1997) işitsel metin ve görsel diyagramlar gibi iki kanal sunum teknikleri kullanılarak hazırlanan öğretim materyalleri, görsel metin ve görsel diyagramlar gibi tek kanal kullanılan öğretim materyallerinden daha etkili olduğunu çalışmalarında göstermişlerdir. Çalışmada yer alan üçüncü ilke aşırılık etkisi, bilginin sunumunda aşırı materyal kullanımının öğrenmeyi engellediğini savunmaktadır. Aşırılık etkisi, gereğinden fazla bilgi sunumunun öğrenmeyi olumsuz yönde etkilemesidir. Bu gereksiz materyallerin çıkarılması öğrenmeyi artırır. Bir öğretim tasarımcısının multimedya öğrenme ortamı dizayn ederken, bilişsel yükü azaltmak ve öğrenmeyi daha etkili hale getirmek için çoklu ortam tasarım ilkelerini göz önünde bulundurması gerekmektedir.

Bu çalışmada belirtilen üç ilke, farklı kaynakların öğretim tasarımcıları tarafından eşzamanlı kullanılmak istendiğinde birbirini tamamlar özellik göstermektedir. Buna göre, bir öğretim tasarımcısının multimedya öğrenme ortamı dizayn ederken, birbirini tamamlayıcı etkisinden dolayı bu üç prensibi birarada kullanmaya dikkat etmesi gerekmektedir. Örneğin bir öğretmen iki kanalın kullanıldığı bir multimedya öğrenme materyali ile ders işlerken, araya girip müdahale etmek istediğinde uygun zamanı seçmesi gerekmektedir. Aksi takdirde öğrencide dikkat bölünmesine ve öğrenmesinin olumsuz yönde etkilenmesine sebep olabilir. Gene aynı şekilde, bilgi aktarımı esnasında bilgiyi tek bir kanal yerine çift kanaldan vererek öğrencinin bilişsel yükünün azalmasını sağlayabilir. Buna örnek olarak, öğretmen öğrenciye dersle ilgili olarak sunmuş olduğu grafiği tanımlarken, öğrencinin bu ilişkiyi kendisinin kurmasını beklemek yerine, sözlü olarak grafik tanımlamasını yaparak öğrencinin bilişsel yükünü azaltabilir. Bu durum biçem etkisi prensibine bir örnek olarak gösterilebilir. Bilgiyi vermek için birden fazla kanal kullanan öğretmen, gene bu bilginin aşırılık ilkesine göre düzenlenmesi gerekliliğini uygulamalıdır. Aynı bilgi hem sözlü hem de yazılı olarak sunulduğunda öğrencide bilişsel yüke sebep olabilir. Sonuç olarak bilgiyi dizayn edenler; öğretmenlerin ve multimedya öğretim tasarımcılarının multimedya tasarım ilkelerini göz önünde bulundurmaları, daha etkili bir öğrenme ortamı tasarlayabilmek için önemlidir.