

## Optimizing Multimedia Learning Objects for Learning in a Procedural-based Course

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**Abstract.** The prevalent use of multimedia learning objects in instructions particularly in e-learning platforms has spurred the interests of many studies to investigate their usability and effectiveness. It is, however, equally important to align proven instructional design principles in the design process in order to maximize learning. This study adopted Principles of Multimedia Design to guide the development of a set of learning objects for a procedural-based course, which involved 54 students for 10 weeks. The findings of the study revealed that the students showed positive acceptance of using the learning objects as the learning materials. A majority of them also reported their capability to perform the given tasks. The findings have provided valuable insights on considerations needed for the design of learning objects and confirmed that the redundancy principle within Mayer's principles will not affect the students' cognition largely due to the students' language proficiency.

**Keywords:** Principles of Multimedia Design, Learning Objects, Visual Learners, Self-Paced Learning, Procedural-Based Learning.

### 1. Introduction

Learning objects can be accepted as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" [1]. The learning objects are created in smaller pieces for the purpose of maximizing the number of learning situations in which the resource can be utilized. Kay and Knaack [2], on the other hand, explain that learning objects are interactive tools that support the learning of a particular concept by enhancing the cognitive process of learners. A suitable learning object should be able to stimulate learners' motivation. In other words, a learning object might be considered less suitable for a learner if it makes his or her learning procedure more difficult or less interesting [3]

Studies pertaining to the areas of standardization, metadata and packaging of learning objects have been widely conducted by major organizations such as those by IMS Global Learning Consortium, Inc. [4] and ADL Initiative and IEEE Learning Technology Standards Committee [5]. Besides these issues, the learning objects are also facing quality artefact issues that deal specifically with the design concept as to how it can function based on its stand-alone yet self-contained object as an effectively high quality learning materials for web-based learning. Recent trends, however, have shifted towards investigating the personalization of learning objects in order to improve their effectiveness in instructions [6, 7, 8]. In order for a learning object to be accepted as appropriate with respect to the learning goal, it requires a greater understanding of how such learning object can be incorporated for instructional purposes. In order to ensure the effectiveness of content delivery from the learning objects to the learners, it must conform to a set of instructional design principles whose primary concerns are the instructional aspects [1]. This study aims to address this gap by investigating how multimedia learning objects can be optimised for learning by considering Mayer's Principles of Multimedia Design [8].

### 2. Procedural-based Course and Multimedia Design Principles

Procedural-based learning is an approach that combines several sources of information such as demonstrations, real examples and user annotation to allow learners to learn a set of skills or content

knowledge by combining sub-steps [9]. Procedural-based courses involve demonstrating step-by-step skills to accomplish a specific task. While learning in the Information-Age is being reconceived as a personalised and learner-centred activity [10], it is very important to ensure the pieces of a learning object are able to train learners to be competent on a task based on the demonstration viewed. Many studies have proven that the use of multimedia can enhance learning [11, 12]. In order to maximize the potential of multimedia in learning, Mayer and Moreno [13] proposed the Cognitive Theory of Multimedia Learning, which outlines six principles that an instructional designer must consider. The principles are listed as follow:

- *Visual Split-Attention Principle* - Students learn better when the instructional material does not require them to split their visual working memory between multiple sources of mutually referring information.
- *Auditory Split-Attention Principle* - Students learn better when extraneous auditory material (such as music and irrelevant sounds) is excluded rather than included in multimedia explanations.
- *Modality Principle* - Students learn better when the verbal information is presented as speech rather than visually as on-screen text both for concurrent and sequential presentations.
- *Spatial Contiguity Principle* - Students learn better when on-screen text and visual materials are physically integrated rather than separated.
- *Temporal Contiguity Principle* - Students learn better when verbal and visual materials are temporally synchronized rather than separated in time.
- *Self-Reference Principle* – Students learn better when instructional explanations are provided in a personalized, dialogue style rather than a non-personalized, monologue style.

These principles serve as a guideline for instructional designer when designing any multimedia learning object so that the ultimate goal of enhancing learning can be addressed. Clark and Mayer [14] utilised the earlier principles and reformulate them into a more comprehensive design guidelines known as The Principles of Multimedia Design. The framework is then improved by Mayer [8]. Several studies [15, 16] have reported positive results from the implementation of the principles in the design and development process of instructional materials. Learning with multimedia is empirically proven to be more affective when these principles are considered.

### **3. Methodology**

The present study was conducted at the Multimedia University (Cyberjaya campus), Malaysia which offers few online courses located via its in-house Learning Management System called the Multimedia Learning System (MMLS). A procedural-based course, Computer Graphics II, that resembles the settings often used by Clark and Mayer [14] was identified and carried out in this study. The aim of the course is to provide demonstration to the students so that they are able to edit bitmap images using Adobe Photoshop. A total of 54 undergraduates of Faculty of Creative Multimedia, Multimedia University were conveniently sampled for this study.

The learning objects were presented to the students on a website hosted from the Multimedia University. The students can access the materials at anytime from anywhere, without password protection. Instructions were given to the students to access the learning objects during their 2-hour weekly tutorial sessions and also encouraged to refer to the learning objects anytime after class hours. A set of questionnaire was given to the students after the 10-weeks period. Each item was listed based on 6-point Likert scale of Strongly Agree, Somewhat Agree, Agree, Somewhat Disagree, Disagree and Totally Disagree. To ensure the validity of this study, the students were instructed to access to the website that consist the set of learning objects at least five hours per week. Unfortunately, only 56% of the students fulfilled the requirement. Among the reasons given were lack of time, no compulsory obligation and slow Internet speed. Nevertheless, their feedback from the gathered questionnaire was still analysed in order to provide a greater understanding of the findings.

### **4. Results and Discussion**

The students' perception on narration and its effect towards movies is tabulated in Table 2. The total agreement was calculated by adding up the students' responses for Strongly Agree, Somewhat Agree and Agree. This can provide a clearer picture of the overall perception of the students.

Table 2. Learners' perception on narration and its effect towards movies

Item		<i>f</i>	Total agreement (%)	Mean	Std Dev
A	The movies helped you to learn the content.	50	92.6	3.93	1.13
B	The presentation of the movies was clear.	48	88.9	3.67	1.21
C	The quality of the movies was acceptable.	48	88.9	3.73	1.32

Students were asked on the ability of the learning objects (referred to as *movie* in the students' context) to help them in learning the skills required to complete the tasks (to achieve the learning objectives). Item A from Table 2 showed that the majority of the students (92.6%) agreed that the movies helped them to learn the content. However, it is not the focus of this study to investigate which aspect or components in the movie that helped them to learn more. In addition, Item B and Item C investigated on the clarity and quality of the learning objects in terms of its content representation, and in this context, they are the visuals, animation, text, and sound. 88.9% of the students noted that the presentation of the movies was clear. However, students complained that the narration was too soft due to the compression format required by ViewletBuilder. Often, designers have to sacrifice audio quality against the file size for Web delivery.

#### 4.1. Perceived Competency

In order to ensure that upon completion a student is able to demonstrate some understanding towards a lesson taught within the procedural course, the students were also asked if they are competent in working on a task after they have completed the learning objects. 92.6% of the students stated that they are able to perform the task as required, while the rest (7.4%) stated they are not confident to complete the task due to their own behaviour of being "*a slow learner*". They also felt that time constraints made them panic and stated their preference to perform the tasks with extra notes at their own pace. None of the reasons were because of the limitation of the learning objects. Even though the participants' competency were not statistically analyzed in this paper, their perceptions about their competency level is equally important because of the self-determination theory stated that positive perception will determine their motivation and self-determination and thus increase their interest to learn [18].

#### 4.2. Self-Paced learning and Independency

During class the students learnt from the learning objects. After class sessions, the students did their revision based on the learning objects. When the students were asked about their perceptions on whether the learning objects could allow them to learn on their own pace, 21 of the students agreed as opposed to only 1 of students who disagreed (refer Table 3).

Table 3. Students' response on learning self-paced

Description/N=54	Agree	I think so	Disagree
I can learn according to my own learning pace	21	32	1
I don't have to wait for other student to proceed to another movie	33	12	9

33 of the students felt glad of not having to wait for other students to proceed to another movie, which in turn allowed them to explore more on other tasks. As Tway [19] mentioned, the ability of multimedia that allows the students to explore and learn at different paces provides the students with the opportunity to learn at their full potential because they have the flexibility to choose the skills they want to learn [19].

#### 4.3. Importance of Audio Narration

Modality principle emphasized that the replacement of text with narration is viewed an important decision made by designers. In this study, we have investigated to what extent is narration important to the students.

Table 4. Actions taken by students while listening to the narration

Actions taken	Frequency (multiple)
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	answers)(N=42)
make sure I complete the narration before proceed to other parts	22
listen all if I have the time	12
listen once	11
Turn the voice off	4
listen all if the narration is short (less than 5 seconds)	3
Totally ignore the voice	0

Based on Table 4, this study acknowledged the importance of narration based on the students' actions towards narration in the learning objects. When asked about their usual actions while listening to the narration, the highest expression made was 22 times noting that they would complete the narration before proceeding to other parts of the learning objects. A student commented that they would listen again if they did not understand the narration. No student (0%) indicated that they would totally ignore the voice although 4 students mentioned that they might turn the voice off.

#### 4.4. Non-Redundancy of the Narration

Results from the study reported that the students did not find the onscreen text and the narration to be redundant. As stated previously, the students who participated in this study use English as a secondary language, therefore text accompanied by narration on some visuals was believed to have allowed clearer understanding of the demonstration explained in the learning objects. To ascertain the findings from this study, a second study was carried out to investigate whether the narration in the learning objects was redundant.

Table 5. Students' perception on the redundancy of the narration

Expression (N=54)	<i>f</i> Not redundant at all	<i>f</i> Neutral	<i>f</i> Redundant
Participant	2	52	0

Based on Table 5, no student actually replied that the narration was redundant. Although majority of the students were neutral in their reply, 2 students replied that the narration was not redundant at all. Students who rated "Not redundant at all" were probed further to state their reason: - one student stated that "*because it reassures me and sometimes the narration gives a better understanding*" while the other student thought that including the narration made the learning objects more interesting. This notion corroborated with the findings based on the previous data (Table 5) that students found the narration useful for repeated listening if they failed to understand it upon the first listen. This result is also in line with the findings from Debusse, Hede and Lawley [20], which discovered that there were no differences in learning efficacy of simultaneous audio and on-screen text for online learning courses.

Another possible cause for this could probably be due to the voice of the narrator. The voice should fit the need of the majority. In this study, the narrator spoke in English which is the language the majority of the students are proficient in. For students who may be weak in English, text-accompanied-narration is viewed as an advantage as they find it as a means to have a permanent record of the tasks demonstrated. Even though the learning objects did not adhere to the redundancy principle as explained, students showed favour to the learning objects. The students perceived that if narration was taken out from the learning objects, it would affect their cognition as well as their learning process. A few students perceived that narration would affect their emotions. This findings confirmed Alten's explanation that generally voice is used to provide direct cognitive information, but by changing the pace, emphasis or inflection of words, it can also affect the mood and the meaning of the sentence [17].

## 5. Conclusion

The findings from this study have shown a successful implementation of Mayer's Principles of Multimedia Design into learning objects. Learners have responded very positively on the learning objects developed based on the principles. It has proven that with proper guidance from instructional principles, learning objects can be designed and developed in order to increase the effectiveness of the learning process.

By identifying how learners will learn better, it allows the instructional designers to design tasks which are not only engaging but also effective in cultivating learning. The study has also shown that audio narration is perceived as a good supplementary tool for learning despite it being noted as redundant by Mayer [8]. Hence, designers should pay close attention in producing audio narration. Future study can investigate further on the effect of redundancy principle on language proficiency and learning in general.

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