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# "USiena" vs "only video": comparing the two models for a mobile course design

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## ABSTRACT

The aim of the research is to investigate how the technological tools that support traditional teaching methods (such as the video files recorded by the lecturer) help learners to study improving their evaluations for examinations. Starting from multimedia learning theories, a mobile course model has been designed using the User-Centered Design methodology (USiena) and the experimental method has been used to carry out a "pilot study" with 32 students. The goal of experimentation was to compare learning results through four experiments, performed in a "mobility environment" (an outdoor area near the university building, using an iPad with "iTunesU App" installed). The experimental hypothesis was that USiena model would favor the contents transmission, compared to a model that only provides for the - lecturer vision that explains (Sparring). The experimentation results have confirmed this hypothesis: students who used USiena model have obtained an average score of 26/30, against a 22/30 rating for the "video-only" model.

**Keywods :** Experimentation, iTunesU, Mobile, Mobile learning, Participatory planning, Prototyping, User-Centered Design

## 1. INTRODUCTION

The aim of this research was to investigate how technological tools supporting traditional teaching (such as audio and video files recorded by the lecturer), help learners to study improving their evaluations for examinations.

Starting from multimedia learning theories, a mobile course model has been designed using the User-Centered Design methodology (USiena model), a comparison model has been chosen which displays only the lecturer explaining (Sparring model), four prototypals contents have been produced (two files created with USiena model and two files created with Sparring model) and the experimental method has been used to carry out a “pilot study” with 32 students.

Four “mobility” experiments has been performed: a typical urban environment outside the university building. In each experiment, students have used an iPad with “iTunesU App” installed to “view” two video contents (products using USiena model and Sparring model).

After each experiment, a multiple choice questionnaire has been used to evaluate the learning level. To achieve a direct and immediate feedback from the students, the test ended with an interview.

The aim of the experimentation was to compare the learning levels through the results obtained by students in the four experiments. The experimental hypothesis was that students who used the USiena model would get a better evaluation. The results of the experimentation have confirmed this hypothesis: students who used USiena model have obtained an average score of 26/30, against a 22/30 rating to "video-only" model.

## 2. MATERIALS AND METHODS

The methodological approach followed, focused on multimedia learning theories, User-Centered Design and experimental method.

Dual Coding Theory (Paivio, 1991a) shows how the visual and auditory stimuli coming from the outside world, are intercepted by different senses and are processed by our brains differently. There are two coding systems for processing information (and their representation): a verbal system and a non-verbal system. In multimedia learning, according Paivio, these two systems are integrated but are processed separately. The experimental results confirm the hypothesis, according to which, memory benefits from the dual coding (Paivio, 1991b).

The Cognitive Load Theory (Chandler & Sweller, 1991) focuses on two concepts: cognitive resources available during task execution, “how” these resources are used to achieve specific learning objectives (avoiding cognitive overload). Student, to learn, needs to process information by building integrated representations of text and illustrations. Seen that cognitive resources are limited, is only possible to process simultaneously a certain amount of information. In multimedia learning environment, not to excessively overload the brain, is better to use various educational methods rather than just one.

The Multimedia Representations Theory (Schnotz, 2001) shows that there are two types of representations: external and internal. External representations can be “exclusively” descriptive (verbal symbols such as text) or pictorial (iconic symbols such as images or shapes); in both cases the representations are associated with a certain content. Internal representations belong to the subjective dimension and coincide with the mental models (or

mental images). Schnotz describes the multimedia learning how the interaction between external and internal representations, emphasizing the nature and role (fundamental) played by these representations in multimedia knowledge construction.

According to Richard Mayer learning requires the "active" participation of the student, through a series of cognitive processes: the outcome of these processes (concept of "active development") is the construction of a coherent mental representation, useful for learning contents (Mayer, 2000). The principle known as "multimedia principle" states that "… *people learn more deeply from words and pictures than from words alone* ..." (Mayer 2005, p. 47). However, simply adding words to images is not an effective way to achieve multimedia learning. Then develops a model that takes into account the theories described above. The purpose is create teaching aids that work in the same way the human mind works. This is the basis for Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2001; Mayer, 2005).

Towards the end of the 70', in the US, companies beginning to work in a different way. The objective is to design efficient and usable systems, trying to have a better understanding of the users, their needs and their interests (Karat and Karat, 2003).

However is just in the 80' that Donald Norman introduces the "User-Centered Design" (UCD) concept. This term was created within the research laboratory directed by Norman at the University of California, San Diego (USCD) and spreads after the publication of the book entitled "User-Centered System Design: New Perspectives on Human-Computer Interaction" (Norman & Draper, 1986).

Norman later, in his book "The psychology of everyday things" (title changed to "The design of everyday things"), further develops the UCD concept stressing the importance of "consider user needs" and centering his attention on usability (Norman, 1988; Norman, 1990; Norman, 2013). He offers four basic tips to designers; in particular the design should be (Norman 1988, p.188):

- make it easy to determine what actions are possible at any moment;
- make things visible, including the conceptual model of the system, the alternative actions, and the results of actions;
- make it easy to evaluate the current state of the system;

- follow natural mappings between intentions and the required actions; between actions and the resulting effect; and between the information that is visible and the interpretation of the system state.

These recommendations put the user "in the core" of the project. The role of the designer is to make easier the tasks that need to be played by users, ensuring that they are able to use the product "as expected" and "with a minimum effort".

The UCD is a methodology comprising a group of different techniques and different interactive activities. Allows the development of artifacts which take into account, from the earliest phases of the design process, the "point of view" of the end users: needs, demands, interests, expectations, possible limitations, the ways by which they are able to work and want to work in the future.

The philosophy behind this methodology is the attention to the potentials and the characteristics of the technological product, but "even" and "primarily" to the people who will use it, in order to promote the best possible use.

## 3. MOBILE COURSE MODEL

A mobile course model has been designed (USiena model), using the User-Centered Design (UCD) methodology: students and lecturers have been involved in a participatory planning to define the course structure (today's students design the course for the students of tomorrow).

The most significant aspects of the design have been:

- the course will have a modular structure (this will allow lecturers to add, edit and remove the single module without altering the course structure);
- each module will contain only a specific topic;
- each module will have a maximum length of 10 minutes;
- for each module will be made available audio, video and PDF contents;
- each video content will begin with a concept map concerning the topic of the module;
- in all video contents will appear – simultaneously and permanently – the lecturer who explains (on the left, in a small box) and the slides used during the lesson (on the right, to reinforce the concept shown);

- when the lecturer explains a specific concept contained in the slide, some “highlights” will be used to attract the student’s attention on that specific point;
- for each course will be produced an initial “Welcome” video (illustrating the content of the collection), a “Getting started” video (outlining the learning environment and the modules that will be contained), a series of videos related to “Tests in process” (the student directly verify his learning level).

## 4.EXPERIMENTATION

The experimental method has been used to carry out a “pilot study” with 32 subjects.

From the "Genetics of populations and conservationist" course of degree in Biodiversity and Nature Conservation, "Genetic drift" lecture was chosen. From this educational content two concepts have been extracted, which were used in experimentation: "Biodiversity and Nature Conservation" and "Genetic drift and natural selection". For each of the two concepts, two prototype video content have been developed, using both the model "Sparring" (figure 1) and the "USiena" model (figure 2).

**figure 1 - "Sparring" model (University of Siena source)**

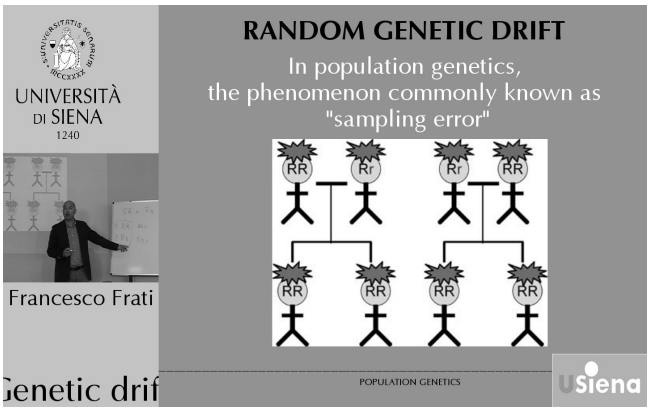


**figure 2 - "USiena" model (University of Siena source)**

Were involved in the experimentation 32 university students (15 males and 17 females) - aged between 20 and 24 years - who attended the graduate programs in the physical and natural sciences. The experimentation has been subdivided in four experiments "between subjects", each of them has been conducted in a mobile perspective: were performed among the people, in an outdoor area near the building college. The 32 students, by drawing lots, were divided into four groups <> each consisting of 8 subjects. Each group has participated in a single experiment.

The task assigned to the subjects was: view learning content created with both models, evaluating the learning level through a multiple choice questionnaire. To perform this task has been used an iPad, with iTunesU App installed. During the execution of the task, we asked the subjects to speak loudly - preferably expressing doubts and misgivings - to videotape the interaction. Students were free to stop watching, to deepen better those concepts they did not understand. The subjects were informed that the clarifications related to doubts and misgivings, would be provided only at the end of the experiment.

The aim of experimentation was to investigate how the model "USiena" influences learning. The experimental hypothesis was that the proposed design solution, facilitates contents transmission improving learning. The independent variable is the model course while the dependent variable is the number of correct answers given by students (learning level).

In the first experiment, subjects studied the "Biodiversity and nature conservation" concept using the "USiena" model and the "Genetic drift and natural selection" concept using the "Sparring" model. In the second experiment, subjects studied the "Biodiversity and nature conservation" concept using the "Sparring" model and the "Genetic drift and natural

selection" concept using the "USiena" model. In the third experiment, the subjects studied the "Genetic drift and natural selection" concept using the "USiena" model and the "Biodiversity and nature conservation" concept using the "Sparring" model. In the fourth experiment, the subjects studied the "Genetic drift and natural selection" concept using the "Sparring" model and the "Biodiversity and nature conservation" concept using the "USiena" model.

Table 01 summarizes the experimentation:

| **Experiment 1** | **Experiment 2** | **Experiment 3** | **Experiment 4** |
|---|---|---|---|
| biodiversity (usiena) | biodiversity (sparring) | selection (usiena) | selection (sparring) |
| vs | vs | vs | vs |
| selection (sparring) | selection (usiena) | biodiversity (sparring) | biodiversity (usiena) |
| Legenda:<br>biodiversity = “Biodiversity and nature conservation” concept<br>selection = “Genetic drift and natural selection” concept<br>usiena = “USiena” model<br>sparring = “Sparring” model | | | |

**table 01 - The experimentation (University of Siena source)**

At the end of each experiment a multiple choice questionnaire with sixty questions was used, thirty on the topic "Biodiversity and nature conservation" and thirty concerning "Genetic drift and natural selection", to evaluate the learning level of the learners. In this manner, considering the number of correct answers provided for each model, was possible to compare the knowledge acquisition from the students. The experimentation ended with an individual interview, in order to receive a direct and immediate feedback from students.

Table 02 shows - for each experiment - the total number of correct answers given by the students.

| Experiment 1 | | | Experiment 2 | | |
|---|---|---|---|---|---|
| subject 1 | biodiversity(usiena):25 | selection(sparring):23 | subject 9 | biodiversity(sparring):24 | selection(usiena):26 |
| subject 2 | biodiversity(usiena):26 | selection(sparring):21 | subject 10 | biodiversity(sparring):20 | selection(usiena):25 |
| subject 3 | biodiversity(usiena):25 | selection(sparring):22 | subject 11 | biodiversity(sparring):22 | selection(usiena):25 |
| subject 4 | biodiversity(usiena):27 | selection(sparring):21 | subject 12 | biodiversity(sparring):22 | selection(usiena):27 |
| subject 5 | biodiversity(usiena):26 | selection(sparring):23 | subject 13 | biodiversity(sparring):21 | selection(usiena):28 |
| subject 6 | biodiversity(usiena):28 | selection(sparring):25 | subject 14 | biodiversity(sparring):24 | selection(usiena):26 |
| subject 7 | biodiversity(usiena):25 | selection(sparring):22 | subject 15 | biodiversity(sparring):21 | selection(usiena):25 |
| subject 8 | biodiversity(usiena):26 | selection(sparring):20 | subject 16 | biodiversity(sparring):22 | selection(usiena):25 |

| Experiment 3 | Experiment 4 |
|---|---|
| subject 17 selection(usiena):26<br>biodiversity(sparring):24 | subject 25 selection(sparring):24<br>biodiversity(usiena):26 |
| subject 18 selection(usiena):27<br>biodiversity(sparring):25 | subject 26 selection(sparring):23<br>biodiversity(usiena):26 |
| subject 19 selection(usiena):25<br>biodiversity(sparring):20 | subject 27 selection(sparring):21<br>biodiversity(usiena):25 |
| subject 20 selection(usiena):26<br>biodiversity(sparring):21 | subject 28 selection(sparring):22<br>biodiversity(usiena):27 |
| subject 21 selection(usiena):24<br>biodiversity(sparring):19 | subject 29 selection(sparring):20<br>biodiversity(usiena):24 |
| subject 22 selection(usiena):27<br>biodiversity(sparring):20 | subject 30 selection(sparring):20<br>biodiversity(usiena):26 |
| subject 23 selection(usiena):28<br>biodiversity(sparring):22 | subject 31 selection(sparring):21<br>biodiversity(usiena):27 |
| subject 24 selection(usiena):25<br>biodiversity(sparring):20 | subject 32 selection(sparring):22<br>biodiversity(usiena):25 |

Legenda:

biodiversity = “Biodiversity and nature conservation” concept

selection = “Genetic drift and natural selection” concept

usiena = “USiena” model

sparring = “Sparring” model

**table 02 - Correct answers (University of Siena source)**

Based on these data, for each experiment, the average value of the results obtained by students (correct answers) was calculated - considering the assigned task and the used model (table 03).

| | **biodiversity** | | | **selection** | | | **usiena** | | | **sparring** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | M | SD | A | M | SD | A | M | SD | A | M | SD |
| **Experiment 1** | 26 | 26 | 1.07 | 22 | 22 | 1.55 | 26 | 26 | 1.07 | 22 | 22 | 1.55 |
| **Experiment 2** | 22 | 22 | 1.41 | 26 | 26 | 1.13 | 26 | 26 | 1.13 | 22 | 22 | 1.13 |
| **Experiment 3** | 21 | 21 | 2.13 | 26 | 26 | 1.31 | 26 | 26 | 1.31 | 21 | 21 | 1.31 |
| **Experiment 4** | 26 | 26 | 1.04 | 22 | 22 | 1.41 | 26 | 26 | 1.04 | 22 | 22 | 1.41 |
| Legenda: A = Average M = Median SD = Standard Deviation | | | | | | | | | | | | |

**table 03 - Average, Median and Standard Deviation (University of Siena source)**

Table 04 shows, for each experiment, a graphic containing the average values in the above table.

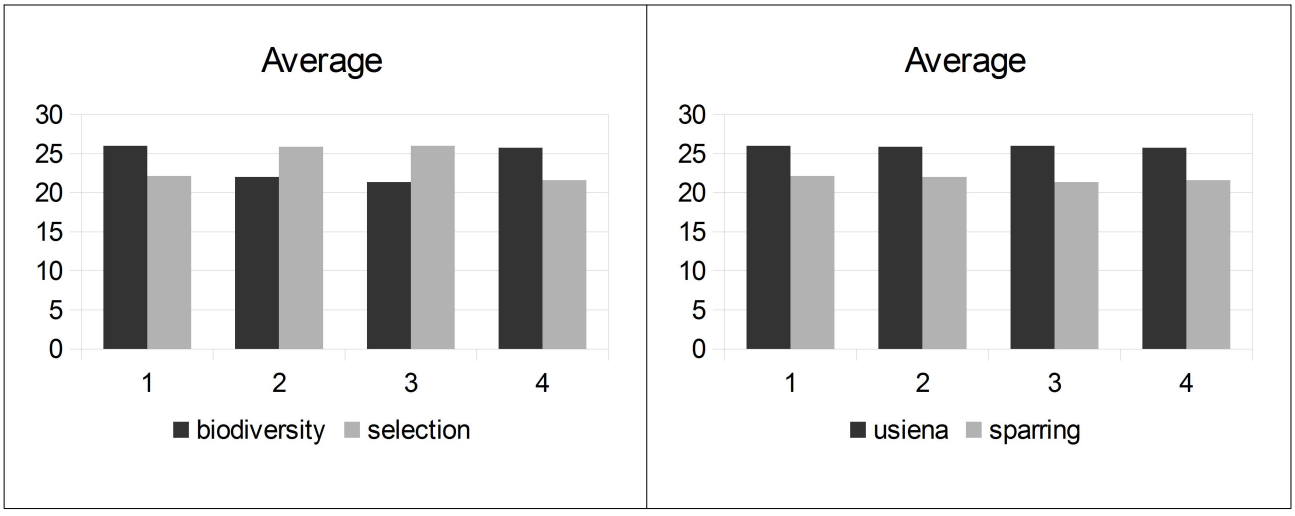


**table 04 - Average for experiment (University of Siena source)**

On the values obtained from 32 subjects (table 02), the Wilcoxon-Mann-Whitney test was applied. Comparing the values of the variables within the same experiment, the test results were all significant (table 05).

| | biodiversity vs selection | usiena vs sparring |
|---|---|---|
| **Experiment 1** | V = 36, p-value = 0.01298 | V = 36, p-value = 0.01368 |
| **Experiment 2** | V = 0, p-value = 0.01391 | V = 36, p-value = 0.01321 |
| **Experiment 3** | V = 0, p-value = 0.01298 | V = 36, p-value = 0.01198 |
| **Experiment 4** | V = 36, p-value = 0.01391 | V = 36, p-value = 0.01356 |

**table 05 - Wilcoxon Signed Rank Test (University of Siena source)**

Comparing the value of a variable with the other variables, for each of the four experiments, 8 "significant" and 16 "not significant" results were obtained. For example, the values for the "Biodiversity and nature conservation" concept are reported (table 06).

| | biodiversity |
|---|---|
| **Experiment 1 vs Experiment 2** | W = 64, p-value = 0.0008295 |
| **Experiment 1 vs Experiment 3** | W = 62.5, p-value = 0.001407 |
| **Experiment 1 vs Experiment 4** | W = 34.5, p-value = 0.826 |
| **Experiment 2 vs Experiment 3** | W = 41, p-value = 0.362 |
| **Experiment 2 vs Experiment 4** | W = 1, p-value = 0.001199 |
| **Experiment 3 vs Experiment 4** | W = 2.5, p-value = 0.002088 |

**table 06 - Wilcoxon Rank Sum Test (source: University of Siena)**

Table 07 shows the results of the experimentation, obtained by crossing each other, the average value of correct answers given by 32 students (table 02) - for each device and for each content.

| | | | | | |
|---|---|---|---|---|---|
| biodiversity: 24 | usiena: 26 | biodiversity (usiena): 26 | biodiversity (sparring): 22 | selection (usiena): 26 | selection (sparring): 22 |
| selection: 24 | sparring: 22 | selection (sparring): 22 | selection (usiena): 26 | biodiversity (sparring): 21 | biodiversity (usiena): 26 |
| Legenda:<br>biodiversity = “Biodiversity and nature conservation” concept<br>selection = “Genetic drift and natural selection” concept<br>usiena = “USiena” model<br>sparring = “Sparring” model | | | | | |

**table 07 - Results of experimentation (University of Siena source)**

# 5. CONCLUSIONS AND DISCUSSIONS

The aim of the research is to investigate how the technological tools that support traditional teaching methods (such as the video files recorded by the lecturer) help learners to study improving their evaluations for examinations.

The experimental hypothesis was that USiena model would favor the contents transmission, compared to a model that only provides for the - lecturer vision that explains (Sparring). The experimentation results have confirmed this hypothesis: students who used USiena model have obtained an average score of 26/30, against a 22/30 rating for the "video-only" model.

In particular, the learning level was influenced by the model used, considering the results both in their generality and in their specificity (in relation to a particular content). On the contrary, considering the different types of concepts studied, an identical ease/difficulty of learning has emerged (table 7).

The main results obtained from the final interviews can be summarized as follows:

- in relation to the "expectations" on "mobile course model" designed, users ratings have been positive (26 of 32) - the remaining 6 subjects have however moved constructive criticism (the suggested changes were minimal and referred to graphics and video-slide proportions);

- in relation to the "personal satisfaction" proven by users interacting with the device, the results were almost identical in both situations (24 subjects positively evaluate the interaction with the "Sparring" model and 28 with the "Usiena" model);
- in relation to the "didactic experience" sustained, valuations are both highly positive (27 for "Sparring" model and 28 for the "Usiena" model);

Starting from this work, which could be the ideas for future research?

Surely is necessary to assess whether the proposed model can be "exported" in other educational areas (economics, medicine, humanities and social sciences just to make an example). In a user-centered perspective, experiments in these disciplinary areas are fundamental to the model "release".

Just as is also crucial involve the lecturers in the participatory planning, in order to evaluate whether the "service providers" expectations - about the proposed model - coincide with the "service users" expectations.

Always starting from the feedback received by students during the final interview, the model may be subject to critical issues for those matters where - the lecturer - should write a series of characters according to a precise timetable (the lecturer writing a formula on the blackboard) . In these cases, it might include the use of an interactive whiteboard (IWB) that allows video recording of the events that occur in the desktop.

Finally, it would be desirable to achieve a full course "prototypal", evaluate the student learning level "with" and "without" the model designed and then compare the average rating of the current year with the average rating of the past years.

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