Dissertation

DESIGNING ADAPTIVE LEARNING MATERIAL IN MOODLE TO SUPPORT USERS COGNITIVE ABILITY

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ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΥΠΡΟΥ

ΤΜΗΜΑ ΠΛΗΡΟΦΟΡΙΚΗΣ

ΣΧΕΔΙΑΣΜΟΣ ΠΡΟΣΑΡΜΟΣΤΙΚΟΥ ΜΑΘΗΣΙΑΚΟΥ ΥΛΙΚΟΥ ΣΤΟ MOODLE ΓΙΑ ΤΗΝ ΥΠΟΣΤΗΡΙΞΗ ΤΗΣ ΓΝΩΣΤΙΚΗΣ ΙΚΑΝΟΤΗΤΑΣ ΤΩΝ ΧΡΗΣΤΩΝ

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Abstract

Why do most people believe that learning is boring? Are we providing the right tools to learners?

Nowadays, e-learning is becoming an increasingly popular way to learn as it is used by an increasing number of learners with different cognitive styles. Such differences should be considered along with different methods that can transform the learning experience into an engaging experience.

The main objective of this study is to re-design and evaluate the module “SQL” of the course “Databases” along with the learning platform that delivers the course, so as to create an engaging learning experience and explore whether there are differences between learners with different cognitive style.

Thus, the study indicates the elements that were utilized and the way that the content of the course was customized to meet learner’s cognitive differences as well as the plugins that were used for the customization of Moodle, the learning platform. Further, the study describes the involved background theory including the cognitive style that it focuses on for the customization of the learning platform and the course’s module. Additionally, an evaluation of the customized learning platform and course’s module is reported in terms of the time individuals with different cognitive style needed to complete the given tasks along with their performance, interaction and behavior with the re-designed learning tools. Finally, a discussion of the experimental results compared to the findings of relative studies is presented.

The results of the evaluation confirmed that all learners, despite their cognitive differences are more engaged and satisfied when the learning tools considered learners as the center of their design. In addition, the findings showed a significant difference between learners with different cognitive style in terms of the time taken to complete the customized course.

Περίληψη

Γιατί οι περισσότεροι άνθρωποι πιστεύουν ότι η μάθηση είναι βαρετή; Παρέχουμε τα κατάλληλα εργαλεία μάθησης στους χρήστες;

Σήμερα, η ηλεκτρονική μάθηση γίνεται όλο και πιο δημοφιλής τρόπος μάθησης, καθώς χρησιμοποιείται από όλο και περισσότερους ανθρώπους που θέλουν να διευρύνουν τις γνώσεις τους. Όμως, ο κάθε εκπαιδευόμενος έχει διαφορετικά γνωστικά χαρακτηριστικά. Τέτοια χαρακτηριστικά καθώς και μεθόδοι οι οποίες έχουν την δυνάτοτητα να μετατρέψουν την εμπειρία μάθησης σε μια συναρπαστική εμπειρία πρέπει να εξεταστούν.

Ο κύριος στόχος της διπλωματικής εργασίας είναι η επανασχεδίαση και η αξιολόγήση της ενότητας “SQL” του μαθήματος “Βάσεις δεδομένων” και του συστήματος που διαχειρίζεται το μάθημα έτσι ώστε να επιτευχθεί μια συναρπαστική εμπειρία μάθησης και να διερευνηθεί εάν υπάρχουν διαφορές ανάμεσα στους εκπαιδευόμενους με διαφορετικά γνωστικά χαρακτηριστικά.

Η διπλωματική εργασία παρουσιάζει τα στοιχεία που έχουν χρησιμοποιήθεί και τον τρόπο με τον οποίο προσαρμόστηκε το περιεχόμενο του μαθήματος έτσι ώστε να ανταποκρίνεται στις γνωστικές διαφορές των εκπαιδευόμενων, καθώς και τα plugins που έχουν χρησιμοποιηθεί για τον σχεδιασμό του Moodle, του συστήματος που διαχειρίζεται το μάθημα. Συγκεκριμένα, η διπλωματική εργασία περιγράφει την θεωρία που έχει μελετηθεί έτσι ώστε να πραγματοποιηθεί ο σχεδιασμός του μαθήματος και του συστήματος το οποίο διαχειρίζεται το μάθημα (Moodle), καθώς και το γνωστικό στυλ που έχει μελετηθεί για τον σχεδιασμό της ενότητας του μαθήματος και του Moodle. Επιπλέον, αξιολογείται ο καινούργιος αυτός σχεδιασμός βάση του χρόνου που χρειάστηκαν οι χρήστες με διαφορετικό γνωστικό στυλ για να ολοκληρώσουν συγκεκριμένες εργασιές και της επίδοσης τους βάση των δοκιμίων που έχουν συμπληρώσει. Επίσης αξιολογείται και συγκρίνεται ο τρόπος αλληλεπίδρασης με τα επανασχεδιασμένα εργαλεία μάθησης και η συμπεριφορά των χρηστών με διαφορετικό γνωστικό στυλ. Επιπρόσθετα παρουσιάζονται τα αποτελέσμάτα του

πειράματος και συγκρίνονται τα αποτελέσματα αυτά σε σχέση με τα αποτελέσματα παρόμοιων ερευνών.

Συγκεκριμένα, τα αποτελέσματα του πειράματος επιβεβαίωσαν ότι όλοι οι εκπαιδευόμενοι, παρά τις γνωστικές τους διαφορές, είναι περισσότερο αφοσιωμένοι και ικανοποιημένοι όταν τα εργαλεία μάθησης σχεδιάζονται έχοντας ως κέντρο τους χρήστες. Επίσης, τα αποτελέσματα έδειξαν ότι οι χρήστες με διαφορετικό γνωστικό στυλ είχαν σημαντική διαφορά σχετικά με τον χρόνο που χρειάστηκαν για να πλοηγηθούν στο μάθημα.

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Chapter 1

Introduction

1.1 Theoretical Background

D.R. Garrison and T. Anderson defined e-learning as the unique opportunity to connect a community of learners, regardless of time and place [1]. Since, e-learning can be accessible from a diversity of learners, who have different cognitive and emotional characteristics, which as proved by Germanakos et al. impact significantly users' personalization and adaptation procedure in online environments [2], it is needful the e-learning tools to be adapted, as well as new learning approaches, such as student-centered learning and distributed cognition, to be considered [1] [3], in order to advance engagement between learners and the learning content.

A critical factor which is not being considered in the design of e-learning systems and e-learning courses is individuals' FDI (Field Dependence-Independence) cognitive style, even though numerous researchers have confirmed the strong correlation towards individuals' FDI cognitive style and content comprehension [3]. FDI cognitive style refers to the two ways individuals process information, the FD (Field Dependence) and FI (Field Independence) approach.

Additionally, e-learning tools or LMSs (Learning Management Systems), which deliver the teaching, should provide experiences instead of just letting learners and teachers perform learning tasks [4]. One way to design a learning environment that provides the most effective experience is by considering individuals' differences and by paying attention to aesthetic and user-centered design [3].

Furthermore, interaction design and gamification should be included in the design of e-learning courses. Precisely, interaction design allows learners to interact with the content of the course, for example by clicking or dragging items, and gamification adds the dimension of fun in the course, something that is missing from the majority of the e-learning courses.

1.2 Rationale

E-learning along with the field of cognitive psychology has become an extremely fruitful area of research. Researchers identified numerous cognitive differences among individuals and applied different methodologies in order to improve individuals' learning experience. Although, further elements should be considered along with individuals' cognitive differences and preferences in order to further improve the learning experience and keep learners engaged in the learning process.

This study introduces different elements and approaches that can be applied in e-learning courses as well as e-learning systems so that the learning experience of individuals can be transformed from an uninteresting experience into an engaged and fun experience.

1.3 Thesis Purpose

Learning is vital. It enriches peoples' lives by offering them many advantages, that they could not even imagine. Although, learning has become an uninteresting experience for most of the people, who end up being surface learners. They learn the courses' material just to pass an exam or get a high grade. So, the purpose of this study is to improve individuals' learning

experience and explore whether differences exist between individuals with different cognitive style. Precisely, an e-learning module of the course “Databases” was re-designed along with the e-learning platform that delivers the course. The main stepping factors for re-designing the module of the course along with the interface of the e-learning system were learners’ cognitive style, the visual design principles and the importance of making learning fun as well as making learners involved and engaged in the learning process.

1.4 Aim and Objectives

This study is aiming to explore whether the different design of the course’s module together with the different design of Moodle, the learning platform which delivers the course, affect individuals’ visual behavior and learning experience as well as if there are differences between individuals with different cognitive styles (FD and FI) regarding their interaction with the customized module of the course along with the customized interface of the learning platform.

With the purpose of achieving these aims, subjects’ visual behavior was inspected on the basis of the time completion of specific tasks (search task in the customized Moodle, pre-test, post-test and customized course) and elements clicked (search task in the customized Moodle). Moreover, subjects’ performance on tasks measuring content comprehension (pre-test and post-test) along with subjects’ overall experience, opinions and behavior were examined (given questionnaire).

Since the module of the course and Moodle were re-designed by taking into account individuals’ preferences and differences as well as elements for improving individuals’ learning experience, FI and FD learners should be affected positively by the new design of Moodle and course’s module.

1.5 Definition of Key Concepts

Cognitive style can be defined as the method with which individuals prefer to process incoming information [5].

(Το *γνωστικό στυλ* ορίζεται ως η μέθοδος με την οποία τα άτομα προτιμούν να επεξεργάζονται τις πληροφορίες.)

FDI (Field Dependence-Independence) cognitive style refers to the two contrasting ways that individuals process incoming information. *FD (Field Dependence)* approach and *FI (Field Independence)* approach [2].

(Το γνωστικό στυλ *Ανεξαρτησίας Πεδίου* αναφέρεται στους δύο τρόπους με τους οποίους τα άτομα επεξεργάζονται τις εισερχόμενες πληροφορίες, είτε με την προσέγγιση Εξάρτησης Πεδίου ή την προσέγγιση Ανεξαρτησίας Πεδίου.)

E-learning (Electronic learning) can be described as the learning which is delivered online, using electronic technologies [6].

(Η *ηλεκτρονική μάθηση* ορίζεται ως η μάθηση η οποία παρέχεται ηλεκτρονικά, χρησιμοποιώντας τις ηλεκτρονικές τεχνολογίες.)

LMS (Learning Management System) is an educational platform which is used to deliver online learning.

(Το *Σύστημα Διαχείρισης Μάθησης* είναι μια εκπαιδευτική πλατφόρμα η οποία χρησιμοποιείται για την παροχή ηλεκτρονικής μάθησης.)

Moodle (Modular Object-Oriented Dynamic Learning Environment) is an example of LMS which provides custom learning environments for users [7].

(Το *Moodle* είναι ένα Σύστημα Διαχείρισης Μάθησης το οποίο δίνει την δυνατότητα στους σχεδιαστές να αλλάξουν σε μεγάλο βαθμό την γραφική του διαπροσωπεία.)

1.6 Thesis Outline

The thesis is divided into seven chapters. Following this chapter, Chapter 2 presents the literature review studied for this research and specifies on which theory and which tools this study is focused on. Chapter 3 states some of the elements that can be utilized to create an engaging learning experience and specifies the elements that were used in this study, for the customization of the learning platform and course's module. Chapter 4 defines the research questions of this study and describes the methodology that was followed in order to answer these research questions. Additionally, Chapter 5 describes the results of the experiment along with the tests and approaches that were used to conclude to these results. Further, Chapter 6 concentrates on the research questions of the thesis and discuss the results in relation to the findings of similar studies. Finally, Chapter 7 recapitulates research's findings, indicates the study's contribution to the e-learning field and proposes recommendations inviting further study.

Chapter 2

Literature Review

2.1 Overview

This chapter presents the background theory of this study. Precisely, it defines cognitive style and describes some of the most widely cognitive styles that appear in the literature. It introduces online education and specifically, it distinguishes online education into distance education and e-learning, along with describing the difference between these terms. Additionally, it defines and describes the e-learning tools, also known as Learning Management Systems (LMSs), as well as some examples of today's most famous LMSs. Finally, this chapter specifies on which cognitive style and LMS this study is built and why.

2.2 Cognitive Styles

Firstly, before referencing to cognitive styles, it is essential to describe what cognition is. Cognition can be defined as the ability of the human mind to assimilate and process information that obtains from numerous sources, such as experience, perception, and beliefs, and transforms them into knowledge. Cognition encompasses several mental processes as for example attention, perception, problem-solving, learning, memory and decision making [8] [2].

Cognitive style represents the characteristic ways in which individuals approach, acquire, organize, process and interpret information as well as how they use these interpretations to direct their actions [2] [9].

Although numerous researches have been conducted in the field of cognitive abilities and shown great validity and reliability principally in the educational field [10] [2], it's still an aspect that is not acknowledged as a significant factor in the present learning practices.

Nevertheless, numerous cognitive styles are appearing in the literature, including Field Dependence-Independence, Reflectivity-Impulsivity, Leveling-Sharpening, Holist-Serialist, Visualizer-Verbalizer and Deep-level/Surface-level processing [10] [11].

2.2.1 Visualizer-Verbalizer

Visualizer-Verbalizer cognitive style describes two ways of processing and mentally representing information, verbally and visually [10]. Specifically, individuals are classified as Visualizers and Verbalizers. Visualizers think more in pictures [10] and prefer to process information from pictures and charts [12]. On the other hand, verbalizers think more in words [10] and prefer to process information from spoken or written words [12].

2.2.2 Reflectivity-Impulsivity

This type of cognitive style is also called a conceptual tempo. Individuals are categorized to Impulsive and Reflective subjects. Reflective individuals spend time to evaluate their options before beginning a task or making a decision, while impulsive individuals solve problems rapidly without considering enough the correctness of their solution. Researchers have found that reflective subjects make fewer mistakes in word-recognition, serial-learning and inductive-reasoning tests, contrary to impulsive subjects who make more mistakes. As a result, impulsive individuals have a direction to quick success, although they have lower performance and motivation to master tasks, compared to reflective individuals [13].

2.2.3 Field Dependence-Independence

The cognitive style of FD and FI is the most popular and most widely studied area especially in its application in the educational technology field [10] [2] [9]. This cognitive style describes two contrasting ways of processing information, the Field Dependence (FD) and the Field Independence (FI) distinct approach [2] [9] [14]. Particularly, learners are categorized as Field Dependent (FD) and Field Independent (FI) [2] individuals according to individual's way of disembedding simple figures from their distracting surroundings. Field Dependent subjects tend to perceive information globally being easily influenced by a prevailing field or context while Field Independent subjects tend to perceive information analytically, separating objects from their backgrounds [15].

Researchers have found significant differences between FI and FD individuals. Individuals located towards the FD end have difficulty in separating incoming information from its contextual surroundings and are more likely to be influenced by external cues (like music and talk) and to be non-selective in their information uptake. On the contrary, individuals located towards the FI end, have less difficulty in separating the most essential information from its context, and are more likely to be influenced by internal than external cues (like thoughts and feelings), and to be selective in their information input [2] [9] [14].

Additionally, studies of the relationship between cognitive style and academic achievement have shown a strong correlation between FDI dimension and academic achievement [14] as individuals differ in terms of learning outcomes, learning behavior and problem-solving approaches [10]. Precisely, these studies have shown that FI subjects obtain consistently better results than FD subjects, in all areas of knowledge [14]. This means that in order to accomplish effective learning which would correspond to both, FD and FI individuals, it is extremely important to consider individuals' cognitive style [10]. Thus, FDI cognitive style will be considered for the purpose of this study.

2.4 Online Education

Online education refers to the procedure of taking a course, acquiring a degree or participating in any other kind of educational endeavor using the Internet [16]. Online education is divided to distance education and e-learning. Distance education and e-learning are often referred as synonyms. Although, these terms are different.

2.4.1 Distance Education

Learners have the ability to be educated regardless of time and place restrictions. Specifically, instructors can deliver learning to people who live at a different geographical place through print or electronic communications. This method of learning, where the instructor and learners are located in a different place, is called "distance education" [17]. Distance education gives the potential for lifelong learning and the opportunity for learners who live far from universities or belong to specific groups of learners, as for example disabled learners, to be educated [18]. Additionally, it provides cost advantages, as distance education costs lower compared to traditional education [19].

2.4.2 E-learning

On the other hand, e-learning is not used for distance education purposes, instead is utilized for different learning purposes than just making accessible content of textbooks and lectures to learners who live far away from the teaching source [19]. Precisely, e-learning can be

described as the virtual classroom on the Web, where the communication between instructor and students, students and students, given material and student assessment are conducted online [20].

Since technology has advanced in all fields including education, e-learning appears to be a dominant field in education, as it offers various advantages. E-learning, as previously mentioned, delivers learning to numerous distance learners quickly, as there are no restrictions on classroom capacity and learners can access learning at any time and place, they wish. Additionally, this new technology has the potential to control the information that is delivered to learners, avoiding information overload that leads to inefficient learning, as in the traditional learning approach. Moreover, with the use of e-learning tools, tracking learners' performance, activity, interaction and engagement with the material don't require any significant effort since these tools are doing all the work [19]. As a consequence, instructors can help students connect with the material much easier and much effectively, using, for example, exercises, quizzes and constant feedback.

However, e-learning is most effective when it is carefully designed and used. It's not just transforming traditional content into a digital representation [21], it's much more than this. Various factors should be considered, such as learners' differences and preferences, user-centered and aesthetic design as well as learners' engagement and feelings.

2.5 Learning Management Systems

Learning Management Systems are among the most popular e-learning tools. The main objective of LMSs is typically to host and track online learning. An LMS allows to manage content, record and measure learning, store learner data, and communicate with users [22]. LMSs break the space-time restrictions in learning. They provide learners an active role in their own education. Rather than just attending classes at a specific time and place, learners can actively build their own knowledge and enjoy their significant autonomy [23].

LMSs platforms can be either open-source or closed-source. Open-source systems are freely available and their original code may be redistributed and modified. In contrast, closed-source systems do not share their code, so they present limitations on their customization and functionality. Moreover, closed-source systems offer more user-friendliness, security and support directly. Although, open-source solutions give flexibility to customize the LMS in order to meet learner's needs and when it utilized to its best abilities, provides other advantages too, such as top security and high service standards [24] [25].

Nowadays, there is a vast number of LMSs available for use both open-source and closed-source. Some examples of open-source LMSs are Moodle, Blackboard, Totara Learn and ATutor [24] [26] and some examples of closed-source LMSs are TalentLMS, Docebo, Adobe Captivate Prime and Litmos LMS [27].

According to the needs of this study, an open-source LMS is an ideal solution to use. The ability to customize the LMS enables the opportunity to improve the learning offer by adapting the learning content delivery system centred on the personalization of the learning experience [23].

2.5.1 Adobe Captivate Prime

Adobe Captivate Prime LMS, as mentioned above, belongs to closed-source learning environments. It is used by millions of learners around the world, as it provides a personalized and enjoyable learning experience to its users [28]. It is a cloud-based LMS and it is mostly used by businesses since it is a priced LMS [29]. Its purpose is to make users' training simple and pleasant. Additionally, Adobe Captivate Prime LMS includes various features. It allows learners to configure their homepage using out-of-the-box themes. Further, it provides many gamification tools, such as badges, leaderboards and rewards, in order to make learners' experience fun, as well as tracking users' performance and comparing their performance opposing other users or their own learning aims [30].

2.5.2 Blackboard

Blackboard, as previously noted, belongs to the open-source LMSs and it is mostly used by academic institutions. It is an easy-to-use software and it makes accessible tools which help learners stay organized and engaged with the content [31]. It allows users to customize their profile and connect with other users. Furthermore, the Blackboard learning platform offers personalized attention to its users according to their interaction with the course [32] and it tracks the activity and performance of its users. Additionally, other important features that the Blackboard LMS includes are Facebook integration feature, which gives the opportunity to users to have access to courses' information and obtain notifications inside Facebook as well as the SafeAssign feature, which gives the ability for detecting and preventing plagiarism [33]. Though, the current LMS has restrictions in its customization and can support a limited number of users [34].

2.5.3 Moodle

Moodle's official name is Modular Object-Oriented Dynamic Learning Environment and it has been written by Martin Devaygsemnas, a Ph.D. student [35]. It is a free and open-source LMS. It is used by educational institutions with a high number of users. Moodle is modular in nature, so it is incredibly flexible and allows to create a best-of-breed e-learning experience by adding plugins and third-party solutions as well as customizing the design and course structure based on learner's needs [35] [24].

Among all LMSs, Moodle was the LMS which was selected for developing a personalized learning platform. Specifically, Moodle was selected for two principal reasons. Firstly and most importantly, Moodle was an ideal solution due to its modularity and extensibility, as it gives the opportunity to customize at a high degree its interface according to the study's needs. Secondly, the university where the experiment took place uses Moodle as its main learning platform, therefore we would have the opportunity to examine how the different visual layout of the LMS affects navigation behavior and experience of learners with different FDI cognitive occupation.

Chapter 3

Design of Moodle and Online Course

3.1 Overview

The present chapter describes the elements that were utilized for the customization of Moodle (the learning platform) and the course's module. Specifically, it introduces and specifies the visual design principles for an effective and successful user interface. Moreover, this chapter reports the plugins that were used in order to customize Moodle and explains why the specific plugins were chosen along with how these plugins are responding to the visual design principles. It presents some of the most famous elements to use in order to achieve a successful and engaging course. Furthermore, it specifies and describes which of these elements were the appropriate elements to utilize for the customization of the course's content. Lastly, it reports how the course's content was re-designed by taking into account individuals' cognitive style too.

3.2 Design of Moodle

Moodle's latest version (version 3.5) was installed in a Windows server. It was installed an updated version of Moodle, compared to the version used by University of Cyprus (version 3.1) since version 3.1 of Moodle presented restrictions regarding on the available plugins for customizing the user interface.

3.2.1 Visual Design Principles

LMS's interface needs to be clear and able to involve the learner in the learning process without overwhelming him/her. Schwier and Misanchunk introduced principles of simplicity, consistency, clarity, aesthetic considerations and minimal memory load [36].

Simplicity. In detail, Schwier and Misanchunk stated that it is very important to include only elements that are necessary when designing a user interface. Extra unnecessary elements, such as animations and sounds, distract users' attention from their principal purpose [37]. For instance, with regards to the educational field, an efficient and motivational design does not distract learners' attention from the actual learning content [36].

Consistency. Further, a good interface keeps colors, fonts, headings, pages' structure as well as interaction behavior in similar tasks, consistent. As a result, users can learn rapidly how pages are matched and therefore master the system easily.

Clarity. Additionally, an informal language and short sentences should be utilized in the user interface.

Aesthetic considerations. Aesthetic considerations such as balance, harmony, and unity are also important. Elements should be organized in a way that they elicit a feeling of stability and look like they form only one element.

Minimal memory load. In addition, the user interface should give the ability to users to recognize items instead of forcing them to remember how to operate the system. For example, including buttons and menus rather than typing commands is a significant factor in reducing users' memory load [37].

Thus, an efficient and motivational design is achieved when it provides simple and efficient navigation, a comprehensive idea of how the content and system's functionalities are organized as well as it is based on learners' needs and goals [36].

3.2.2 Fordson Theme Plugin

Despite the numerous plugins that were developed for changing the visual design of Moodle, only the Fordson theme plugin was ideal to create a user-centered design. The Fordson theme plugin was designed and built in Dearborn, Michigan [38] and is maintained by Chris Kenniburg [39]. This type of plugin changes the "look and feel" of the learning platform [40]. The Fordson theme provides impressive customizations and is purposefully designed to go from login to learning as quickly and efficiently as possible with the minimum number of distractions [38]. Its minimal design, clean interface, and simple layout get students engaged with learning, quickly and efficiently. Students can navigate and discover the learning courses quickly without being distracted by things unnecessary for learning [38]. Every item that does not take the student to his/her goal of the course is a distraction, as well as all items that student could click to achieve his/her goal, can easily overwhelm him/her [38]. That's why the Fordson theme was preferred. It minimizes distractions and helps students engage with the content along with improving user experience. Further, it uses color, icons, space, images and other elements to help students navigate through a course [39] (see Figure 3.1).

Besides, Fordson theme is the only theme that provides the ability to hide and organize the blocks that appear in Moodle. In particular, the blocks are organized in a three-column block panel and they are displayed with a click of a button as well as hidden when students want to pay attention to the learning content [41] (see Figure 3.4).

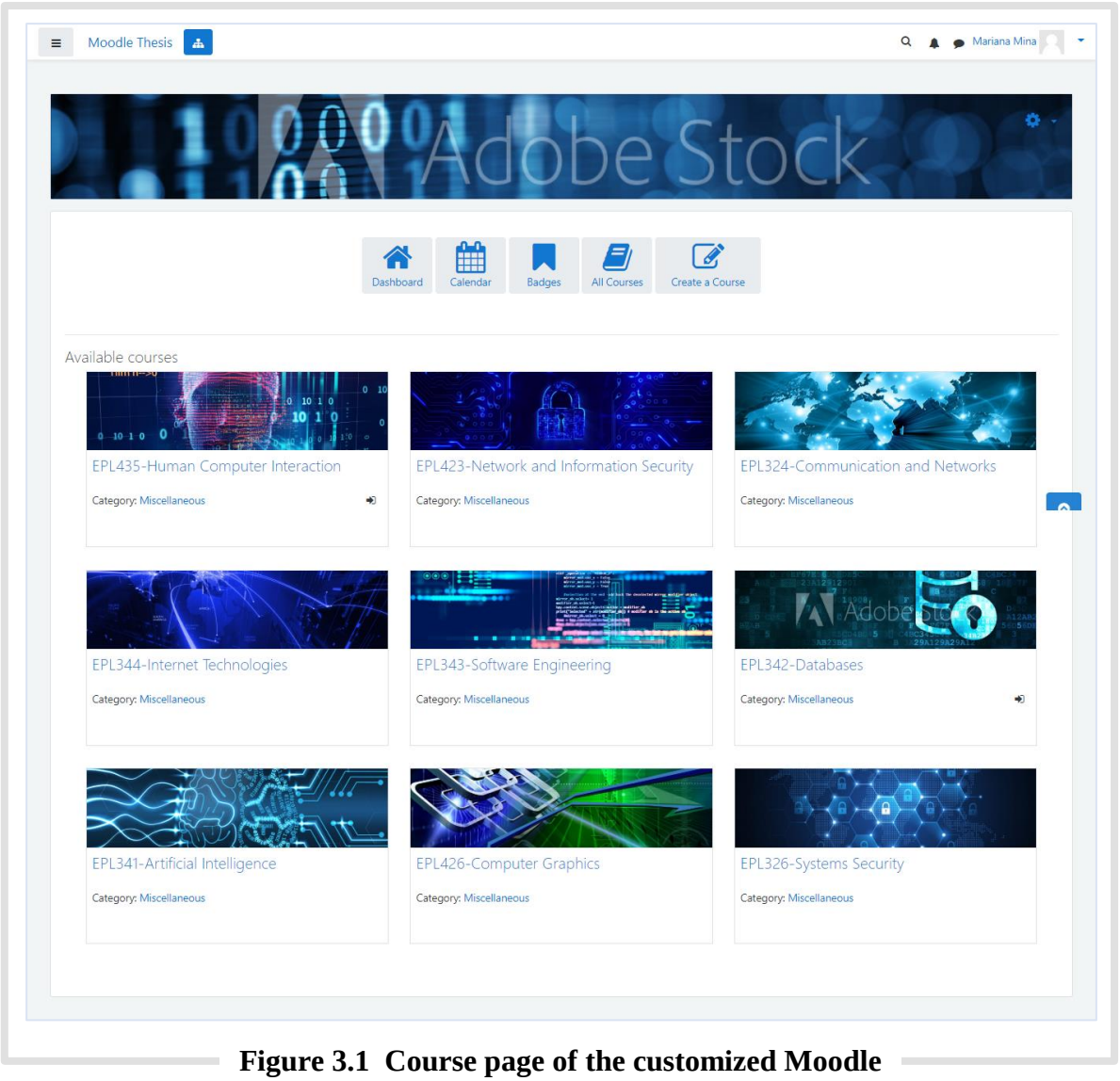


Figure 3.1 Course page of the customized Moodle

3.2.3 Grid Format Plugin

Instead of using the topics format, which is the default course's format, the grid format plugin was selected to be added in Moodle. This plugin contributed by Gareth J Barnard and created by Paul Krix [42]. It creates a grid of icons, one of each course's topic, and each grid includes the content for the corresponding topic [41]. The main benefit of the grid format over topics format is that the "scroll of death" problem -all courses' content is displayed on the page- for students [43] is solved. Rather than causing anxiety and distraction, the way that the content

is organized with the use of the grid format, neither overwhelm students nor distract them from their goal (see Figure 3.2 and Figure 3.3).

Figure 3.2 Course's content

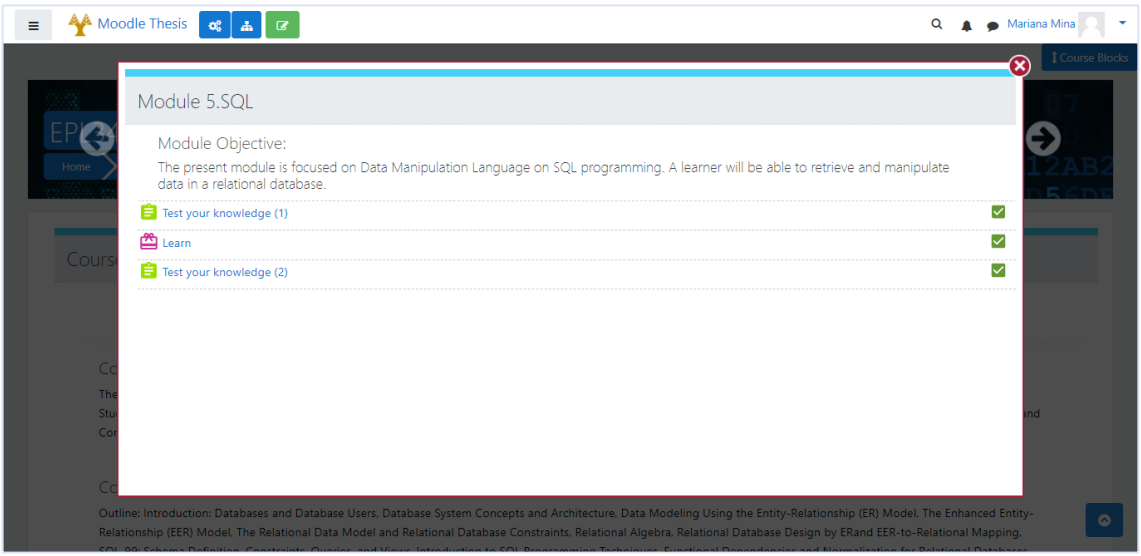


Figure 3.3 Content of the Course's Module

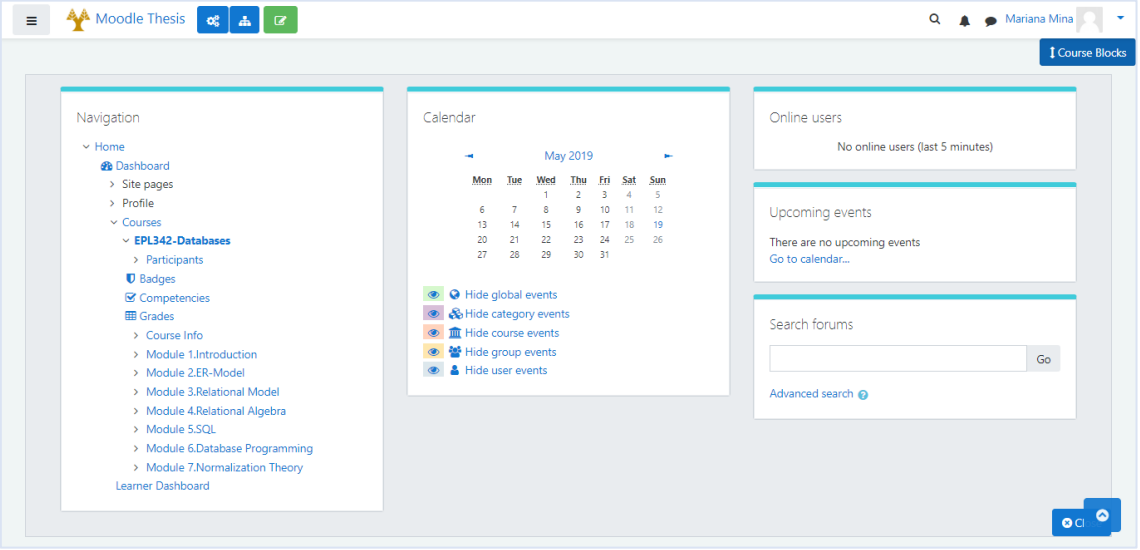


Figure 3.4 Blocks of the customized Moodle

3.3 Design of Online Course

What makes an e-learning course successful? An e-learning course is successful when learner engagement is achieved, as it can metamorphose a boring and harsh course into an interesting and engaging course. Although, in order to reach this, it's mandatory to include the appropriate engaging elements in the course, such as interactivity, gamification, visuals (in terms of videos, animated GIFs and charts), stories (that will arise learners' curiosity and help them to connect with the course's content) and humor (in terms of jokes and cartoons) [44].

In this study, the right interactions and gamification were utilized and described in the following sections along with how the content was modified to meet individuals' different cognitive style. The e-learning course was developed using Articulate 360 software and specifically Storyline 360, as it provided everything that was needed for designing an engaging e-learning course [23].

3.3.1 Interaction

Whenever an individual click, select, rollover to display content, as well as, answer a question, undertake a quiz, etc.; these activities are called interactions. Interactions in online learning benefits learners, as they are able to interact with the course, in the subject of action and thinking. Thus, learners are active, paying attention to the content of the course and they are involved in the learning process [45].

Despite the various options available for creating interactive content, the following interactions were suitable to be applied to the present course's design.

Tab interactions. Tab interactions were used in order to motivate learners to explore the content of the course. Instead of just filling slides with bullets, tab interactions trigger users' interest to reveal information, a desire that is missing from the majority of today's e-learning courses. Further, the learning content presented in a single slide is significantly reduced. As

a result, learner's cognitive load also reduces, thus learners can process the presented information much easier [44] [45] (see Figure 3.5).

Slider. The slider is a different method of interaction with which learners should drag a slider to explore and move on through the course. Its purpose is identical to the previous form of interaction (tab interactions) (see Figure 3.6).

Markers. Markers add a hover-and-reveal way of interaction to the course. It is a quick and easy way to reveal additional information, such as examples, if learners want to (see Figure 3.7).

Buttons. Buttons are another way to discover information. This option of interaction was used to demonstrate the solutions of the encompassed exercises as well as additional information, like examples along with animations, in order to help students to understand better the course's material. Exercises' along with buttons' purpose is to give the ability to learners to think before viewing the solution and in this manner connect to the content effectively [44] (see Figure 3.8 and 3.9).

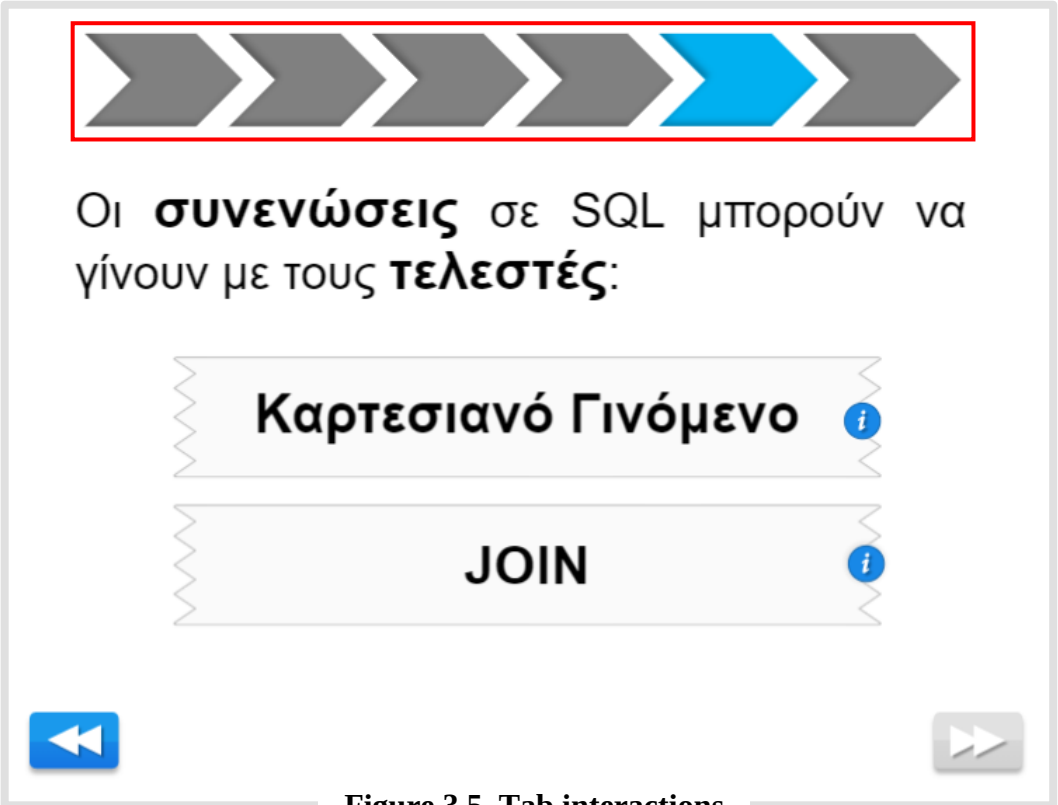


Figure 3.5 Tab interactions

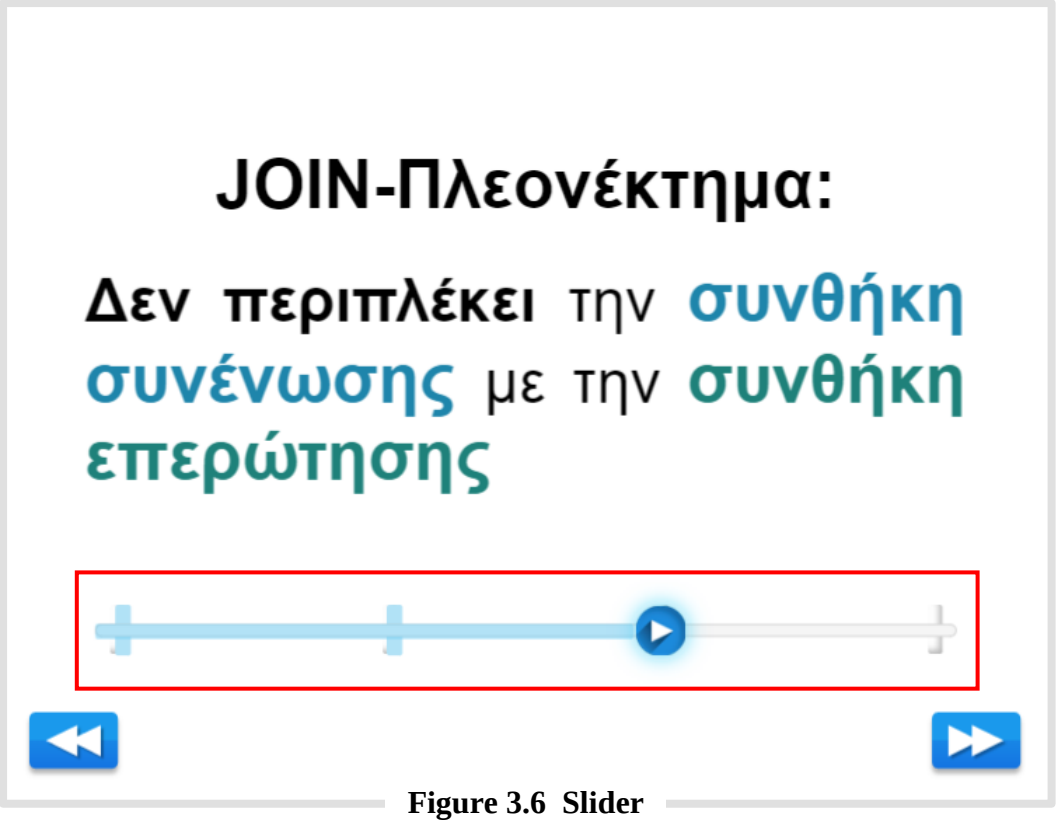


Figure 3.6 Slider

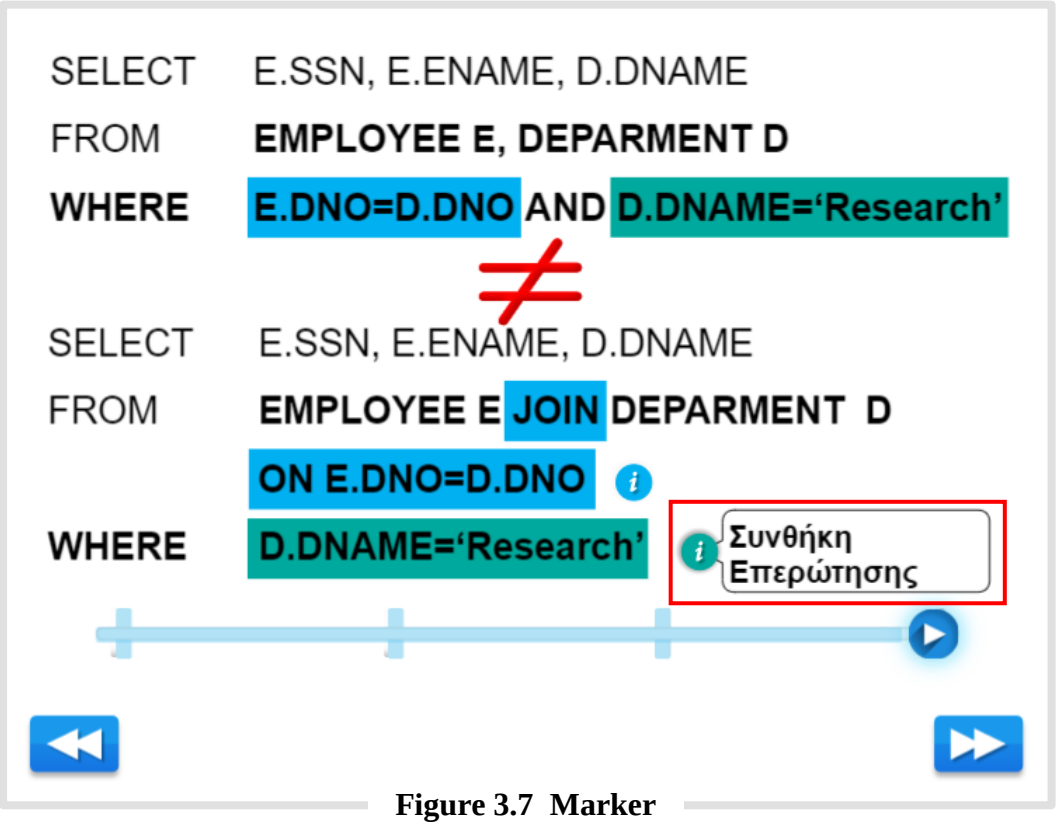


Figure 3.7 Marker

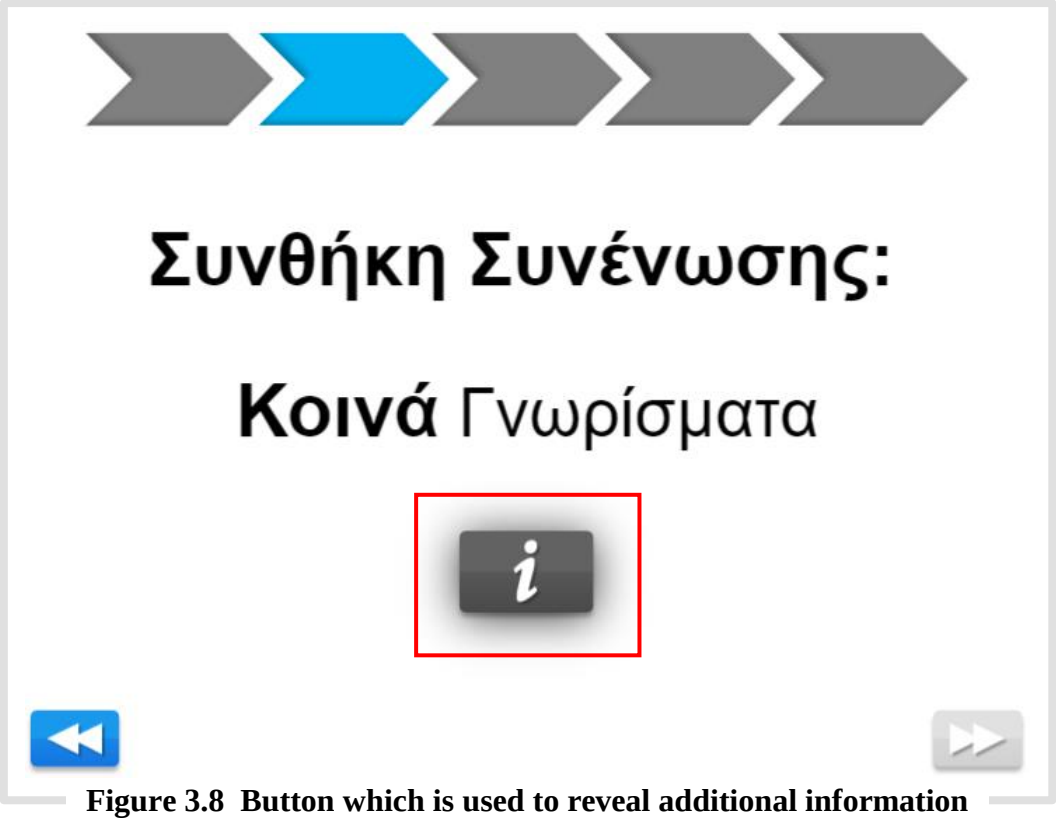


Figure 3.8 Button which is used to reveal additional information

Figure 3.9 Button which is used to reveal exercise's solution

3.3.2 Gamification

Gamification can be defined as the design procedure, which applies game elements, such as points, leaderboards, and levels, to non-game problems [46] [4]. Although, gamification in education is mostly about how learners feel as they move on through a course, rather than the final design of the course [4]. Additionally, gamification is about finding the fun. Finding the game-like elements and use them to create a context that moves learners a little bit more towards learning. The best paradigm is not the one that applies the most game-like elements, but the one that uses the game-like elements effectively [46].

First, fun does not just happen, it must be designed. Nicole Lazarro, (a researcher and game designer), classifies fun into four categories. Easy fun, hard fun, people fun and serious fun. Though, in this research, hard fun was mostly considered and designed, as it was the best meet. Hard fun is the one that represents accomplishment. It was designed by means of challenging the learner and triggering learner's emotions of accomplishment. Precisely, a completeness bar along with a path which illustrated the different sections of the course were integrated, as individuals respond to these elements. One reason for this, is real-time feedback since these elements inform users how far along, they are from their goal. Feedback simply provides information to individuals, it does not force them to do anything. That psychologically increases the potential for individuals to progress. The second reason for this is the sense of progression. The process of moving forward for completing a goal makes learners progress to the end of the course since, as individuals, we like completion.

Additionally, different kinds of other game elements added to the course, according to the pyramid of game elements. The pyramid-structure consists of three levels. Dynamics at the first, mechanics at the second and components at the third level (See Figure 3.10).

Dynamics. These elements are the high-level conceptual elements which provide the framing of the gamified system. Elements of this level adopted in the course were constraints and emotions. Learners should navigate linearly through the content of the course and emotions that make the experience richer and produce the sense of accomplishment and progression have been created respectively.

Mechanics. The intention of these elements is to move the action forward. Challenges, feedback and rewards were the elements utilized in the design of the course. Students were challenged to complete the course (see Figure 3.11) and solve the exercises included in the course. Further, feedback provided to students such as completeness bar (see Figure 3.12) and path (see Figure 3.13), since it's very important for them to see how they are doing in real time. In addition, verbal rewards (see Figure 3.14) along with an intangible reward (see Figure 3.15) provided to students, in order to recognize their achievements and performance. *Components.* Mechanisms to fulfill dynamics and mechanics. Avatars, content unlocking and leveling up were the main game elements that were utilized. Students had the option to choose an avatar (male or female) to guide them through the course (see Figure 3.16). In order to make avatars more impactful, audio was used along with avatars. Further, the content of the course was organized in levels in order to provide the ability for learners to unlock new content (see Figure 3.17) and level up (see Figure 3.18) [46].

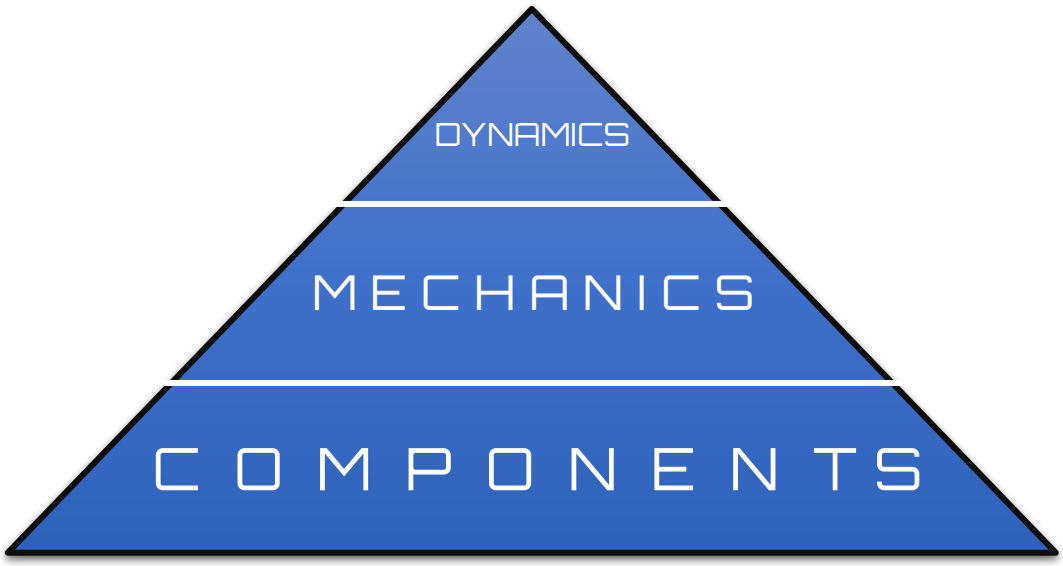


Figure 3.10 The pyramid of game elements

3.3.3 Preferred Visual Type of Field Dependence-Independence Cognitive Groups

To further increase learner's engagement and motivation, FDI cognitive differences could not be ignored. It is crucial to take into account learners' preferences. As stated in the previous chapter the two cognitive groups differ in visual perceptiveness. Particularly, FD individuals prefer a pictorial representation of the content. On the other hand, FI individuals prefer a textual representation of the content. So, learners pay attention to the visual type they prefer (FD individuals pay attention to pictures, while FI individuals pay attention to text). Because the present course's content couldn't be represented in the form of pictures and text (text was the main form of the customized course's content), the form of the text needed to be adapted in order to help FD individuals pay attention to the text. According to a related study, researchers found that FD learners pay more attention to the textual content when specific keywords that are crucial for greater content comprehension are emphasized [3]. Consequently, in the present study, the course's content was adapted in a similar form. Specific keywords were emphasized by changing their format to bold, increasing their size and using a different color (see Figure 3.19).

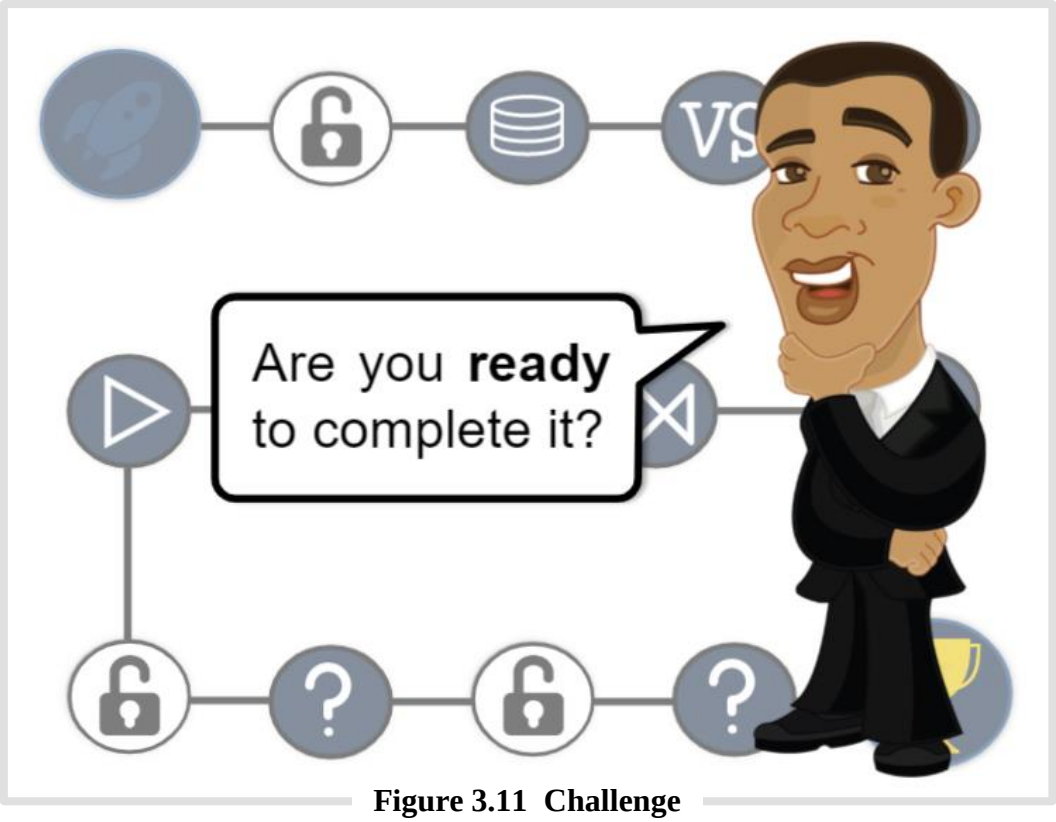


Figure 3.11 Challenge

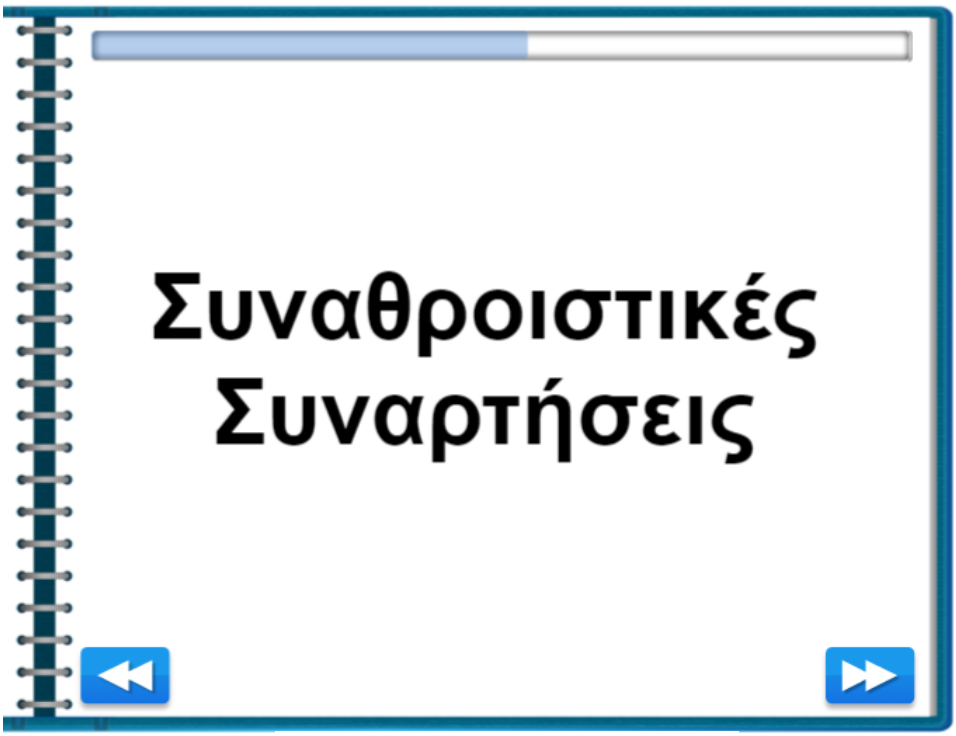


Figure 3.12 Completeness Bar

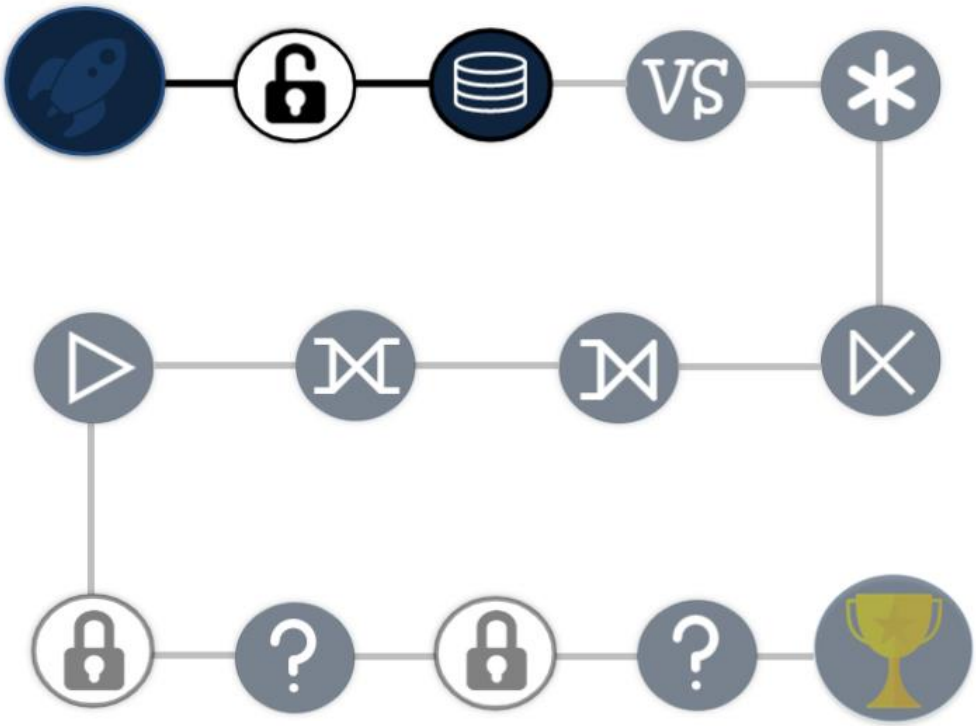


Figure 3.13 Learning Path

Figure 3.14 Verbal Reward

Figure 3.15 Intangible Reward

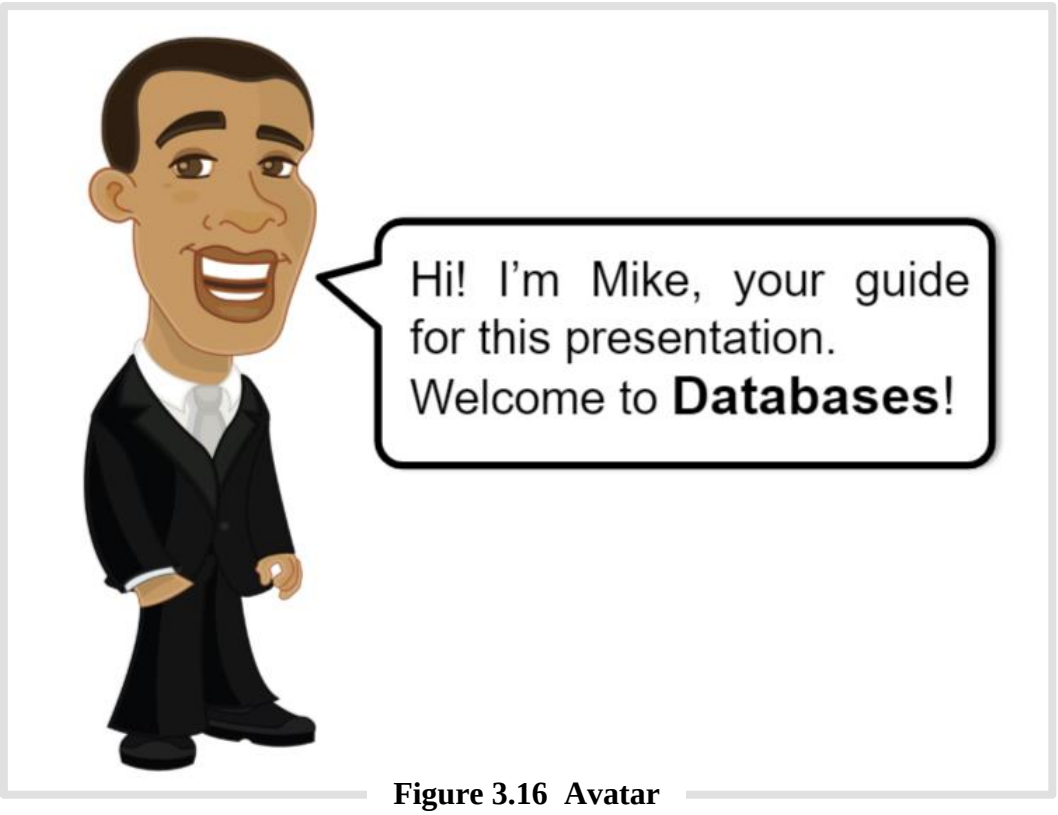


Figure 3.16 Avatar

Figure 3.17 Content Unlocking

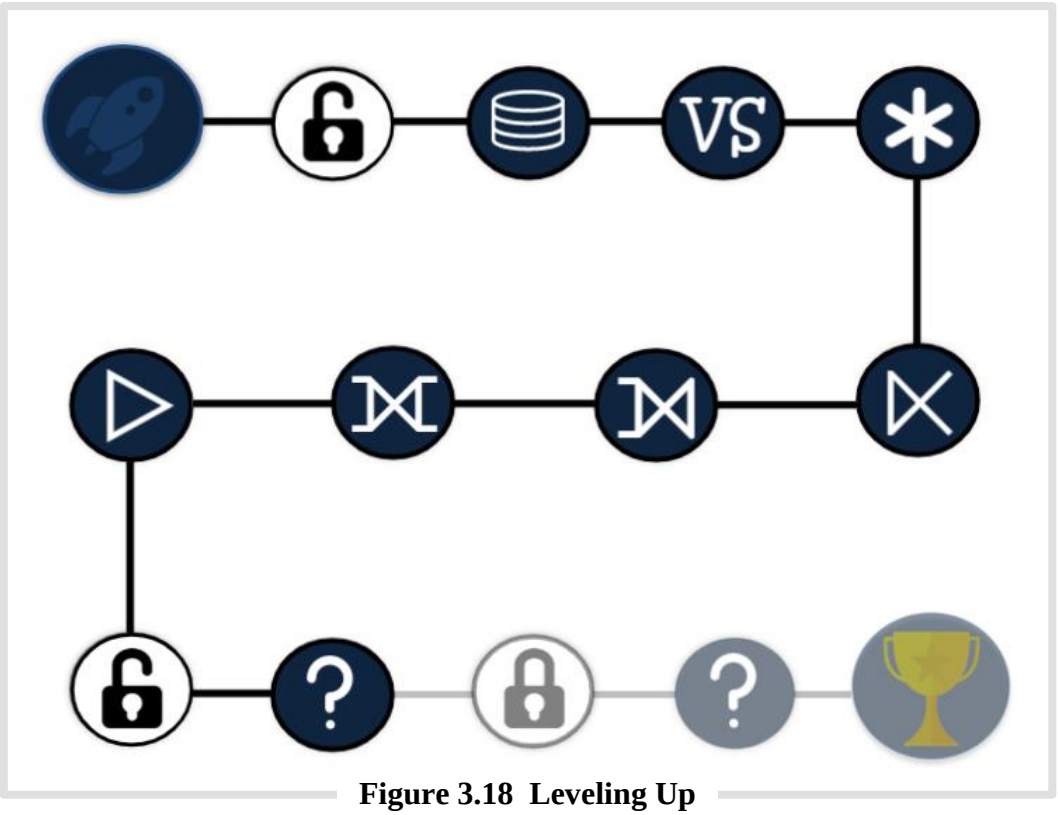


Figure 3.18 Leveling Up

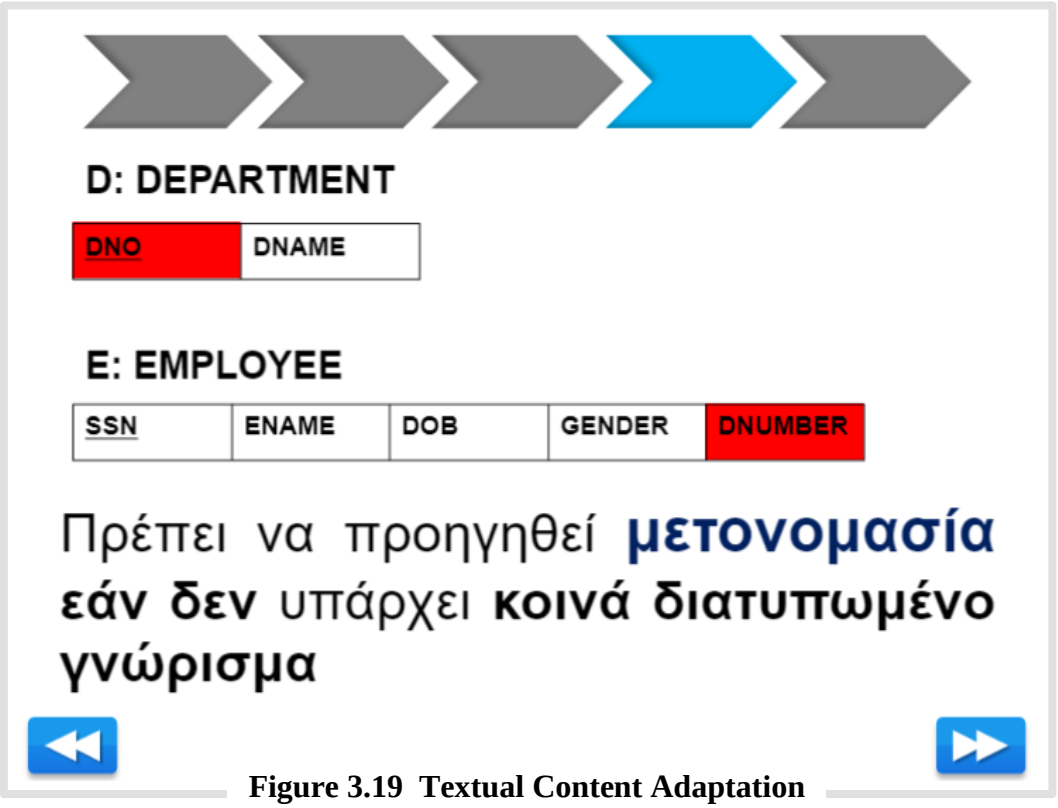


Figure 3.19 Textual Content Adaptation

Chapter 4

Methodology

4.1 Overview

The current chapter describes the methodology that was followed so that it is possible to answer the research questions of the study. Specifically, this chapter states the research questions and reports the method that was followed, in terms of the participants and the experimental procedure, including the phases of the experiment and the tools that were utilized for the collection of the data. Finally, it describes the techniques that were utilized for the analysis of the data.

4.2 Research Questions

This study will address the following research questions:

Q1. Do differences exist between the two cognitive groups, FD and FI, with regards to tasks time completion and tests' performance?

Q2. How does the different visual layout design of the course, along with Moodle, affect students' interaction and behavior with different FDI cognitive style?

4.3 Method

4.3.1 Participants

The population of the study was recruited from the Department of Computer Science of the University of Cyprus. The participants had to attend the "Databases" course in order to take part in the experiment. A total number of 15 undergraduate university students (11 females and 4 males) ranging in age between 21 and 24 years old (Mean = 22.00, Std. Deviation = 0.654654) participated voluntarily in the experiment. Four of the participants were attending the "Databases" course this semester, six of the participants attended the "Databases" course past semester and five of the participants attended the "Databases" course three semesters ago. The participants were initially categorized into their current FDI cognitive style (FD and FI) based on their performance on the Group Embedded Figures Test (GEFT). GEFT is a psychometric tool [47] which measures the level of an individual's field dependence. It consists of three sections. The first section consists of 7 problems and it is primally for practice with the format of the test. In addition, the second and third section includes 9 problems each. Scores are ranged from 0 to 18, according to how many figures the individual finds. Specifically, the test presents eight simple figures and asks participants to identify one of the eight simple figures embedded in a more complex pattern [47]. Individuals who scored 11 or lower were categorized as FD and those who scored from 12 to 18 were categorized as FI.

4.3.2 Experimental Procedure

All participants were informed about the study and signed a consent form due to the General Data Protection Regulation (GDPR), which stated that a participant's data will be used anonymous and only for the purpose of the study [48]. The study was divided into six phases (See Figure 4.1).

Phase A (GEFT). Participants were asked to complete the paper-based GEFT in order to assess their level of dependence. The duration limit of the GEFT was 12 minutes. The first

section of the test was 2 minutes, while the second and third section was 10 minutes (5 minutes each).

Phase B (Moodle Search Task). At this phase, students were placed in front of a desktop and requested to perform a specific search task in the customized Moodle. Precisely, they were asked to find the course named “EPL342-Databases” and register in this course. After registering, they had to detect the section named “Module 5.SQL” and then the activity “Test your knowledge (1)”.

Phase C (Pre-Test). At this stage, participants were invited to complete the activity “Test your knowledge (1)”, which they were asked to identify it in the previous phase. The activity was a simple test, which included four multiple choice questions. The questions were based on the SQL module of the Databases course.

Phase D (Course Navigation). Participants were asked to navigate through the “Learn” activity. The activity was the customized version of the SQL module of the Databases course.

Phase E (Post-Test). At this phase, participants were asked to complete a second test named “Test your knowledge (2)” which is a post-test, meaning that this test was given upon completion of the experimental intervention. The test was similar to the first. It consisted of four multiple choice questions based on the SQL module of the Databases course with the same level of difficulty as the first. In the second test students had the opportunity to see feedback at the end of each question and as feedback appeared the correct choice and (1) if an individual chose the correct choice a motivational message and (2) if an individual didn’t choose the correct choice, the reason why his/her incorrect response was wrong. On the other hand, in the first test, the traditional approach was followed. Feedback was shown at the end of the entire test and only the correct answer appeared as feedback.

Phase F (Questionnaire). As a final phase, students were asked to complete a questionnaire related to their experience with their navigation through the customized Moodle and course as well as the two tests.

Regarding the tools utilized for data collection, Moodle Logs were used to find the time taken and the elements each user clicked to find the requested activity in the customized Moodle (Phase B), Moodle Quiz Reports were used to find the score and time taken for each user to finish pre-test and post-test (Phase C, Phase E), Moodle Activity Report was used to find the time taken for each user to complete the customized course (Phase D) and a questionnaire was used to collect data about each user's experience, opinion, and behavior about the customized Moodle, customized course and the two tests (Phase F).

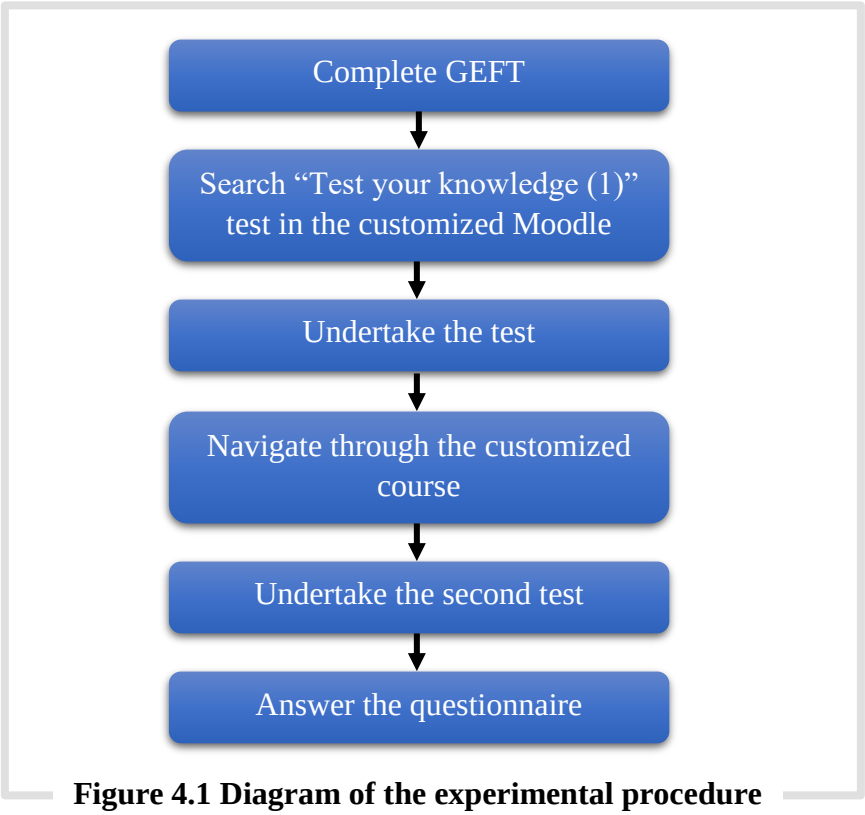


Figure 4.1 Diagram of the experimental procedure

4.4 Data Analysis

The results of this study are based on (1) data collected by GEFT, (2) data extracted via the Moodle learning platform and (3) data derived from the given questionnaire. Firstly, for the analysis, individuals' cognitive occupation (FD or FI) was identified with the use of GEFT's score. Secondly, the participant's visual behavior was analyzed and evaluated using Moodle

Logs and tasks' time completion (time completion of the search task in the customized Moodle, pre-test, post-test and customized course). Specifically, the Moodle Log's data that were examined was the time that an event occurred and the name of the event. Therefore, the total time each student needed for the predefined Moodle search task was calculated. Further, depending on events' names that occurred, student's navigation behavior was examined. Additionally, participant's content comprehension of the course was analyzed and evaluated based on the participant's scores of the pre-test and post-test. Further learning experience, opinions, and behavior were analyzed and evaluated on the basis of the questionnaire's results.

Subsequently, the total score and time completion of the pre-test and post-test, as well as the average score and average time completion of the pre-test and post-test for each cognitive group (FD and FI), were computed. Furthermore, the total time that each participant needed for the predefined search task in the customized Moodle (Phase B) as well as the total time that each participant needed to complete the course, were measured. In addition, the average times for the search task in the customized Moodle and completion of the course for the two cognitive groups were calculated.

Pre-test's and post-test's scores along with the time completion of the search task in the customized Moodle were statistically analyzed using the SPSS software and specifically, the Mann-Whitney Test. Moreover, pre-test's and post-test's time completion, as well as the customized course's time completion, were also statistically analyzed using the SPSS software and particularly the Independent-Samples T-Test. Finally, the questionnaire's results were analyzed automatically using the Google Forms app.

Chapter 5

Results

5.1 Overview

This chapter presents the experimental results of the study by comparing the two cognitive groups of individuals, FD and FI. Specifically, the significant difference between the two cognitive groups of participants was studied regarding individuals' time completion for the search task in Moodle, pre-test's and post-test's time completion along with performance, customized course's time completion and questionnaire's results. Although, before presenting and analyzing the results of the above tasks, the results of the GEFT are presented and analyzed. Lastly, this chapter states the participant's suggestions with regards to the customized course.

5.2 Group Embedded Figures Test

In accordance with the analysis of participants' GEFT scores, participants were classified as ten Field Independent and five as Field Dependent. Because of the large difference between FI and FD participants, as FD were half of FI, five out of ten FI participants were randomly included in the analysis, in order to have the same number of participants in the two groups and thus more accurate results.

5.3 Statistical Analysis

With the intention of answering the research questions, a number of hypotheses were formed. Hypotheses of each task are described in the following sub-sections.

5.3.1 Search Task in Moodle

A Mann-Whitney test [49] was used in order to examine whether FD and FI individuals showed differences in terms of time needed to find the activity "Test your knowledge (1)" in the customized Moodle, since a parametric test could not be used as the data which represented the total time of the search task weren't normally distributed.

The null and alternative hypotheses indicate that:
$H0_1$ There is no difference among FD and FI individuals regarding the time taken to find the requested activity in the customized Moodle.
$H1_1$ There are differences among FD and FI individuals regarding the time taken to find the requested activity in the customized Moodle.

The mean difference between FD and FI individuals indicated that there wasn't a statistically significant difference among the two cognitive groups ($p = 0.176$, $p > 0.05$), regarding the time taken to find the requested activity (See Figure 5.1 and Table 5.1). Thus, the null hypothesis ($H0_1$) is accepted. Consequently, FD and FI individuals needed more or less the same time to find the requested activity in the customized Moodle.

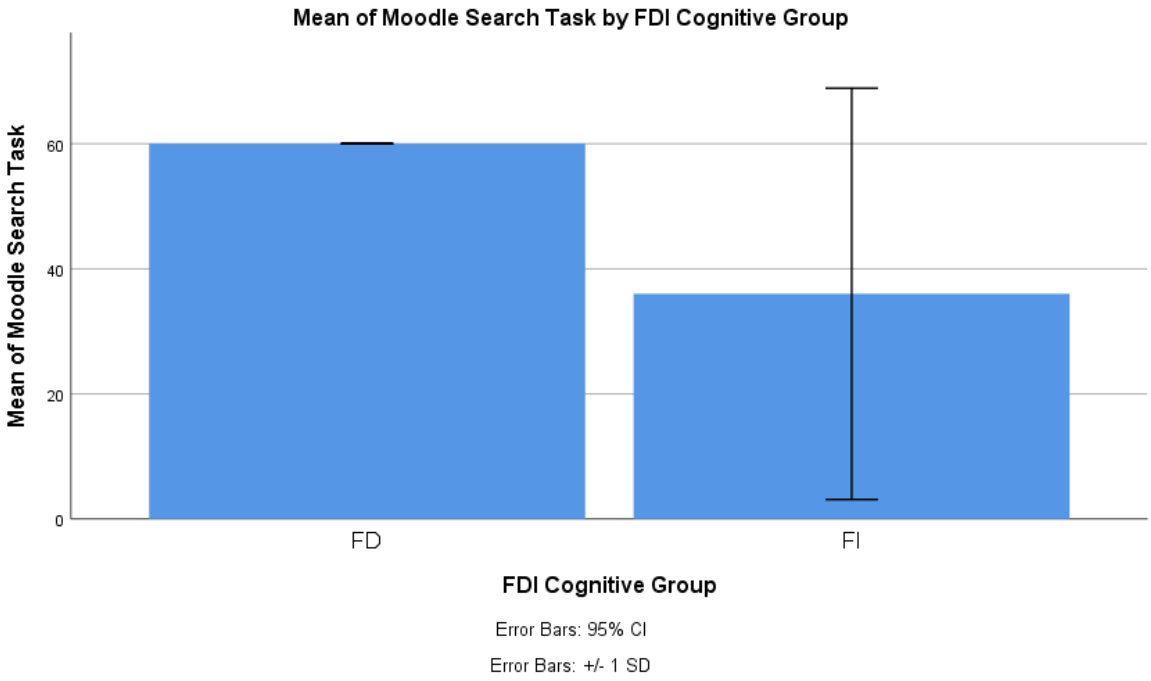


Figure 5.1 Graph – Mean of Moodle Search Task by FDI Cognitive Group

	Moodle_Search_Task
Mann-Whitney U	6.000
Wilcoxon W	21.000
Z	-1.352
Asymp. Sig. (2-tailed)	.176
Exact Sig. [2*(1-tailed Sig.)]	.413[b]

a. Grouping Variable: FDI_Cognitive_Group

b. Not corrected for ties.

Table 5.1 Mann-Whitney Test for the Search Task in Moodle

5.3.2 Pre-Test and Post-Test

5.3.2.1 Time Completion

Independent-Samples T-Test [50] was used to inspect whether the two cognitive groups of participants had differences regarding time completion difference of post-test and pre-test (Post-Test Time Completion – Pre-Test Time Completion) since the data which represented participants' time difference of post-test and pre-test met all of the assumptions of it.

The null and alternative hypotheses are stated as follow:
$H0_2$ There is no difference among FD and FI individuals in terms of time completion difference of post-test and pre-test.
$H1_2$ There are differences among FD and FI individuals in terms of time completion difference of post-test and pre-test.

The mean difference between FD and FI individuals signified that there wasn't a statistically significant difference among the two cognitive groups ($p = 0.053$, $p > 0.05$), regarding the time difference of post-test and pre-test (See Figure 5.2 and Table 5.2). Therefore, the null hypothesis ($H0_2$) is accepted, although the significant difference among FD and FI was very close to the 0.05 level.

Further, according to the means of the time difference between the two cognitive groups of participants, FI individuals needed a lot less time to complete the second test than the first test (Mean = -108.8), compared to FD individuals (Mean = 6.5) (See Table 5.3).

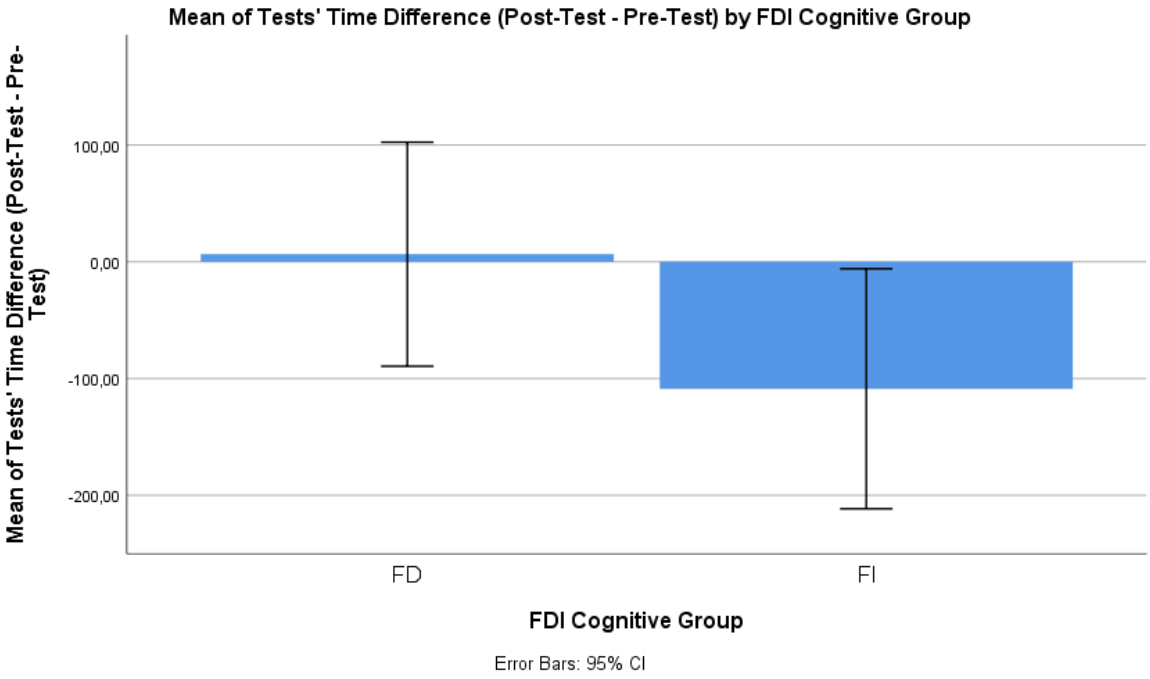


Figure 5.2 Graph – Mean of Tests' Time Difference by FDI Cognitive Group

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Time_Difference	Equal variances assumed	2.324	7	.053	115.30000	49.62245
	Equal variances not assumed	2.415	6.975	.047	115.30000	47.73632

Table 5.2 Independent-Samples T-Test of Tests' Time Difference

	FDI_Cognitive_Group	N	Mean	Std. Deviation	Std. Error Mean
Time_Difference	FD	4	6.5000	60.29649	30.14824
	FI	5	-108.8000	82.75989	37.01135

Table 5.3 Group Statistics of Tests' Time Difference according the Independent-Samples T-Test

5.3.2.2 Score

A Mann-Whitney test [49] was used in order to examine whether FD and FI individuals showed differences with regard to score difference of post-test and pre-test (Post-Test Score – Pre-Test Score) since a parametric test could not be used, as the data which represented the score difference weren't normally distributed.

The null and alternative hypotheses are indicated as follow:
$H0_3$ There is no difference among FD and FI individuals in terms of the score difference of post-test and pre-test.
$H1_3$ There are differences among FD and FI individuals in terms of the score difference of post-test and pre-test.

The mean difference between FD and FI individuals showed that there wasn't a statistically significant difference among the two cognitive groups ($p = 0.59$, $p > 0.05$), regarding the score difference of post-test and pre-test (See Figure 5.3 and Table 5.4). Thus, the null hypothesis ($H0_3$) is accepted, though the significant difference among FD and FI was very close to the 0.05 level.

In addition, corresponding to the mean ranks of the score difference between the two cognitive groups of participants, FI individuals' mean rank (Mean Rank = 6.40) was higher than FD individuals' mean rank (Mean Rank = 3.25). Therefore, FI individuals performed better in the second test than the first test, compared to FD individuals. (See Table 5.5).

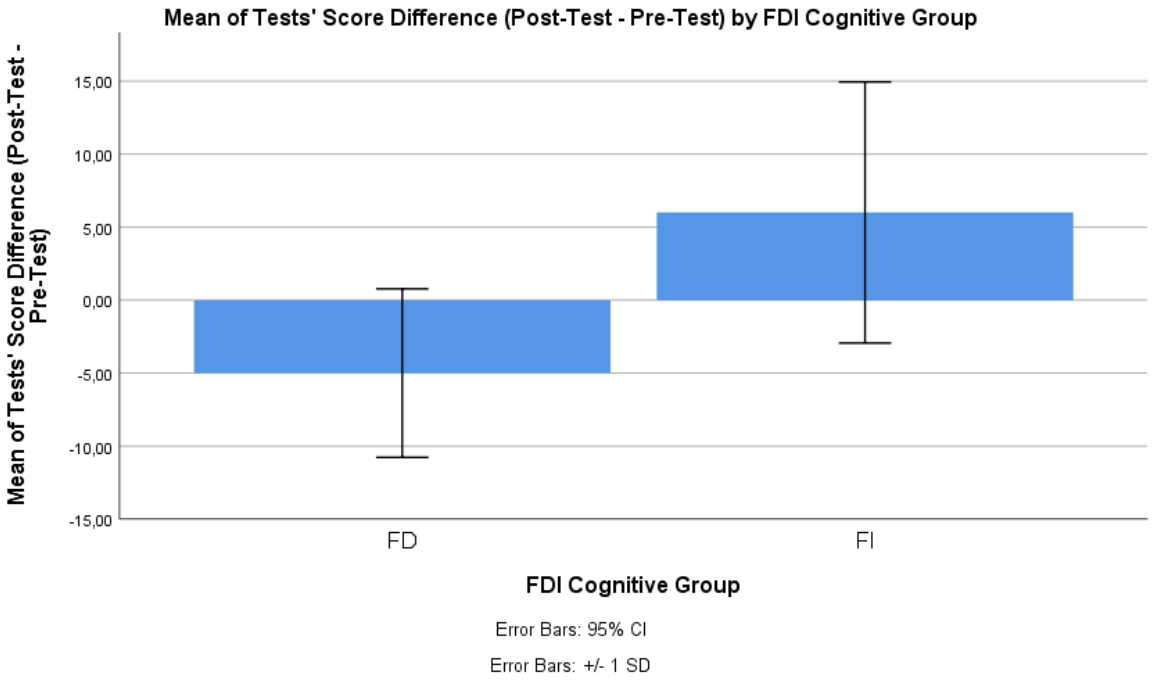


Figure 5.3 Graph – Mean of Tests' Score Difference by FDI Cognitive Group

	Score_Difference
Mann-Whitney U	3.000
Wilcoxon W	13.000
Z	-1.888
Asymp. Sig. (2-tailed)	.059
Exact Sig. [2*(1-tailed Sig.)]	.111[b]

a. Grouping Variable: FDI_Cognitive_Group

b. Not corrected for ties.

Table 5.4 Mann-Whitney Test for Tests' Score Difference

	FDI_Cognitive_Group	N	Mean Rank	Sum of Ranks
Score_Difference	FD	4	3.25	13.00
	FI	5	6.40	32.00
	Total	9		

Table 5.5 Ranks according to the Mann-Whitney Test for Test' Score Difference

5.3.3 Customized Course

Independent-Samples T-Test [50], was used to test whether the two cognitive groups of participants had differences regarding the time completion of the customized course since the data which represented participants' time completion of the course met all the assumptions of it.

The null and alternative hypotheses indicate that:
H0₄ There is no difference among FD and FI individuals in terms of the time completion of the customized course.
H1₄ There are differences among FD and FI individuals in terms of the time completion of the customized course.

The mean difference between FD and FI individuals indicated that there was a statistically significant difference among the two cognitive groups ($p = 0.042$, $p < 0.05$), regarding the time completion of the customized course (See Figure 5.4 and Table 5.6). Therefore, the null hypothesis ($H0_4$) is rejected.

Thus, according to the means of the time difference between the two cognitive groups of participants, FI individuals needed more time to complete the customized course (Mean = 729.6), than FD individuals (Mean = 584.5) (See Table 5.7).

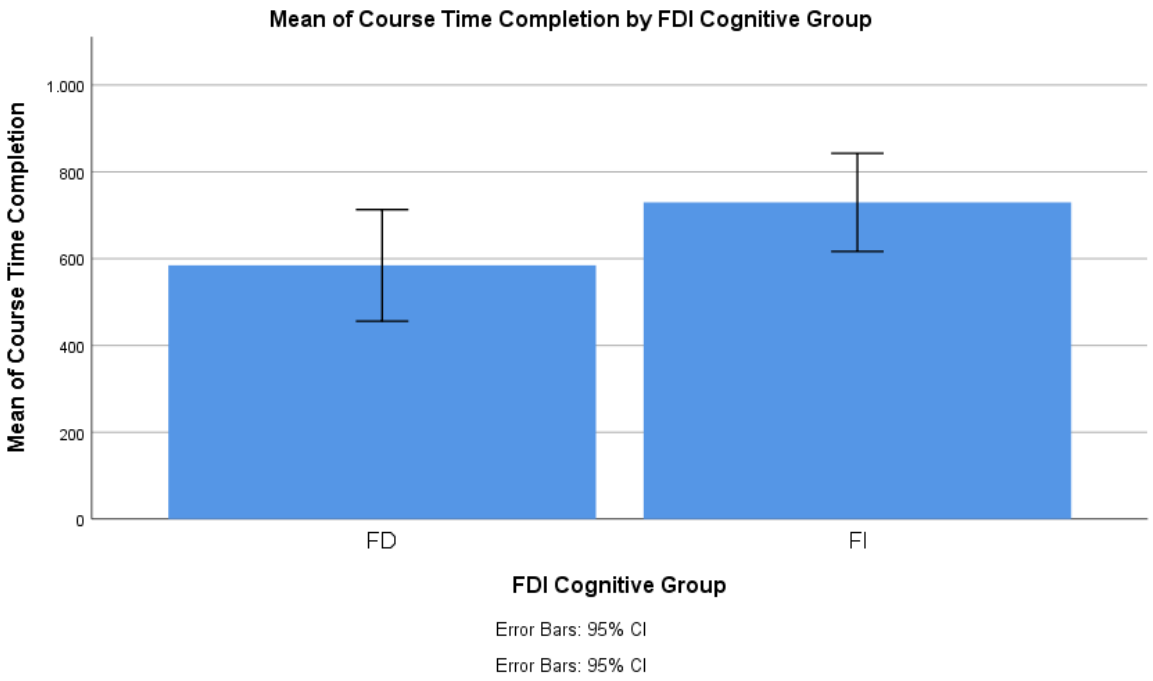


Figure 5.4 Graph – Mean of Course Time Completion by FDI Cognitive Group

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Course_Time_Completion	Equal variances assumed	-2.492	7	.042	-145.100	58.237
	Equal variances not assumed	-2.530	6.874	.040	-145.100	57.360

Table 5.6 Independent-Samples T-Test for Course Time Completion

	FDI_Cognitive_ Group	N	Mean	Std. Deviation	Std. Error Mean
Course_Time_Completion	FD	4	584.50	80.765	40.383
	FI	5	729.60	91.090	40.736

Table 5.7 Group Statistics according Independent-Samples T-Test for Course Time Completion

5.3.4 Questionnaire

Both FD and FI individuals strongly agreed that it was easy to detect the activity "Test your knowledge (1)" in the customized Moodle as well as they preferred to navigate through the customized Moodle than the traditional one.

With regards to the customized course, FD and FI individuals agreed that the customized course was easy to use and that they noticed information which was difficult to notice at the traditional presentation of the course. Further, FD and FI individuals strongly agreed that the overall experience offered by the customized course was fun and satisfying as well as the overall structure of the customized course motivated them to complete the course. Precisely, audio and avatar helped them to understand better how to move on through the customized course. Menu, next and previous buttons along with the ability to change the volume of the sound made them feel that they had control over the customized course. Further, animations helped them to understand better the content and feedback motivated them to complete the course. Also, FI and FD individuals strongly agreed that interactions kept them active to complete the course. Moreover, they didn't find elements that distracted them from the main content of the course. Although, FD individuals neither agreed or disagreed about the fact that audio was a distracting element. On the other hand, FI individuals didn't find audio a distracting element.

Generally, both cognitive groups of individuals preferred to navigate through the customized course than the traditional course because they liked more the design of the customized course. It was simple, fun, more pleasant and understandable as well an easier way to study.

Interactions kept longer their attention. Unlocking levels motivated them to continue and study. Colors and animations helped them to understand and remember better the course's content.

Finally, regarding pre-test and post-test, both groups of participants found the post-test easier to complete than the pre-test and they preferred feedback to be shown for each question instead at the end of the test.

5.4 Suggestions of Participants

Participants made some suggestions for the improvement of the customized course. Firstly, they preferred clicking on tabs rather than dragging the slider interaction to navigate through the customized course. They found dragging the slider interaction a little bit difficult when they first interacted with it, so they suggested keeping only one way of interaction (clicking on tabs). Secondly, regarding the animations that were included in the customized course, for making the course's content more comprehensive, participants preferred to have control over them. For example, having the ability to skip the animations as well as moving to the next and the previous one rather than this process being automatically. Finally, they suggested to include both, keyboard and mouse controls over the customized course instead of just mouse controls.

Chapter 6

Discussion

6.1 Overview

The present chapter reports the findings of this study in relation to existing studies' findings. Although, the generalizability of the results along with the relation of existing studies are limited by the small sample of FD and FI participants.

6.2 First Research Question: determine whether the two cognitive groups differ with regards to tasks' time completion and tests' performance

The first research question investigates whether FD and FI individuals differed with regards to tests' performance and tasks' time completion. Specifically, with regards to the time

completion of the search task in the customized Moodle, pre-test and post-test tasks as well as users' navigation in the customized course task.

6.2.1 Search Task in Moodle

The results of the search task in the customized Moodle indicated that there wasn't a significant difference among FD and FI users regarding the time taken to complete the task (Chapter 5). Thus, the results confirm that a careful design of the user interface, based on Schwier and Misanchunk principles along with learner's needs and goals (Chapter 3), help users navigate through the user interface without being distracted from their purpose. These results also build on existing studies, such as the study made by Nisiforou, Michailidou and Laghos [51], where they found that task time completion is not statistically different on simple pages among FD and FI individuals, while on complex pages the task time completion is significantly different between the two cognitive groups of users, as a simple page causes an oriented navigation while a complex page causes a disoriented navigation [51].

6.2.2 Pre-Test and Post-Test

6.2.2.1 Time Completion

Analysis of the data which represented time completion difference of post-test and pre-test showed that FD and FI individuals didn't have a significant difference (Chapter 5). Though the significant difference was really close to the 0.05 level, despite the very small sample of participants. So, according to the means of each cognitive group, FI individuals needed less time to complete the second test than the first, compared to FD individuals. In line with these results, FI individuals benefited from the new design of the course, while FD showed pretty much the same performance. Due to the lack of data which determine whether FD learners paid attention to the course's content or they just skipped it, the results cannot confirm whether the different design of the course including interactions, game-elements, animations along with the different form of the text helped FD individuals or not (Chapter 3). On the other hand, FI individuals' results confirm that elements such as interaction and gamification motivated and engaged them with the course's content, as they needed less time to complete

the post-test, than the pre-test, since the two tests had the same level of difficulty. These results build on existing evidence of studies, such as studies with regards to the insertion of gamification in different fields, where they found that gamification has the ability to motivate people and change their behavior [46] and studies by eLearning Industry, where they found that interactions keep learner's interest and keep them active in the learning process [44].

6.2.2.2 Score

Analysis of the data which represented the score difference of post-test and pre-test showed that FD and FI individuals didn't have a significant difference (Chapter 5). Though the significant difference was close to the 0.05 level, despite the very small sample of participants. So, with regards to the mean ranks of the two cognitive groups of participants FI individuals performed better in the second test than the first, compared to FD individuals. According to these results, FI individuals benefited from the new design of the course, while FD showed more or less similar performance. As stated above, due to the lack of data which determine whether FD learners paid attention to the course's content or they just skipped it, the results cannot confirm whether the different design of the course helped FD individuals or not (Chapter 3). On the other hand, FI individuals' results confirm that elements such as interaction and gamification motivated and engaged them with the course's content, as they performed better in the post-test than the pre-test since the two tests had the same level of difficulty. These results build on existing evidence of studies, which are already mentioned in the previous section.

6.2.3 Customized Course

The results of users' navigation in the customized course revealed that FD and FI individuals tended to have a significant difference with regards to the task's time completion since FD individuals needed less time than FI individuals to complete the customized course (Chapter 5). Although, the results don't fit in with studies that examine the FDI cognitive style in relation to tasks' time completion [2] since these studies noted that FD individuals need more time to complete tasks compared to FI individuals. Due to the lack of data which determine

whether learners paid attention to the course's content or they just skipped it, the results cannot confirm whether the different design of the course including interactions, game-elements, animations along with the different form of the text helped more FD individuals than FI individuals (Chapter 3).

6.3 Second Research Question: determine whether the different visual layout design of the course, along with Moodle, affect students' interaction and behavior with different FDI cognitive style

The second research question investigates whether the new design of the course and the learning platform affected FD and FI individuals' interaction and behavior. Analysis of the questionnaire's data confirmed that both FD and FI individuals preferred the new design of the Moodle learning platform and course's content and thus their interaction and behavior was positively affected. Precisely, these results confirm that when is paid attention to the design of the learning platform as well as to the design of the course's content, students are engaged with the learning process. A clean interface, simple layout and minimal design with the minimum number of distractions improve user's learning experience. Further, elements such as interaction, fun, gamification along with user-centered design (based on users' needs, goals and cognitive differences), have the potential to transform a boring course to an interesting and engaging course (Chapter 3). These results build on existing evidence of studies, such as the study made by Nisiforou and Michailidou, where they found that a simple page causes an oriented navigation while a complex page causes a disoriented navigation [51], the study made by Raptis, Katsini, Fidas, and Avouris [3], where they found that the cognition-based design help FD and FI learners to understand better the course's material and thus have better performance, studies with regards to the insertion of gamification in different fields, where they found that gamification has the ability to motivate people and change their behavior [46] and studies by eLearning Industry, where they found that interactions keep learner's interest and keep them active in the learning process [44].

Chapter 7

Conclusion

7.1 Summary of Research Findings

The two cognitive groups of participants needed pretty much the same time for the search task in the customized Moodle. Further, FD and FI individuals didn't show a significant difference among the time and score difference of the post-test and pre-test. Although, the significant difference of these tasks were very close to the 0.05 level, despite the limited sample of participants, so it is worth mention that FI individuals got higher score and needed less time to complete the post-test than the pre-test, compared to FD individuals, who had more or less the same performance in these tasks, compared to FI individuals. Finally, regarding the course's time completion FD individuals needed less time to navigate through the course than FI individuals.

7.2 Contribution

Regarding the findings of this research, although the limited number of participants, still we end up in the same inference. Designing a user interface and an online course isn't simple. It is crucial to include the right engaging elements along with considering individuals'

cognitive style. This study proposes different elements and techniques that unlock the aspect of fun in learning and help learners to achieve their full potential. Thus, this research represents a practical example of the benefits that a carefully designed course along with the LMS can make individuals engage with learning.

7.3 Implications for Research

It is essential to give much more attention to the design of the courses' content along with the tools that deliver learning if we truly desire to promote deeper learning instead of surface learning. Therefore, this study should interest educators who care and want to help their students connect with the learning process. Elements like visual aesthetics, interaction and gamification have shown that they can metamorphose learners' behavior and engage them with learning [44]. Additionally, paying attention to learners' cognitive style can eliminate learners' unbalances and motivate them to engage in learning. Moreover, according to the findings, there is a need for more studies in order to test the reliability and validity of the findings.

7.4 Recommendations

This work can be improved by conducting the research to a wider number of learners (a balanced number among FD and FI individuals) as well as by decreasing the number of variables such as the time when participants attended the "Databases" course, in order to have more valid and reliable results. Further, two significant aspects that need to be inspected with regards to learners' cognitive style are learners' emotions and attention, as it can give us a clearer picture of how learners feel as they navigate through the customized Moodle and course as well as which elements helped them, which elements learners ignored and where they focused. Further, more characteristics of users should be considered such as their academic grades, gender and age. Finally, the participants' suggestions should be considered.

7.5 Further Study

The current study should be expanded with further research using Microsoft HoloLens. The customized Moodle and course should be developed in Microsoft HoloLens. Microsoft HoloLens is a mixed reality wearable device, which blends the physical world with the digital world and let users interact with it in real time. Its capability of combining the physical world with the digital world presents new possibilities for learning and therefore researchers around the world are experimenting on how its application in learning could help learners achieve their full potential [54]. Furthermore, Microsoft HoloLens is fitted with sensors which can help us detect the likely emotional states of users while interacting with the customized Moodle and course [55].

A comparative study should follow among users' navigation, experience and behavior in Desktop versus HoloLens. Therefore, we would determine how FD and FI users have been affected by their interaction with HoloLens, whether there are differences among the two cognitive groups of learners and eventually which technology has helped most each cognitive group of learners.

7.6 General Conclusion

This study highlights the importance of understanding that is time to stop giving learners broken tools and start paying attention to the design of a remarkable learning experience. The results of this study provide evidence that learning can be fun when is carefully designed. Interaction, gamification, aesthetic design and individuals' cognitive differences were combined in order to engage users with learning and improve learner's content comprehension of the course. Further, FDI cognitive style was the main dimension of the experiment, as studies proved the significant relation of individuals' cognitive style and academic achievement. Hence, this research constitutes a significant step in designing an engaging learning experience.

References

[1] N. Friesen, "Re-Thinking E-Learning Research," [Online]. Available: http://elearning656.yolasite.com/resources/Introduction%20to%20E-Learning.pdf.

[2] E. A. Nisiforou and A. Laghos, "Do the eyes have it? Using eye tracking to assess students cognitive dimensions," in *Educational Media International*, 2013.

[3] G. E. Raptis, C. Katsini, C. Fidas and N. Avouris, "Visualization of Cultural-Heritage Content based on Individual Cognitive Differences," 2018.

[4] N. Denmeade, Gamification with Moodle, 2015.

[5] "Cognitive/Learning Styles," [Online]. Available: https://www.instructionaldesign.org/concepts/cognitive-styles/.

[6] eLearningNc, "What is eLearning?," 2019. [Online]. Available: http://www.elearningnc.gov/about_elearning/what_is_elearning/.

[7] TechTerms, "Moodle," [Online]. Available: https://techterms.com/definition/moodle.

[8] "Cognition and Cognitive Science," CogniFit, [Online]. Available: https://www.cognifit.com/cognition.

[9] E. Nisiforou and A. Laghos, "Field dependence-Independence and eye movement patterns: investigating users' differences through an eye-tracking study," in *Interacting with Computers, 28(4), 407-420*, Limassol, Cyprus, 2016.

[10] J.-C. Yen and W.-C. Liao, "Effects of Cognitive Styles on Learning Performance and Gaming Behavior in a Programming Board Game," in *7th International Congress on Advanced Applied Informatics*, 2018.

[11] P. Lucas-Stannard, "Cognitive Styles: A Review of the Major Theories and Their Application to Information Seeking in Virtual Environments," 2003. [Online]. Available: http://www.personal.kent.edu/~plucasst/Cognitive%20Styles.pdf.

[12] I. a. G. C. Sanchez, "Understanding and supporting the culturally diverse distance learner," in *C.C. Gibson, (Ed.), Distance learners in higher education (pp. 47-64)*, Madison, WI: Atwood Publishing, 1998.

[13] Grigorenko, R. J. Sternberg and a. E. L., "Are Cognitive Styles Still in Style?," 1997.

[14] M. A. Guisande, M. F. Paramo, C. Tinajero and L. S. Almeida, "Field dependence-independence (FDI) cognitive style: An analysis of attentional functioning," Spain, 2007.

[15] E. Oh and D. Lim, "Cross Relationships between Cognitive Styles and Learner Variables in Online Learning Environment," *Journal of Interactive Online Learning* , vol. 4, 2005.

[16] A. Friedman, "Definition of Online Education," 3 March 2019. [Online]. Available: https://www.theclassroom.com/definition-online-education-6600628.html.

[17] J. L. Moore, C. Dickson-Deane and K. Galyen, "e-Learning, online learning, and distance learning environments: Are they the same?," [Online]. Available: http://portfolio.kgalyen.com/pdf/moore2010_journal.pdf. [Accessed 15 October 2010].

[18] C. Ardito, M. F. Costabile, M. D. Marsico, R. Lanzilotti, S. Levialdi, T. Roselli and V. Rossano, "An approach to usability evaluation of e-learning applications," 2005.

[19] S. Guri-Rosenblit, "Distance education' and 'e-learning': Not the same thing," 2005. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.467.4220&rep=rep1&type=pdf.

[20] E. S. Soegoto and F. Ardian, "Designing E-Learning Application," 2018.

[21] D. Tavangarian, M. E. Leypold, K. Nölting, M. Röser and D. Voigt, "Is e-Learning the Solution for Individual Learning?," [Online]. Available: https://files.eric.ed.gov/fulltext/EJ1099252.pdf.

[22] eThink, "What is an LMS? The Basics of Learning Management Systems," 2019. [Online]. Available: https://ethinkeducation.com/what-is-an-lms-the-basics- of-learning-management-systems/.

[23] C. Limongelli, F. Sciarrone and G. Vaste, "Personalized e-learning in Moodle: the Moodle_LS System," 2011.

[24] "What is an LMS? The Basics of Learning Management Systems," eThink, 2019. [Online]. Available: https://ethinkeducation.com/what-is-an-lms-the-basics-of-learning-management-systems/.

[25] "Open-Source vs. Closed-Source: Why the Technology Your LMS Uses is Important," eThink, 2019. [Online]. Available: https://ethinkeducation.com/open-source-vs-closed-source-technology-lms/.

[26] M. Shojafar, S. Barzegar, F. Aeini and H. Rashidi, "The Practical Guidelines for Designing User Interface in Virtual Learning Environment," Iran.

[27] C. Pappas, "The 20 Best Learning Management Systems (2018 Update)," 2018. [Online]. Available: https://elearningindustry.com/the-20-best-learning-management-systems.

[28] C. K. Pandya and S. J. Boricha, "LIBRARIANSHIP DEVELOPMENT THROUGH INTERNET OF THINGS AND CUSTOMER SERVICES: INTERNATIONAL CONFERENCE PROCEEDINGS JANUARY 2019," 2019.

[29] A. Anand and S. Eswaran, "A SURVEY OF OPEN SOURCE LEARNING MANAGEMENT SYSTEMS," India, 2018.

[30] "Features," Adobe, 2019. [Online]. Available: https://www.adobe.com/cy_en/products/captivateprime/features.html.

[31] "Blackboard," [Online]. Available: https://www.blackboard.com/blackboard-learn/index.html.

[32] "Blackboard Open LMS," [Online]. Available: https://www.blackboardopenlms.com/resource/learning-features/.

[33] D. Pishva, G. Nishantha and H. A. Dang, "A Survey on How Blackboard is Assisting Educational," 7 February 2010. [Online]. Available: http://www.icact.org/upload/2010/0218/20100218_finalpaper.pdf.

[34] R. Gotarkar, "Which LMS is Better For You- Moodle or Blackboard?," Edwiser, 16 October 2017. [Online]. Available: https://edwiser.org/blog/moodle-versus-blackboard/.

[35] M. Shojafar, S. Barzegar, F. Aeini and H. Rashidi, "The Practical Guidelines for Designing User Interface in Virtual Learning Environment".

[36] C. Ardito, M. F. Costabile, M. D. Marsico, R. Lanzilotti, S. Levialdi, T. Roselli and V. Rossano, "An approach to usability evaluation of e-learning applications".

[37] R. A. Schwier and E. R. Misanchuk, "Interactive Multimedia Instruction," in *Interactive Multimedia Instruction*, United States of America, Educational Technology Publications Inc., Englewood Cliffs, New Jersey 07632, 1993.

[38] "Introducing the Fordson Theme for Moodle," [Online]. Available: https://michiganmoodle.dearbornschools.org/fordson-theme-for-moodle/.

[39] Moodle, "Themes: Fordson," [Online]. Available: https://moodle.org/plugins/theme_fordson.

[40] Moodle, "Themes," [Online]. Available: https://moodle.org/plugins/browse.php?list=category&id=3&p=1.

[41] Moodle, "Course formats: Grid Format," [Online]. Available: https://moodle.org/plugins/format_grid.

[42] J. Barnard and P. Krix, "Moodle-format grid," [Online]. Available: http://gjb2048.github.io/moodle-format_grid/.

[43] "Course Formats in Moodle," The University of Minnesota Disability Resource Center, [Online]. Available: https://accessibility.umn.edu/moodle/course-formats-moodle#topics%20format.

[44] A. H. Omer, "Missing Learner Engagement In Your eLearning? 5 Ways To Bring It In," eLearning Industry, 2019. [Online]. Available: https://elearningindustry.com/missing-learner-engagement-elearning-ways-bring.

[45] A. K. K, "Intuitive Interactivities that Enhance Learning Using Articulate Storyline," CommLab India, [Online]. Available: https://blog.commlabindia.com/elearning-development/interactivities-that-enhance-learning-using-storyline?utm_campaign=elearningindustry.com&utm_source=%2Fmissing-learner-engagement-elearning-ways-bring&utm_medium=link.

[46] K. Werbach, "Gamification," Coursera, University of Pennsylvania.

[47] P. K. Oltman, E. Raskin, H. A. Witkin and S. A. Karp, "Group Embedded Figures Test," 1971.

[48] "Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC," 27 April 2016. [Online]. Available: https://eur-lex.europa.eu/eli/reg/2016/679/oj.

[49] "Mann-Whitney U Test using SPSS Statistics," Laerd Statistics, [Online]. Available: https://statistics.laerd.com/spss-tutorials/mann-whitney-u-test-using-spss-statistics-2.php.

[50] "Independent t-test using SPSS Statistics," Laerd Statistics, [Online]. Available: https://statistics.laerd.com/spss-tutorials/independent-t-test-using-spss-statistics.php.

[51] E. A. Nisiforou, E. Michailidou and A. Laghos, "Using Eye Tracking to Understand the Impact of Cognitive Abilities on Search Tasks," in *International Conference on Universal Access in Human-Computer Interaction (pp. 46-57). Springer, Cham*, Cyprus, 2014.

[52] "ABOUT US: WHAT IS EYETRACKING?," [Online]. Available: http://www.eyetracking.com/About-Us/What-Is-Eye-Tracking.

[53] C. Hondrou and G. Caridakis, "Affective, Natural Interaction Using EEG:Sensors, Application and Future Directions," 2012.

[54] M. N. Giannakos, M. Divitini, O. S. Iversen and P. Koulouris, "Make2Learn: Fostering Engagement and Creativity in Learning through Making," 2015.

[55] A. Ezenwoke, O. Ezenwoke, A. Adewumi and N. Omoregbe, "WEARABLE TECHNOLOGY: OPPORTUNITIES AND CHALLENGES FOR TEACHING AND LEARNING IN HIGHER EDUCATION IN DEVELOPING COUNTRIES," in *Proceedings of INTED2016 Conference*, Valencia, Spain, 2016.

Appendix A

Appendix A includes the consent form that students signed, due to the GDPR, which stated that their data will be used anonymous and only for the purpose of the study.

ΕΝΤΥΠΟ ΕΝΗΜΕΡΩΣΗΣ ΚΑΙ ΣΥΓΚΑΤΑΘΕΣΗΣ ΣΕ ΕΡΕΥΝΑ

Αγαπητοί συμμετέχοντες,

Η παρούσα έρευνα έχει ως στόχο την μελέτη της επίδρασης του σχεδιασμού ενός διαδικτυακού μαθήματος στο Moodle στην αλληλεπίδραση και επίδοση των φοιτητών με διαφορετική γνωστική ικανότητα (Field Dependent/Independent). Η μελέτη αυτή υλοποιείται στο πλαίσιο διεξαγωγής της διπλωματικής μου εργασίας ως φοιτήτρια του Πανεπιστημίου Κύπρου.

Η έρευνα αυτή θα διενεργηθεί ως εξής:

α. Αναζήτηση του μαθήματος Databases και ακολούθως του διαγνωστικού δοκιμίου (Test your knowledge 1)
β. Ολοκλήρωση του διαγνωστικού δοκιμίου
γ. Αλληλεπίδραση με το διαδραστικό μάθημα στο Moodle
δ. Ολοκλήρωση ενός δεύτερου διαγνωστικού δοκιμίου (Test your knowledge 2)
ε. Συμπλήρωση ερωτηματολογίου αξιολόγησης του διαδραστικού μαθήματος

Η έρευνα θα λάβει χώρα εντός του Πανεπιστημίου Κύπρου και θα διαρκέσει περίπου 30 λεπτά. Επίσης προκειμένου να εντοπιστεί η γνωστική σας ικανότητα και η κατηγοριοποίησή σας σε Field Dependent (εξαρτημένου πεδίου) και Field Independent (ανεξάρτητου πεδίου) θα πρέπει να συμπληρώσετε το Embedded Figures Test το οποίο θα διαρκέσει περίπου 20 λεπτά.

Με εκτίμηση

Η ερευνήτρια

Μαριάνα Μηνά

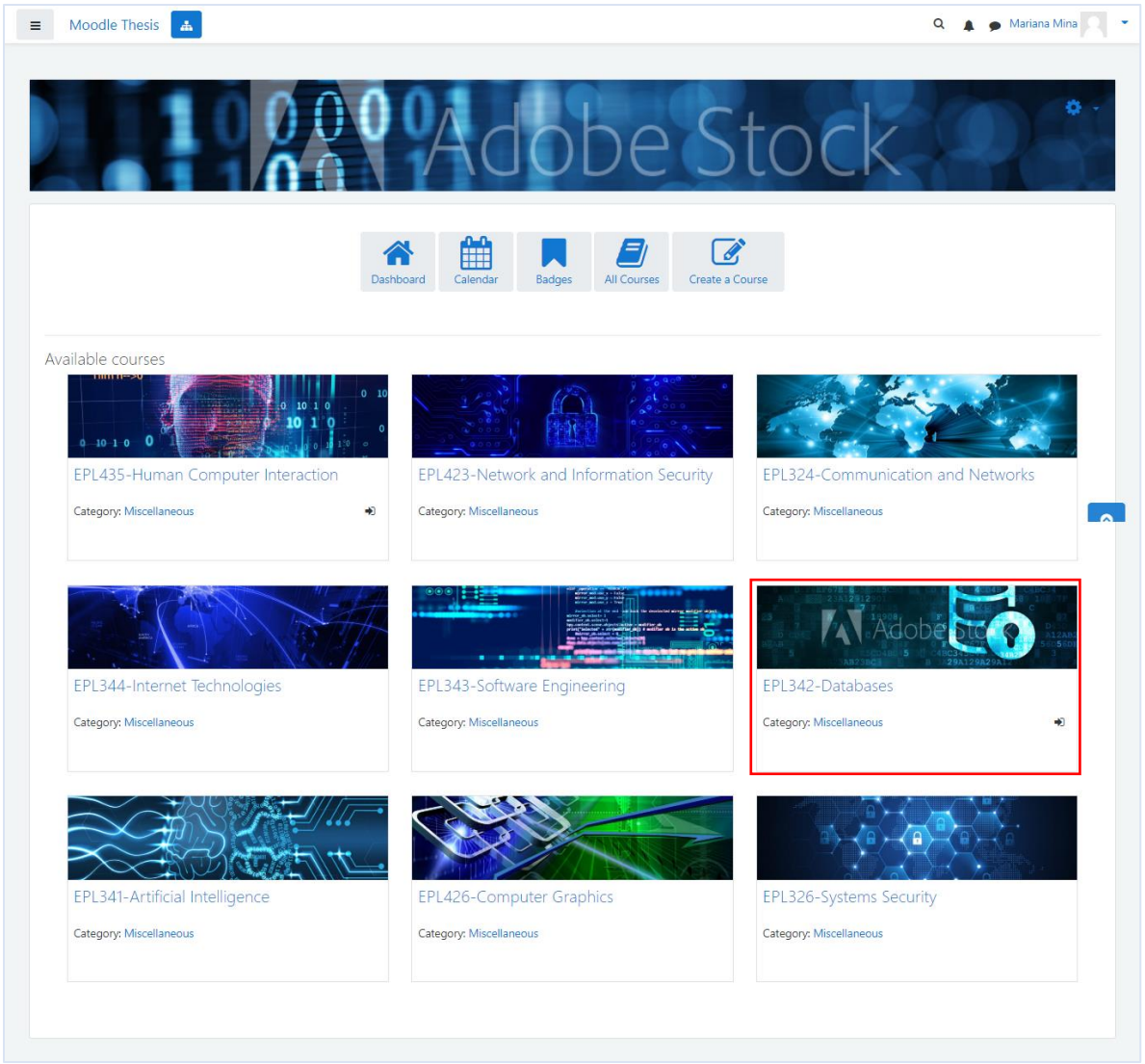
Ο/η κάτωθι υπογραφόμενος/η ..... συμμετέχοντας …….. δηλώνω ότι συμφωνώ:

Να χρησιμοποιηθούν ανώνυμα και να μελετηθούν τα δεδομένα της έρευνας στο πλαίσιο της διπλωματικής εργασίας.

Ημερομηνία Υπογραφή συμμετεχόντα

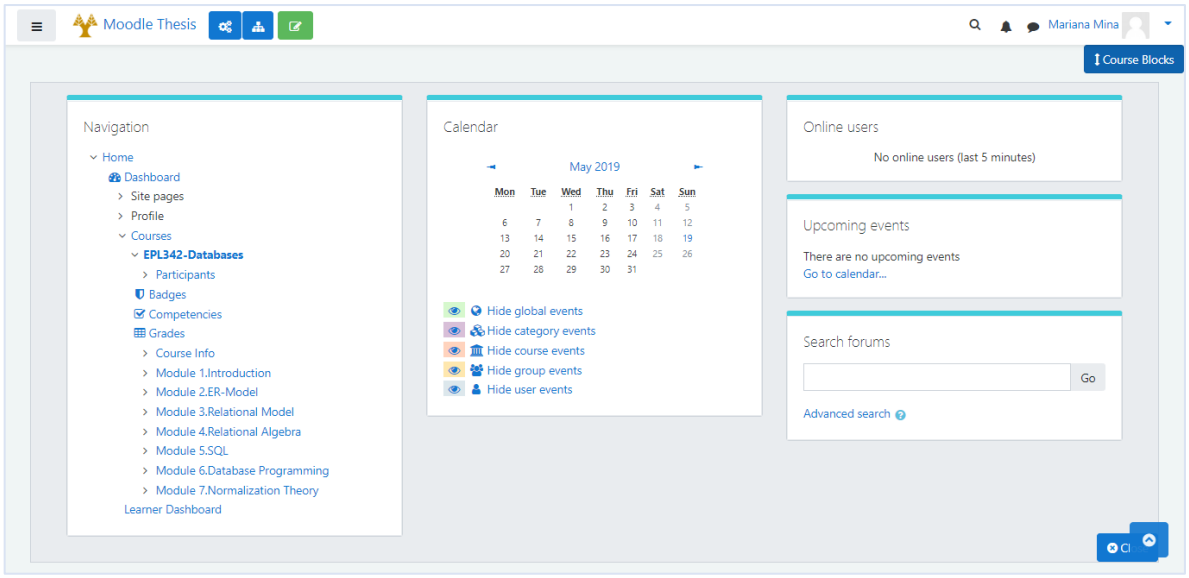
Appendix B

Appendix B includes screenshots of the customized Moodle. Images added in Moodle designed by Freepik from www.flaticon.com, Adobe Stock and other online sources.

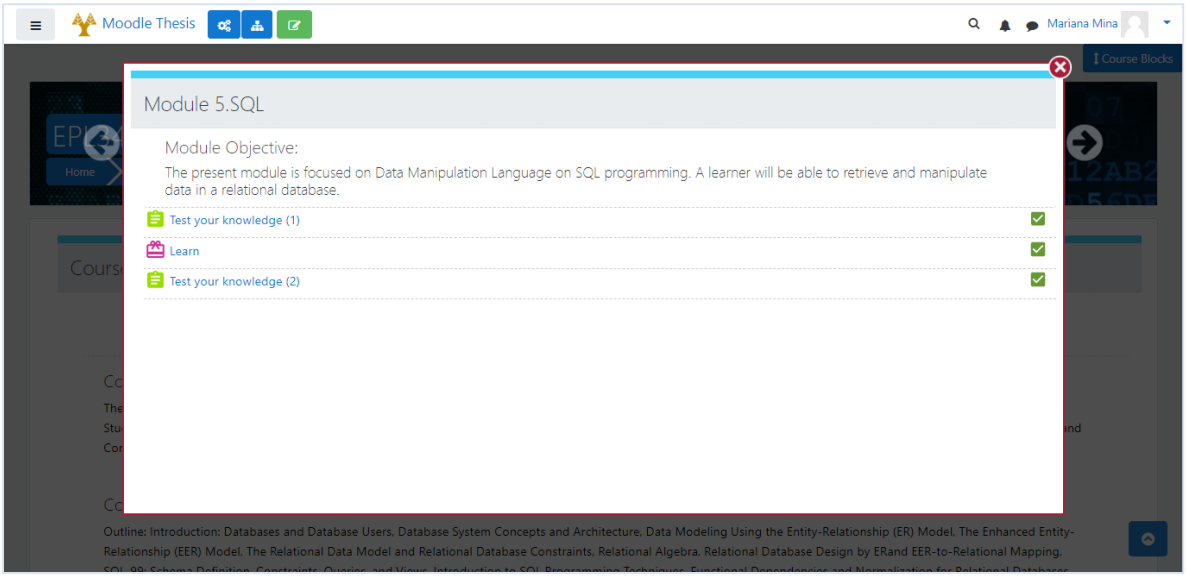


Course Page

After clicking "EPL 342-Databases" grid



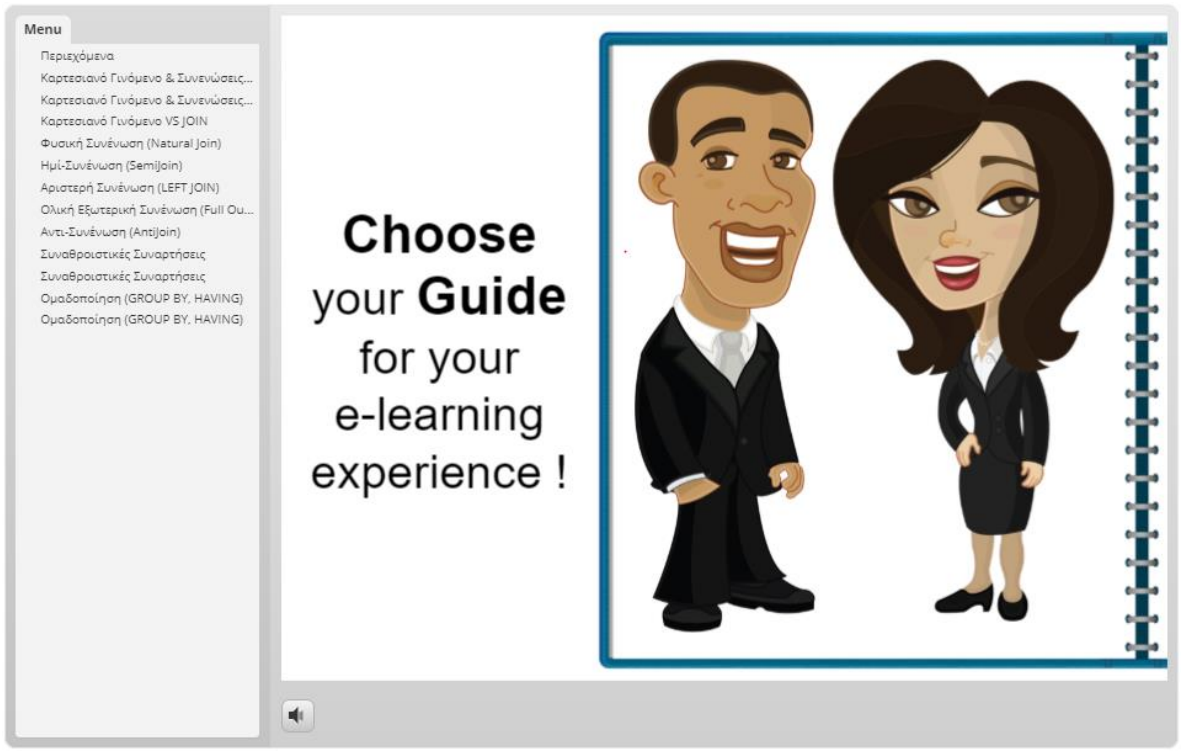
1 After clicking "Course Blocks" button



2 After clicking "Module 5.SQL" grid

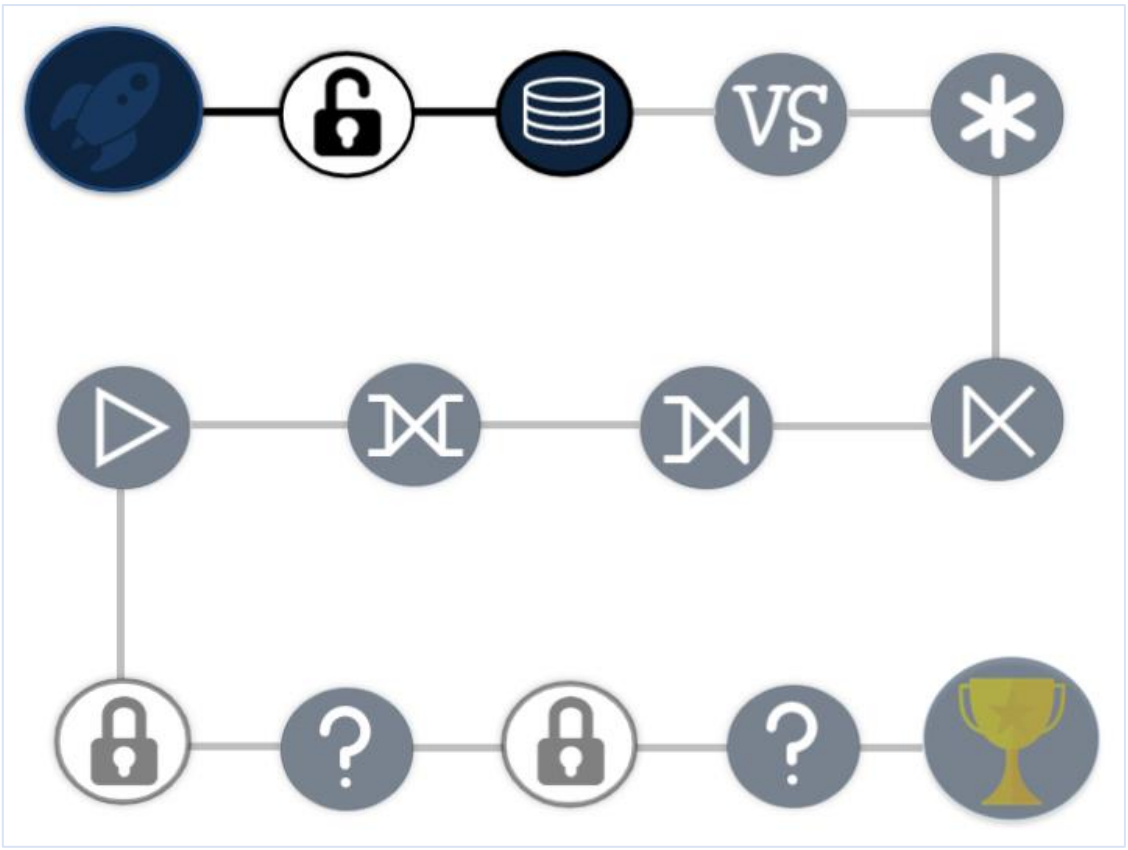
Appendix C

Appendix C includes some screenshots of the customized course. The screenshots that were chosen include elements of interaction and gamification, along with the customized text (different color, size and font), in order to provide a general idea of how the course was customized to make learners engage and connect with it.

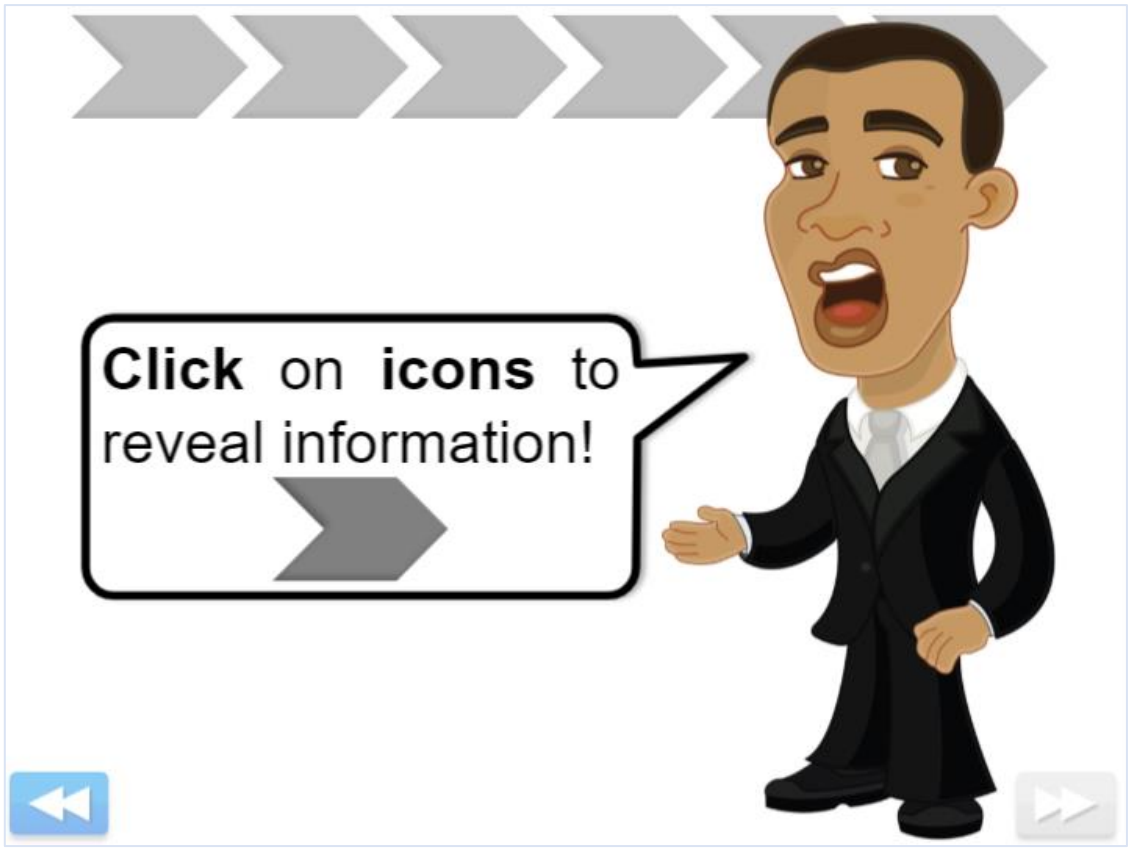


Choose your **Guide** for your e-learning experience !

Περιεχόμενα


VS

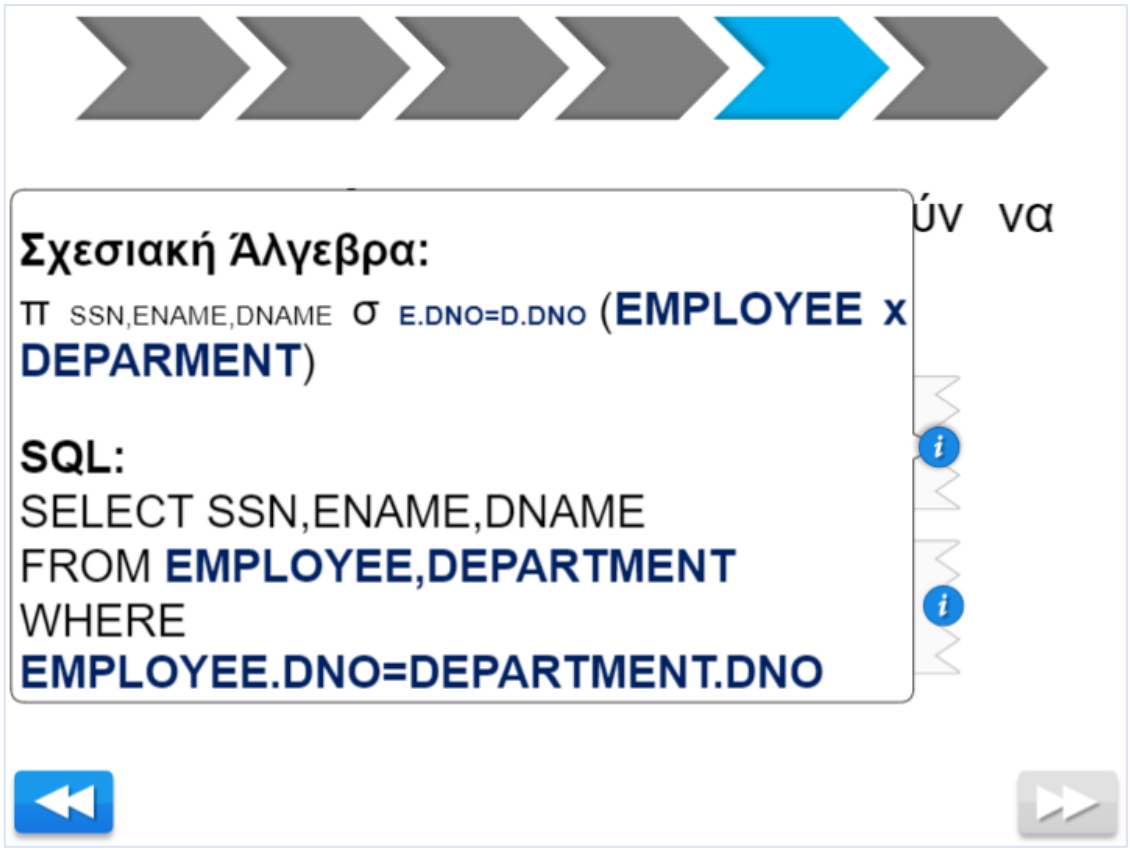

This icon shows your progress!



Οι **συνενώσεις** σε SQL μπορούν να γίνουν με τους **τελεστές**:

Καρτεσιανό Γινόμενο

JOIN


ύν να
Σχεσιακή Άλγεβρα:
π SSN,ENAME,DNAME σ E.DNO=D.DNO (EMPLOYEE x DEPARMENT)
SQL:
SELECT SSN,ENAME,DNAME
FROM EMPLOYEE,DEPARTMENT
WHERE
EMPLOYEE.DNO=DEPARTMENT.DNO


Καρ
Γιν
Drag the slider!

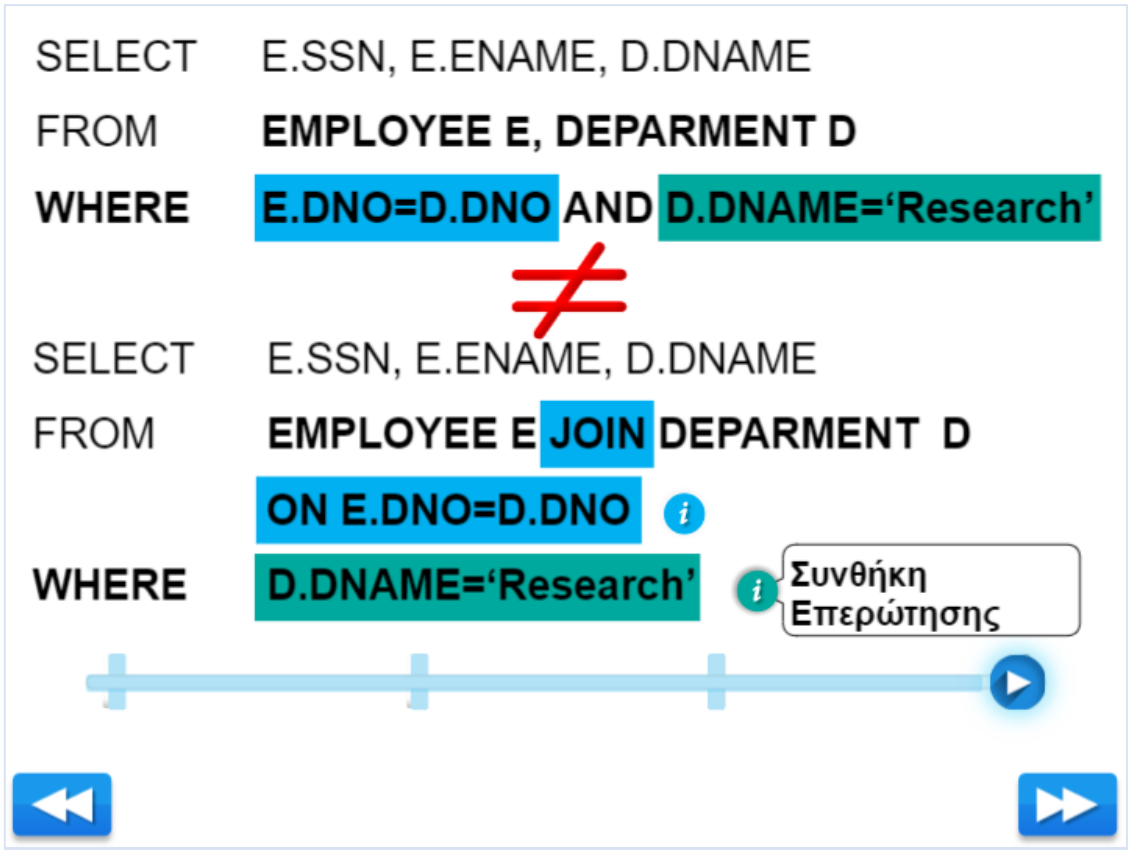
JOIN-Πλεονέκτημα:

Δεν περιπλέκει την **συνθήκη συνένωσης** με την **συνθήκη επερώτησης**

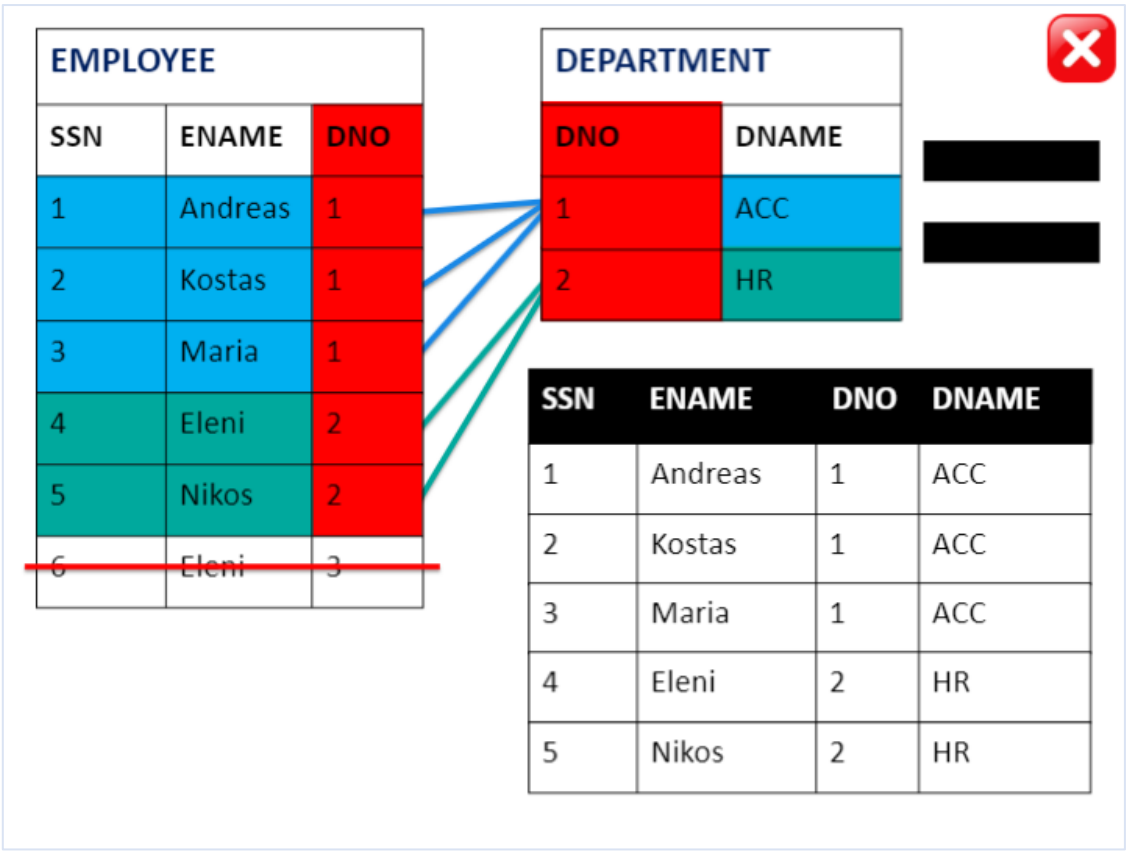
```
SELECT   E.SSN, E.ENAME, D.DNAME
FROM     EMPLOYEE E, DEPARMENT D
WHERE    E.DNO=D.DNO AND D.DNAME='Research'
```

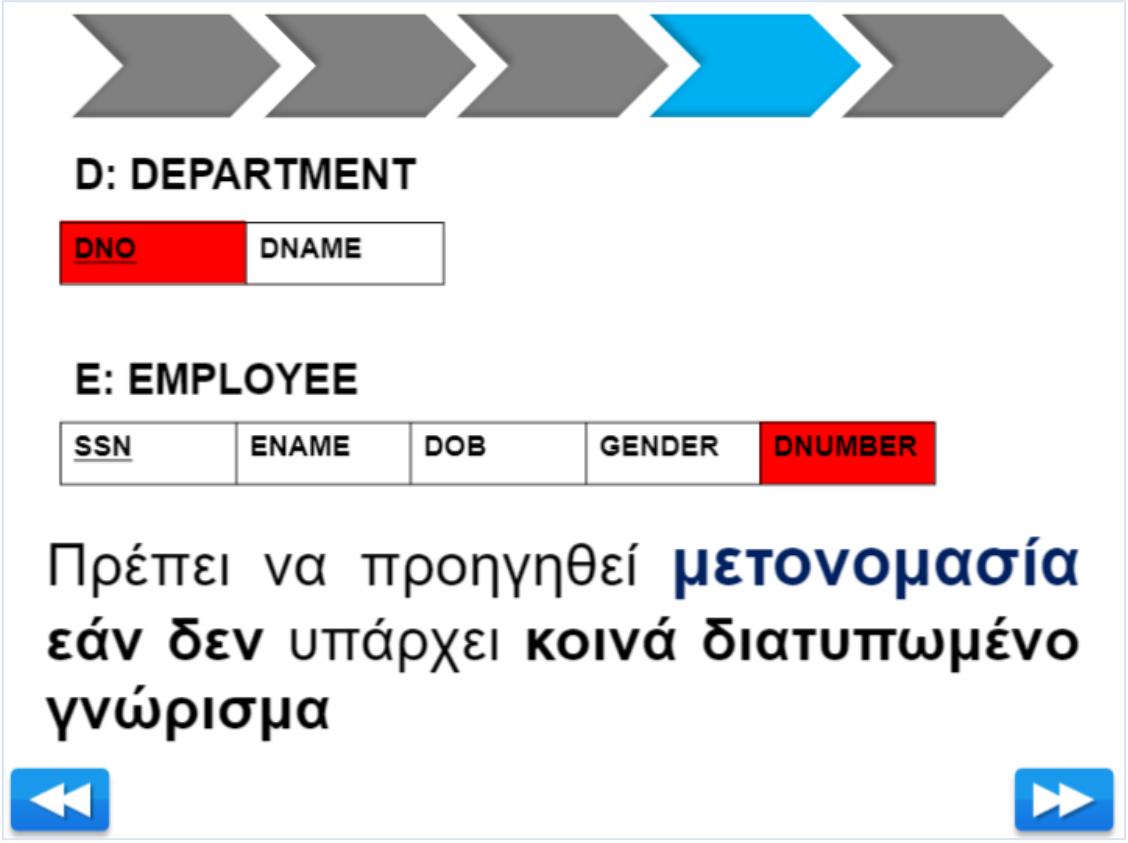
≠

```
SELECT   E.SSN, E.ENAME, D.DNAME
FROM     EMPLOYEE E JOIN DEPARMENT D
         ON E.DNO=D.DNO
WHERE    D.DNAME='Research'
```


SELECT E.SSN, E.ENAME, D.DNAME
FROM EMPLOYEE E, DEPARMENT D
WHERE E.DNO=D.DNO AND D.DNAME='Research'
≠
SELECT E.SSN, E.ENAME, D.DNAME
FROM EMPLOYEE E JOIN DEPARMENT D
ON E.DNO=D.DNO
WHERE D.DNAME='Research'
Συνθήκη Επερώτησης


Συνθήκη Συνένωσης:
Κοινά Γνωρίσματα


EMPLOYEE
SSN
ENAME
DNO
1
Andreas
1
2
Kostas
1
3
Maria
1
4
Eleni
2
5
Nikos
2
6
Eleni
3
DEPARTMENT
DNO
DNAME
1
ACC
2
HR
SSN
ENAME
DNO
DNAME
1
Andreas
1
ACC
2
Kostas
1
ACC
3
Maria
1
ACC
4
Eleni
2
HR
5
Nikos
2
HR


D: DEPARTMENT
DNO
DNAME
E: EMPLOYEE
SSN
ENAME
DOB
GENDER
DNUMBER
Πρέπει να προηγηθεί μετονομασία εάν δεν υπάρχει κοινά διατυπωμένο γνώρισμα

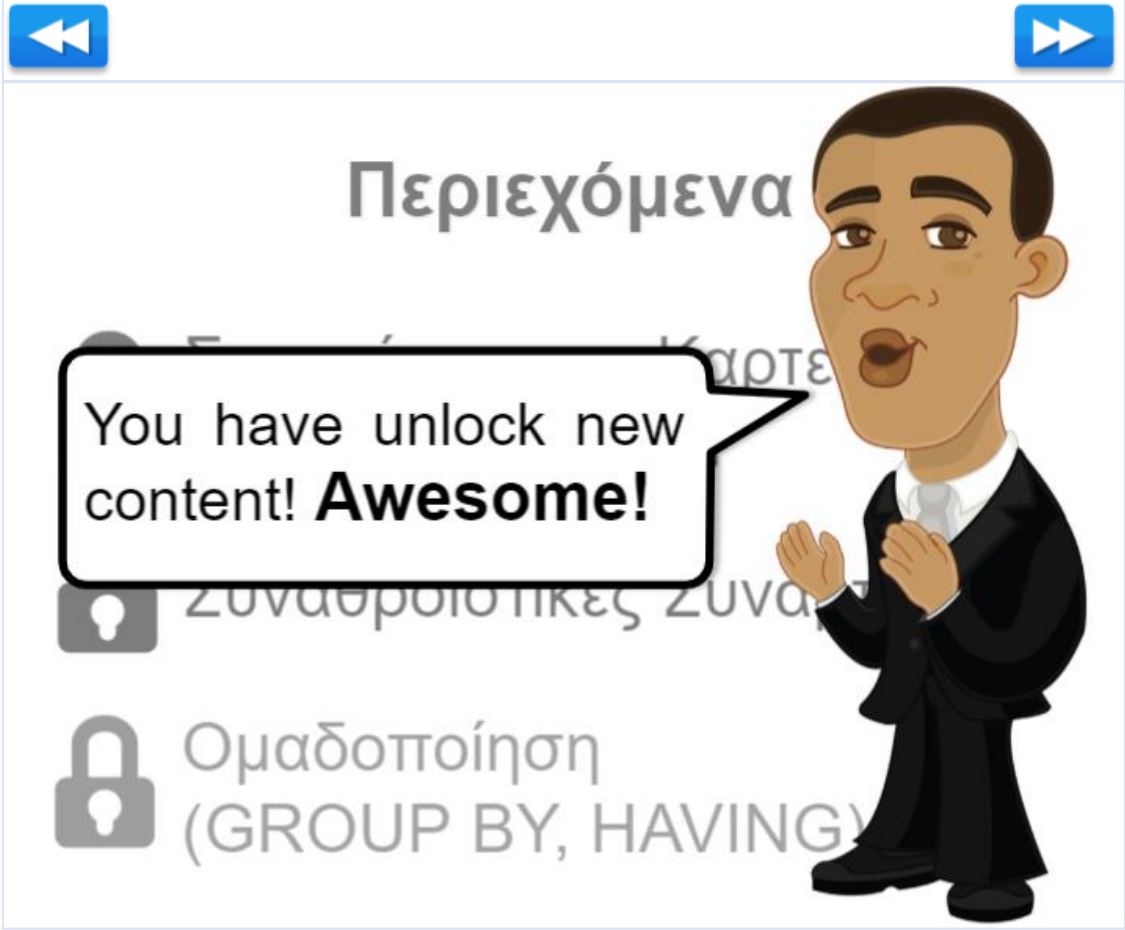
SELECT *
FROM EMPLOYEE NATURAL JOIN DEPARMENT
AS DEPARTMENT(DNUMBER, DNAME)

D: DEPARTMENT

DNUMBER	DNAME

E: EMPLOYEE

SSN	ENAME	DOB	GENDER	DNUMBER

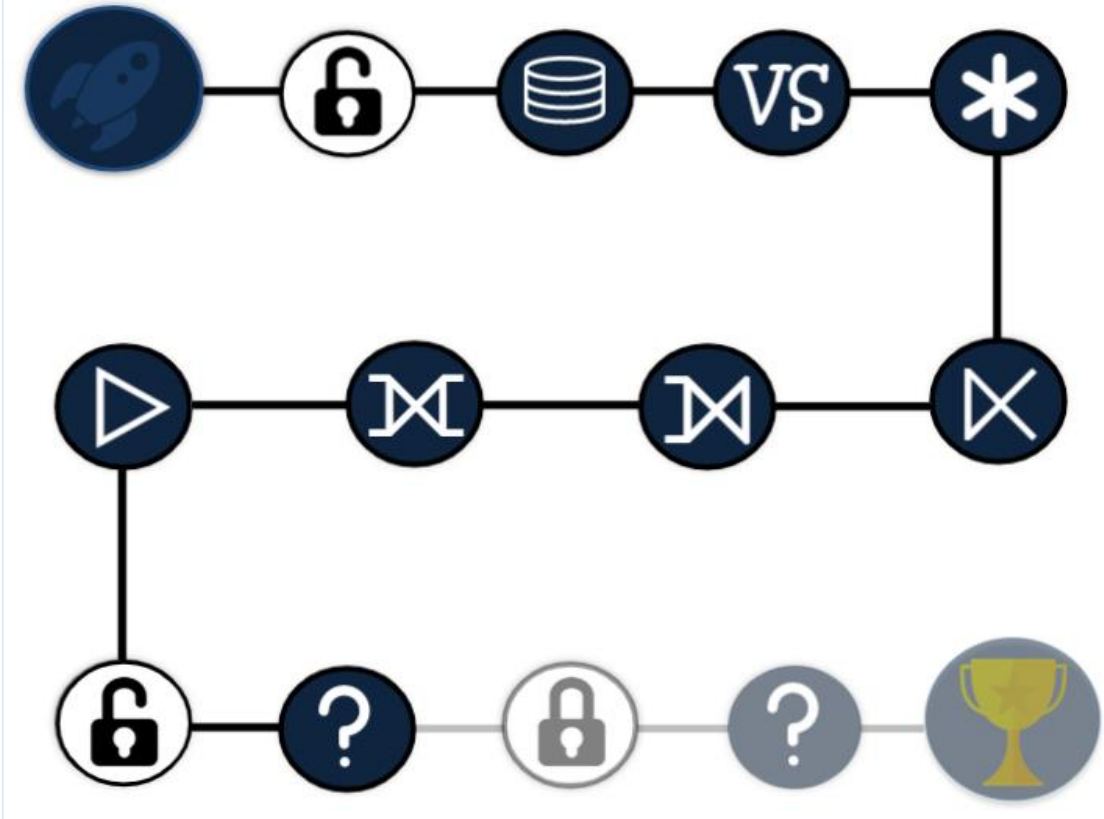


Περιεχόμενα

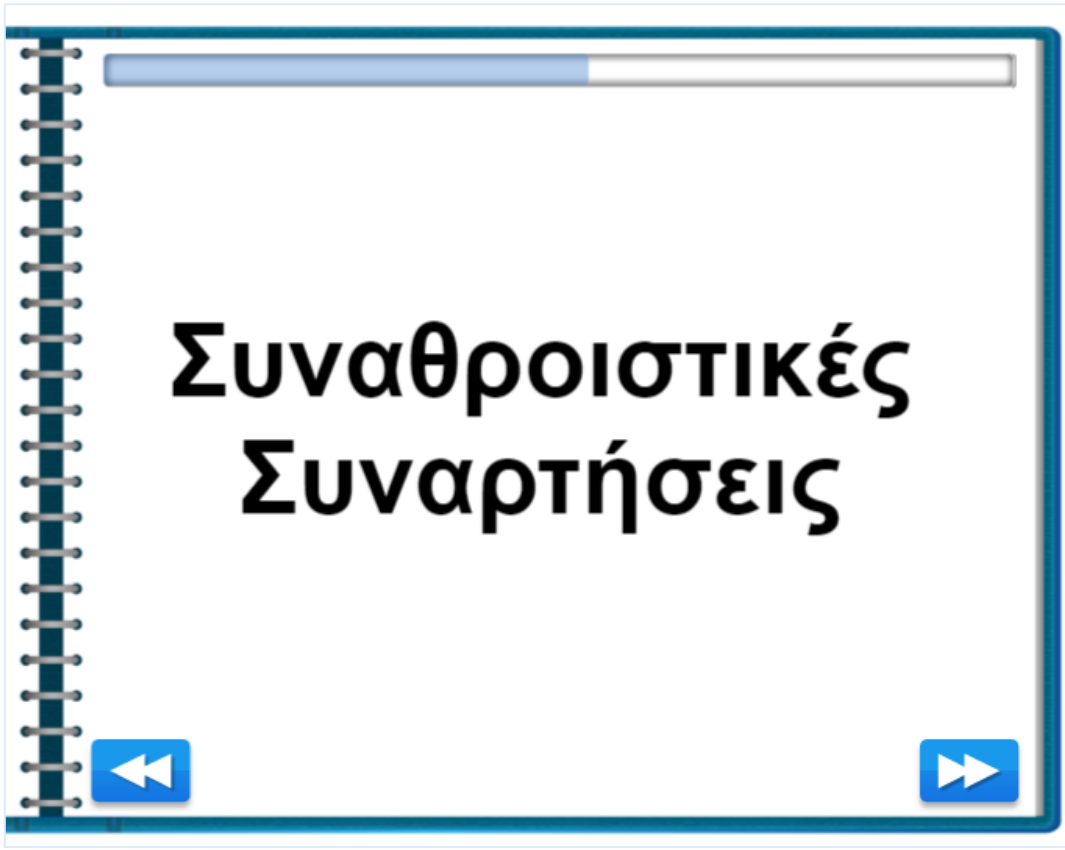
Συνενώσεις με Καρτεσιανό Γινόμενο και JOIN

Συναθροιστικές Συναρτήσεις

Ομαδοποίηση (GROUP BY, HAVING)




Παραδείγματα
COUNT
SUM
MAX
MIN
AVG


Συναθροιστικές
Συναρτήσεις

E: EMPLOYEE

SSN	ENAME	DOB	GENDER	DNO	SALARY
1	Andreas	1/1/80	M	1	1000
2	Kostas	1/1/85	M	1	1500
3	Maria	4/3/83	F	1	2000
4	Eleni	6/7/85	F	2	2500
5	Victoria	27/2/84	F	3	3000

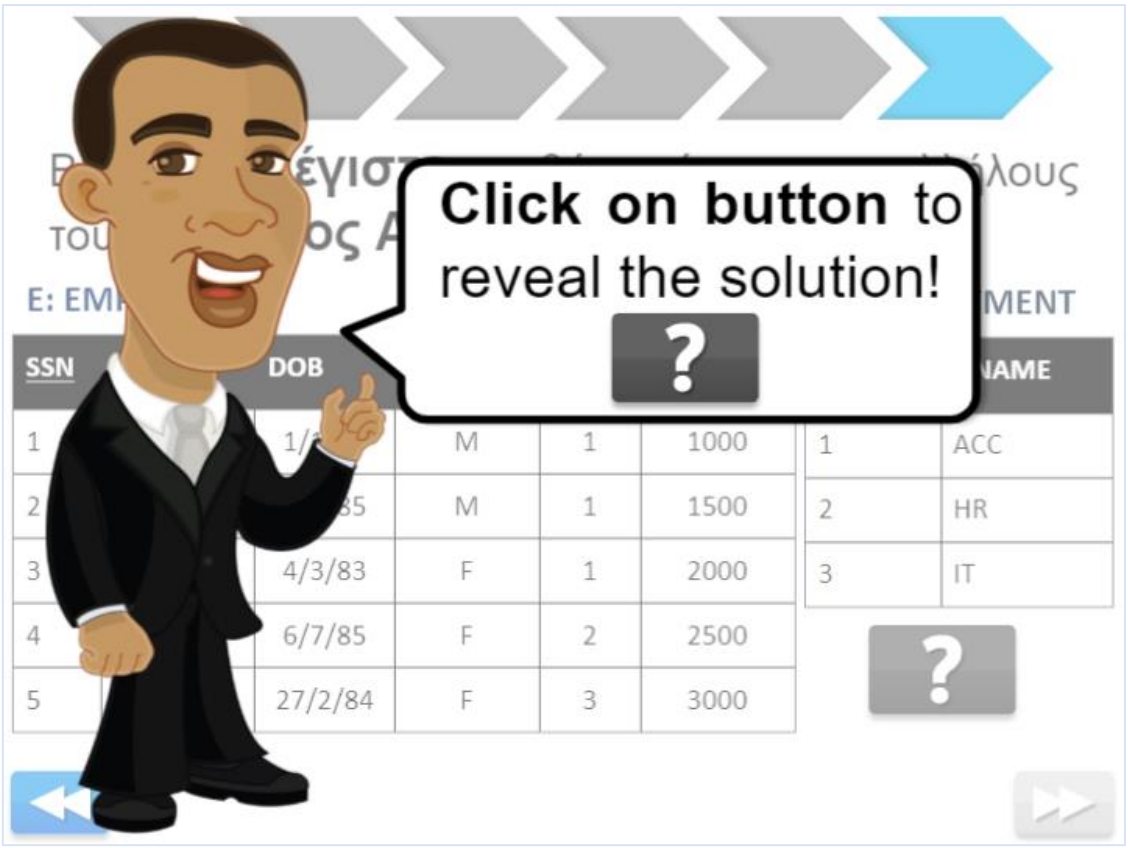
Βρες τον **μέγιστο** μισθό από τους υπαλλήλους

E: EMPLOYEE

SSN	ENAME	DOB	GENDER	DNO	SALARY
1	Andreas	1/1/80	M	1	1000
2	Kostas	1/1/85	M	1	1500
3	Maria	4/3/83	F	1	2000
4	Eleni	6/7/85	F	2	2500
5	Victoria	27/2/84	F	3	3000

Βρες τον **μέγιστο** μισθό από τους υπαλλήλους

```
SELECT MAX(SALARY)
FROM EMPLOYEE
```



Βρες τον **μέγιστο** μισθό από τους υπαλλήλους του **τμήματος ACC**:

E: EMPLOYEE

SSN	ENAME	DOB	GENDER	DNO	SALARY
1	Andreas	1/1/80	M	1	1000
2	Kostas	1/1/85	M	1	1500
3	Maria	4/3/83	F	1	2000
4	Eleni	6/7/85	F	2	2500
5	Victoria	27/2/84	F	3	3000

D: DEPARTMENT

DNO	DNAME
1	ACC
2	HR
3	IT

?

E: EMPLOYEE

SSN	ENAME	DOB	GENDER	DNO	SALARY
1	Andreas	1/1/80	M	1	1000
2	Kostas	1/1/85	M	1	1500
3	Maria	4/3/83	F	1	2000
4	Eleni	6/7/85	F	2	2500
5	Victoria	27/2/84	F	3	3000

D: DEPARTMENT

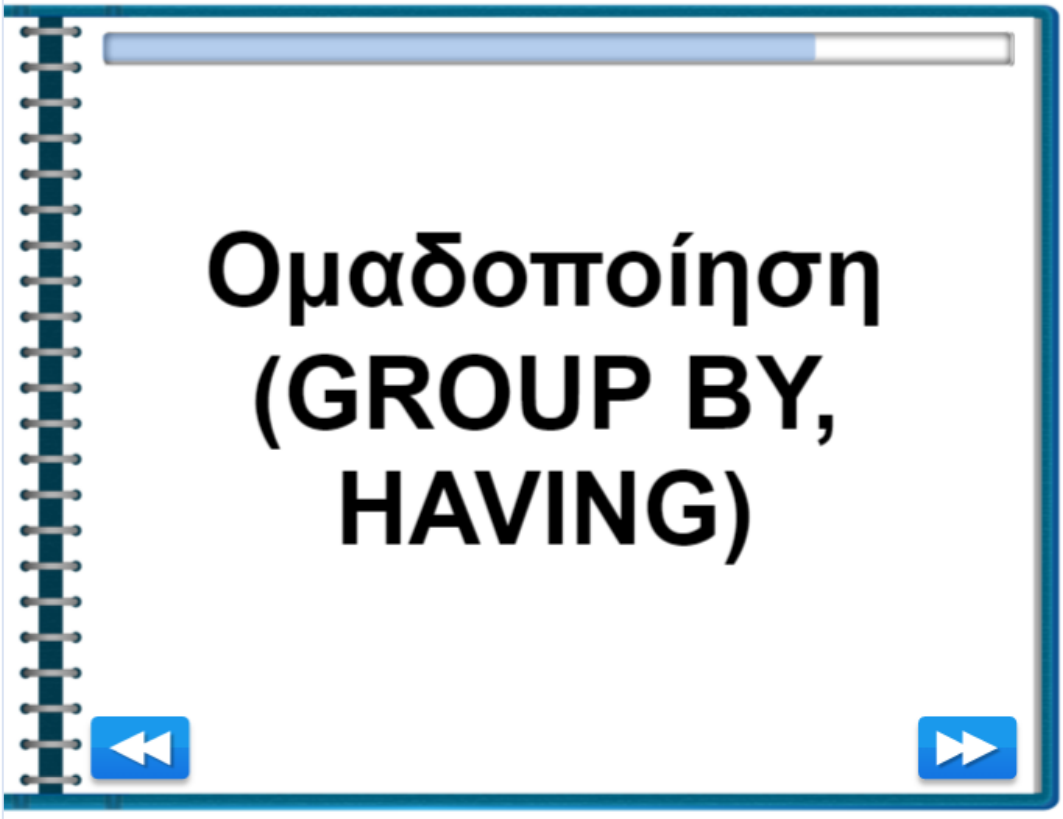
DNO	DNAME
1	ACC
2	HR
3	IT

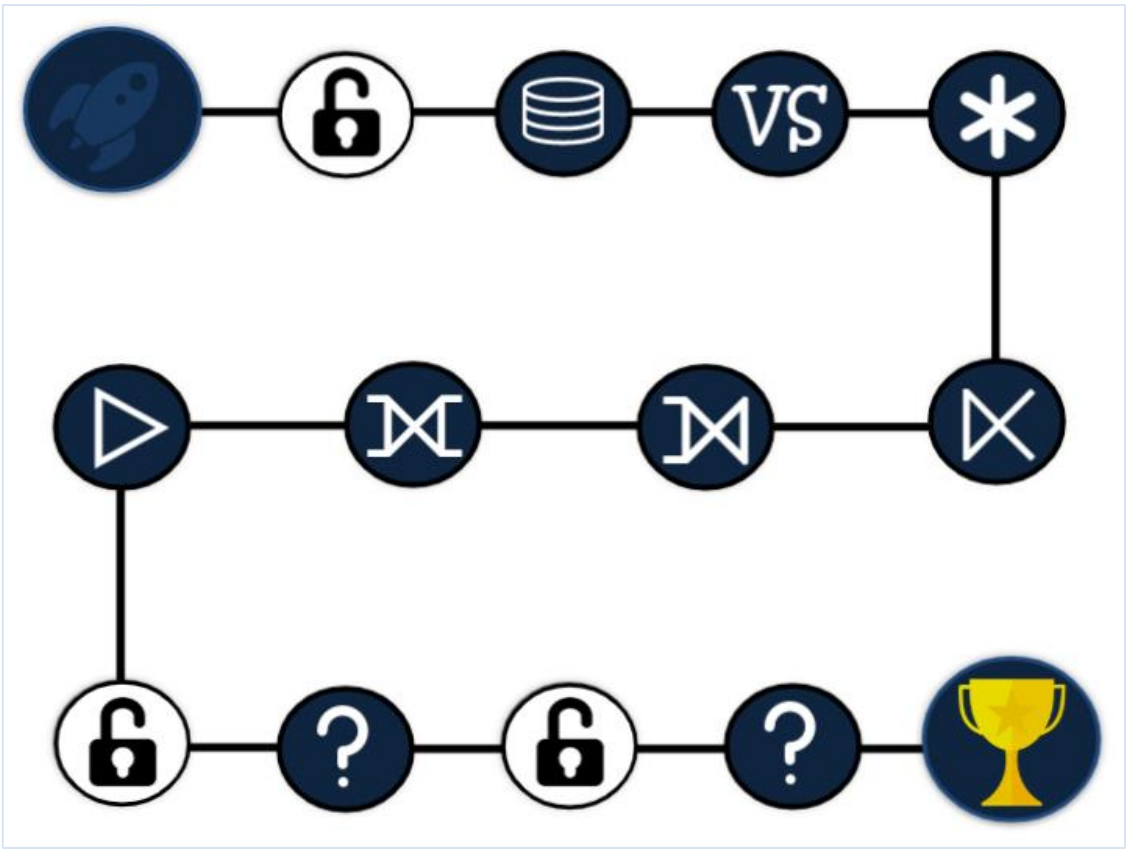
SELECT **MAX**(E.SALARY) AS MSAL
FROM E JOIN D ON E.DNO=D.DNO
WHERE **D.DNAME='ACC'**

MSAL
2000

Περιεχόμενα

- Συνενώσεις με Καρτεσιανό Γινόμενο και JOIN
- Συναθροιστικές Συναρτήσεις
- Ομαδοποίηση (GROUP BY, HAVING)




VS

Appendix D

Appendix D includes screenshots of the pre-test and post-test. The multiple-choice questions were taken from the website: http://sql-plsql.blogspot.com/2017/04/sql-join-questions-answers-7.html

Pre-test

Feedback, if the answer is correct or wrong and which option is the correct, is shown for each question at the end of the test.

What does the HAVING clause do?

Select one:

- The HAVING keyword is used to join 2 or more tables.
- The HAVING keyword is used to select distinct values.
- The HAVING keyword specifies a search condition for an aggregate or a group. ✔

The correct answer is: The HAVING keyword specifies a search condition for an aggregate or a group.

Which of the following SQL statements selects the total number of orders from the 'Sales' table?

OrderNumber	Date	CustomerID
1	12/12/2005	13
2	13/12/2005	17

Select one:

- SELECT SUM(OrderNumber) FROM Sales
- SELECT AVG(OrderNumber) FROM Sales
- SELECT COUNT(*) FROM Sales ✔

The correct answer is: SELECT COUNT(*) FROM Sales

Select the code which would show the player and their team for those who have scored against Poland(POL) in National Stadium, Warsaw.

game				
id	**mdate**	**stadium**	**team1**	**team2**
1001	8 June 2012	National Stadium, Warsaw	POL	GRE
1002	8 June 2012	Stadion Miejski (Wroclaw)	RUS	CZE
1003	12 June 2012	Stadion Miejski (Wroclaw)	GRE	CZE
1004	12 June 2012	National Stadium, Warsaw	POL	RUS

goal			
matchid	**teamid**	**player**	**gtime**
1001	POL	Robert Lewandowski	17
1001	GRE	Dimitris Salpingidis	51
1002	RUS	Alan Dzagoev	15
1001	RUS	Roman Pavlyuchenko	82

Select one:

```
SELECT DISTINCT player, teamid
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND (team1 = 'GER' OR team2 = 'GER') AND teamid != 'GER'
```

```
SELECT DISTINCT player, teamid
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND (team1 = 'POL' OR team2 = 'POL') AND teamid != 'POL'
```

```
SELECT DISTINCT player, teamid
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND teamid != 'POL'
```

```
SELECT DISTINCT player, teamid
FROM game JOIN goal ON matchid = id
WHERE stadium = 'Stadion Miejski (Wroclaw)' AND (team1 = 'POL' OR team2 = 'POL') AND teamid != 'POL'
```
✖

```
SELECT DISTINCT stadium, mdate
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND (team1 = 'POL' OR team2 = 'POL') AND teamid != 'POL'
```

The correct answer is:

```
SELECT DISTINCT player, teamid
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND (team1 = 'POL' OR team2 = 'POL') AND teamid != 'POL'
```

Orders table
order_number, customer, prod, qty, cost, disc

Customers table
customer_number, company, cust_rep

Sales_Persons table
repnbr, name, rep_office, quota, sales

Display all the orders over $95000 along with the name of the salesperson who took the order and the name of the customer who placed it.

Select one:

```
SELECT order_number, cost, company, name
FROM orders, customers, Sales_Persons
WHERE customer = customer_number AND cust_rep = repnbr OR cost >= 95000;
```

```
SELECT order_number, cost, company, name
FROM orders, customers, Sales_Persons
WHERE customer = customer_number AND cust_rep = repnbr AND cost <= 95000;
```

```
SELECT order_number, cost, company, name
FROM orders, customers, Sales_Persons
WHERE customer = customer_number AND cust_rep = repnbr AND cost >= 95000;
```

```
SELECT order_number, cost, company, name
FROM orders, customers, Sales_Persons
WHERE customer = customer_number OR cust_rep = repnbr AND cost >= 95000;
```

✖

The correct answer is:
SELECT order_number, cost, company, name
FROM orders, customers, Sales_Persons
WHERE customer = customer_number AND cust_rep = repnbr AND cost >= 95000;

Post-test

Feedback, if the answer is correct or wrong, the reason why the answer is wrong whether is wrong and the correct answer, is shown for each question while doing the test.

What is the **difference** between the **WHERE** and **HAVING** SQL clauses?

Select one:

- The HAVING SQL clause condition(s) is applied to all rows in the result set before the WHERE clause is applied (if present). The WHERE clause is used only with SELECT SQL statements and specifies a search condition for an aggregate or a group.
- The WHERE and the HAVING clauses are identical ✖ Both introduce a condition but **WHERE** clause introduces a condition on **individual rows** and **HAVING** clause introduces a condition on **aggregations.**
- The WHERE SQL clause condition(s) is applied to all rows in the result set before the HAVING clause is applied (if present). The HAVING clause is used only with SELECT SQL statements and specifies a search condition for an aggregate or a group.

You didn't select the correct answer... You can definitely answer the next one correctly!

The correct answer is: The WHERE SQL clause condition(s) is applied to all rows in the result set before the HAVING clause is applied (if present). The HAVING clause is used only with SELECT SQL statements and specifies a search condition for an aggregate or a group.

Which of the following SQL statements does **count** the **rows** in the 'Sales' table?

Select one:

- SELECT COUNT(*) IN Sales
- SELECT NUM() FROM Sales ✖ The **NUM()** function converts a **string** argument to a **numeric** equivalent.
- SELECT COUNTER(*) FROM Sales
- SELECT COUNT(*) FROM Sales

Your didn't selected the correct answer... Don't worry, you can answer correctly the next questions!

The correct answer is: SELECT COUNT(*) FROM Sales

Select the code which shows the **player**, their **team** and the **time** they scored, for players who have played in **Stadion Miejski (Wroclaw)** but **not** against **Italy (ITA)**.

game				
id	**mdate**	**stadium**	**team1**	**team2**
1001	8 June 2012	National Stadium, Warsaw	POL	GRE
1002	8 June 2012	Stadion Miejski (Wroclaw)	RUS	CZE
1003	12 June 2012	Stadion Miejski (Wroclaw)	GRE	CZE
1004	12 June 2012	National Stadium, Warsaw	POL	RUS

goal			
matchid	**teamid**	**player**	**gtime**
1001	POL	Robert Lewandowski	17
1001	GRE	Dimitris Salpingidis	51
1002	RUS	Alan Dzagoev	15
1001	RUS	Roman Pavlyuchenko	82

Select one:

```
SELECT DISTINCT player, teamid, gtime
FROM game JOIN goal ON matchid = id
WHERE stadium = 'Stadion Miejski (Wroclaw)'
AND (( teamid = team2 AND team1 != 'GRE') OR ( teamid = team1 AND team2 != 'GRE'))
```

```
SELECT DISTINCT teamid, gtime
FROM game JOIN goal ON matchid = id
WHERE stadium = 'Stadion Miejski (Wroclaw)'
AND (( teamid = team2 AND team1 != 'ITA') OR ( teamid = team1 AND team2 != 'ITA'))
```

✖ Select the code which shows the **player**, their **team** and the **time** they scored. You selected the answer which does **NOT** show the **player** attribute.

```
SELECT DISTINCT player, teamid, gtime
FROM game JOIN goal ON matchid = id
WHERE stadium = 'National Stadium, Warsaw' AND (( teamid = team2 AND team1 != 'ITA') OR ( teamid = team1 AND team2 != 'ITA'))
```

```
SELECT DISTINCT player, teamid, gtime
FROM game JOIN goal ON matchid = id
WHERE stadium = 'Stadion Miejski (Wroclaw)'
AND (( teamid = team2 AND team1 != 'ITA') OR ( teamid = team1 AND team2 != 'ITA'))
```

You didn't select the correct answer... It's OK, keep trying!

The correct answer is:

```
SELECT DISTINCT player, teamid, gtime
FROM game JOIN goal ON matchid = id
WHERE stadium = 'Stadion Miejski (Wroclaw)'
AND (( teamid = team2 AND team1 != 'ITA') OR ( teamid = team1 AND team2 != 'ITA'))
```

Customers table
Custnbr, Company, Custrep, Creditlim

Orders table
Order_no, Cust, Prodt, Qty, Amt, Discount

Find all the customers with orders **more** than 500 **or credit limits greater** than or **equal** to 500.

Select one:

SELECT DISTINCT Custnbr
FROM Customers RIGHT JOIN Orders ON Custnbr = Cust
WHERE (Creditlim >= 500 OR Amt > 500)

✖ Find **ALL** the customers, NOT all the orders (Customers table is written first so **LEFT JOIN** is the correct).

SELECT Custnbr
FROM Customers LEFT JOIN Orders ON Custnbr = Cust
WHERE (Creditlim > 500 OR Amt > 500)

SELECT DISTINCT Custnbr
FROM Customers LEFT JOIN Orders ON Custnbr = Cust
WHERE (Creditlim > 500 OR Amt >= 500)

SELECT DISTINCT Custnbr
FROM Customers LEFT JOIN Orders ON Custnbr = Cust
WHERE (Creditlim >= 500 OR Amt > 500)

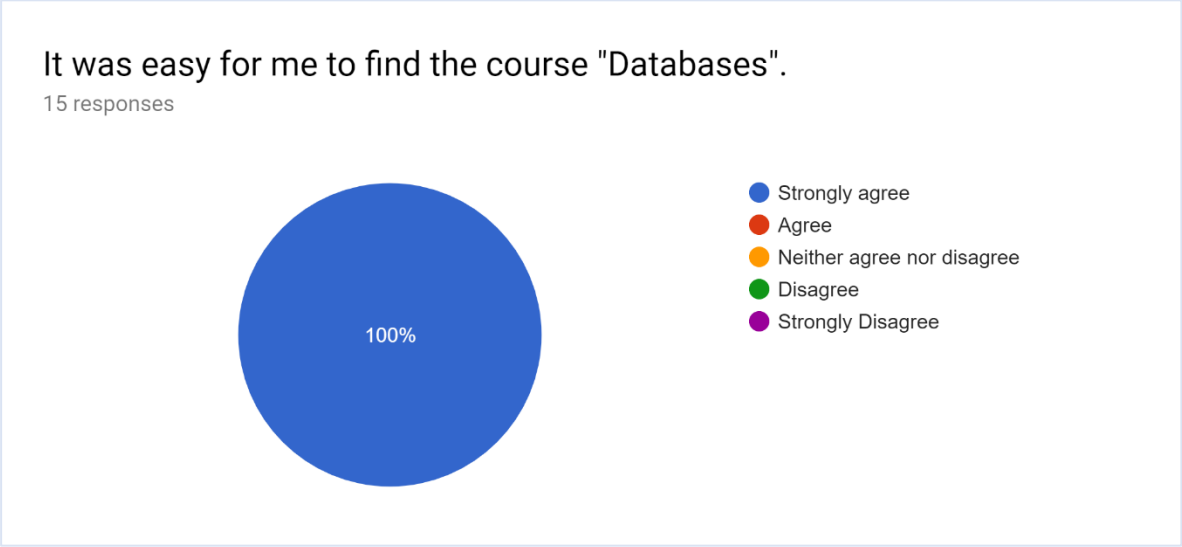
You didn't select the correct answer... Keep trying!

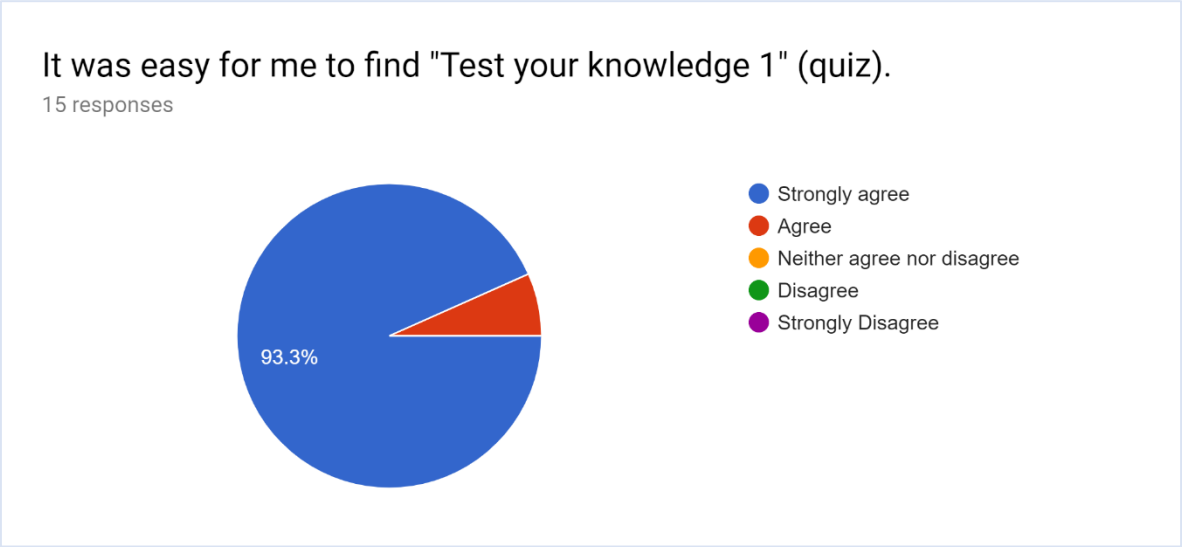
The correct answer is:
SELECT DISTINCT Custnbr
FROM Customers LEFT JOIN Orders ON Custnbr = Cust
WHERE (Creditlim >= 500 OR Amt > 500)

Appendix E

Appendix E includes screenshots of the given questionnaire along with the results.

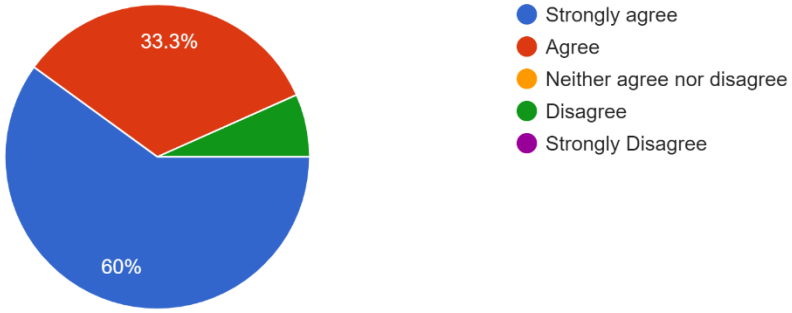
Customized Moodle





I prefer to navigate through the customized Moodle, than the traditional one.

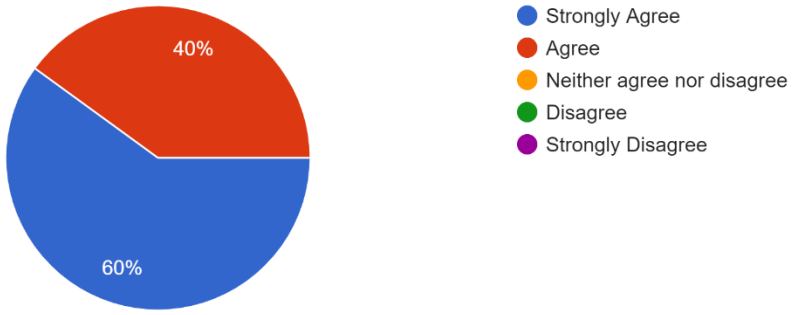
15 responses



Customized Course

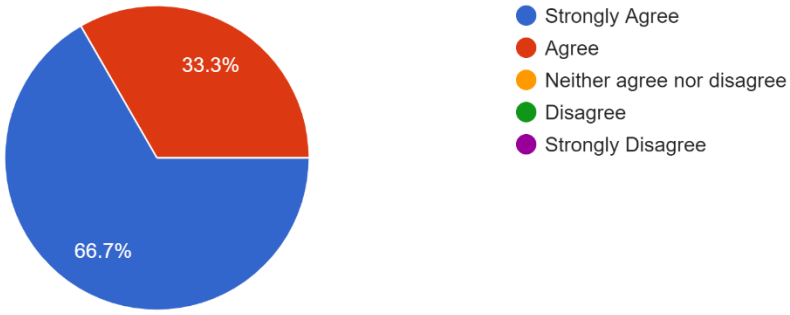
It was simple to use.

15 responses



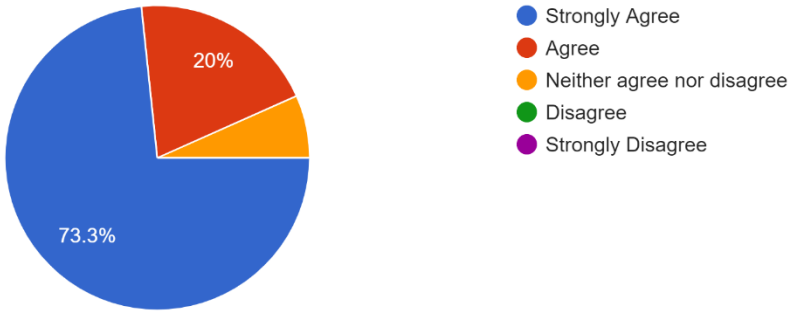
I am satisfied with the overall experience.

15 responses



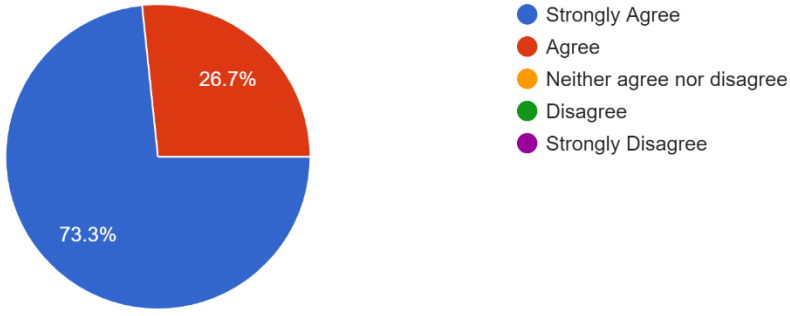
The overall experience was fun.

15 responses



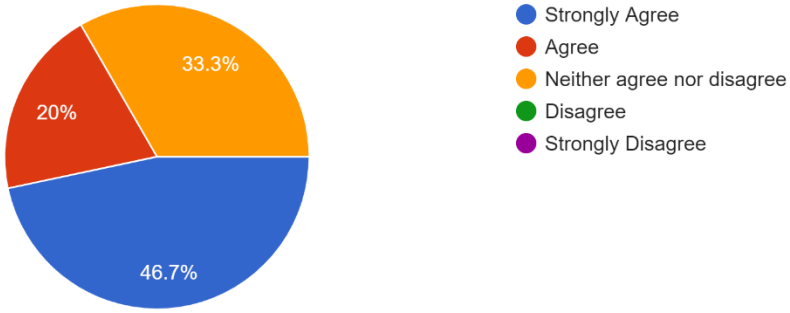
The overall structure of the customized course, motivated me to complete the course.

15 responses



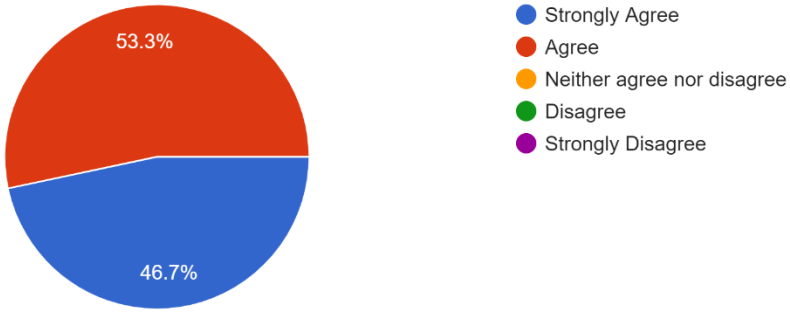
I noticed information that at the traditional presentation of the course was difficult to notice.

15 responses



I prefer to navigate through the customized course than the traditional one.

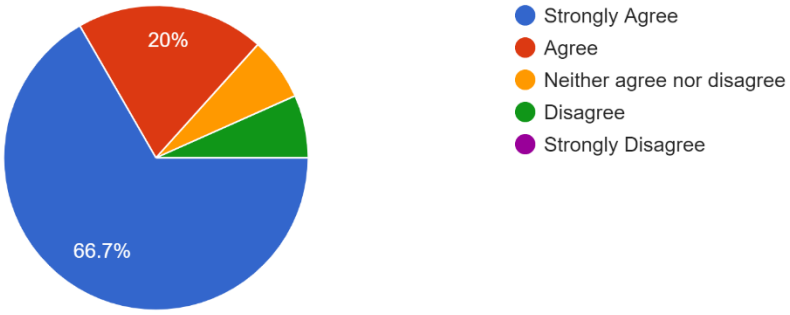
15 responses



Elements of the Customized Course

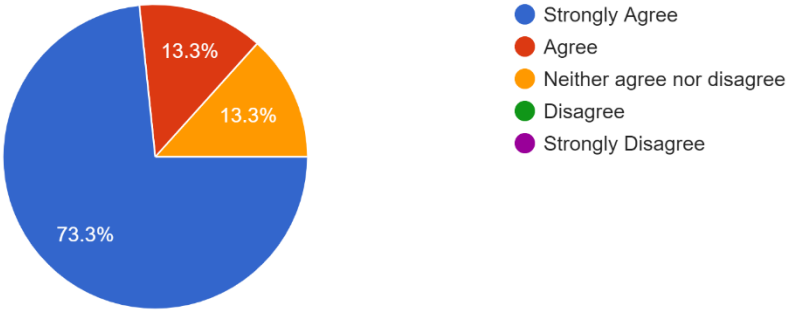
AUDIO and AVATARS help me to understand easily what I have to do to move on through the course.

15 responses



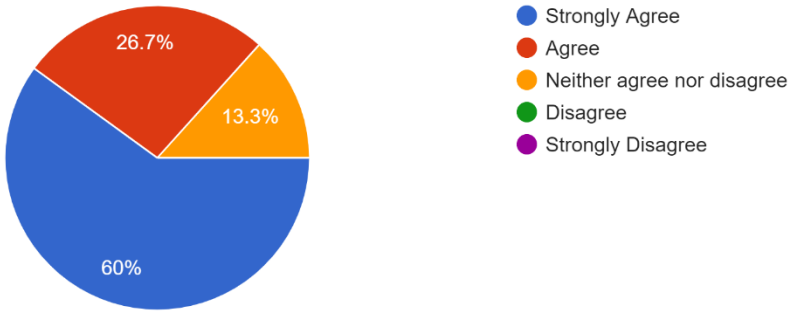
MENU, NEXT and PREVIOUS BUTTONS made me feel that I was in control of the customized course.

15 responses



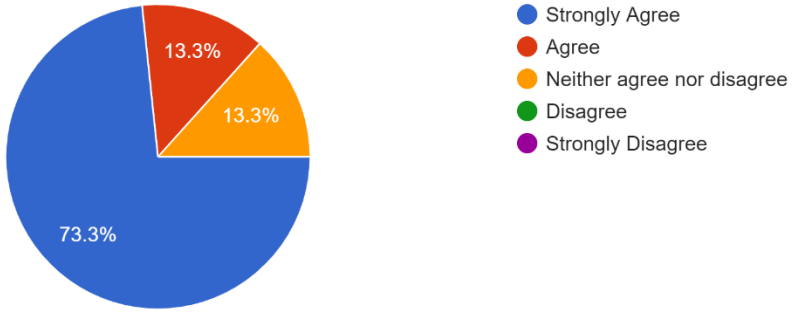
The way ANIMATIONS were used help me to understand better the content.

15 responses



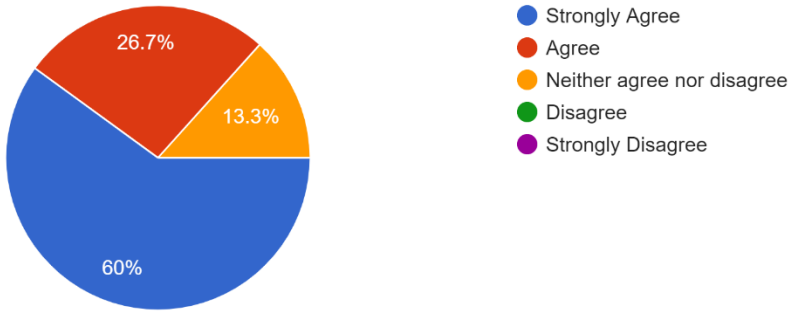
Interactions(e.g., CLICKS of buttons, DRAG the slider) kept me active to complete the course.

15 responses



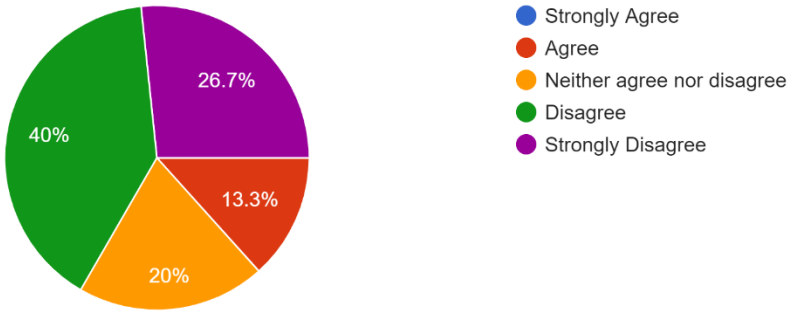
Feedback (e.g., COMPLETENESS BAR, MESSAGES, UNLOCK LEVELS) motivated me to complete the course.

15 responses



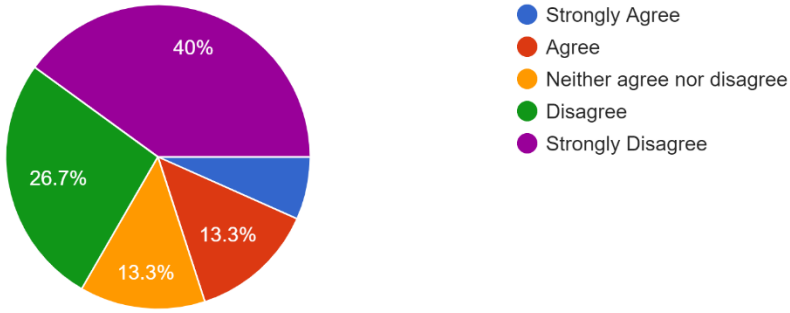
There were elements that distracted me from the content.

15 responses



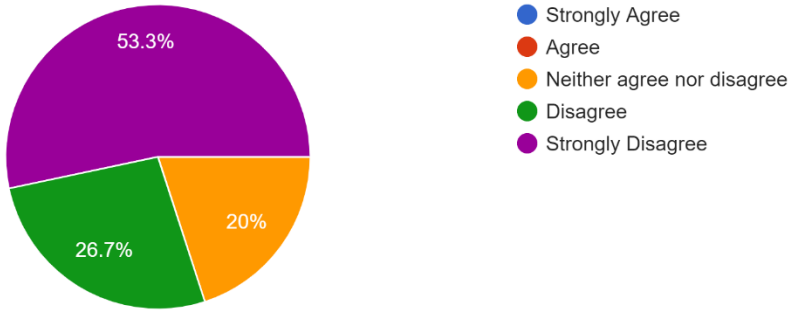
AUDIO distracted me from the content.

15 responses



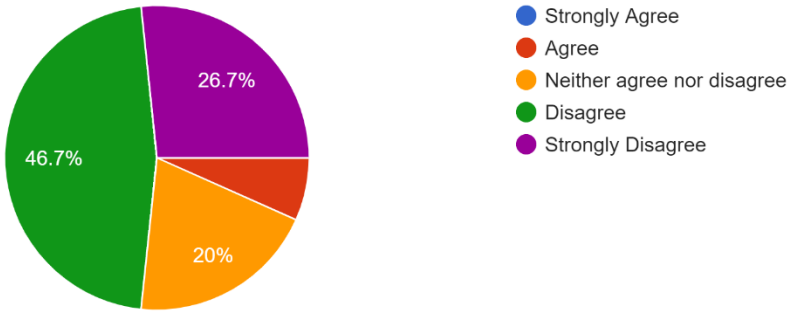
BUTTONS distracted me from the content.

15 responses



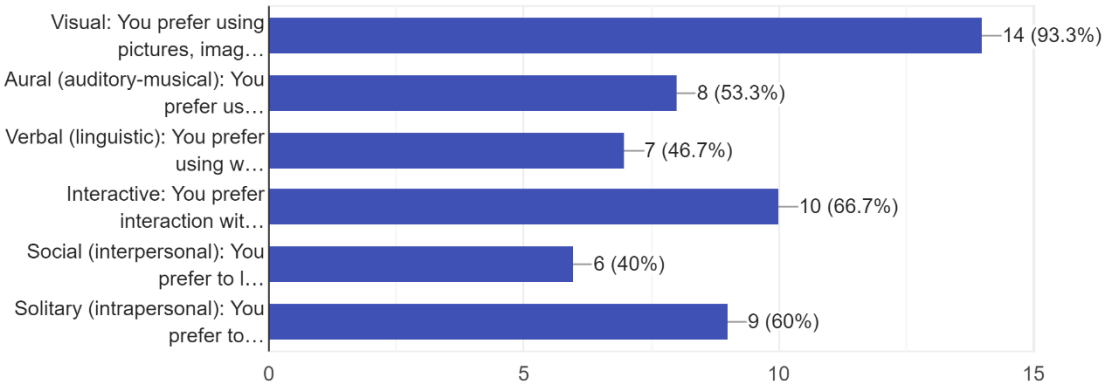
AVATAR distracted me from the content.

15 responses



How would you prefer the information to be presented in an online learning platform? (Select all that apply)

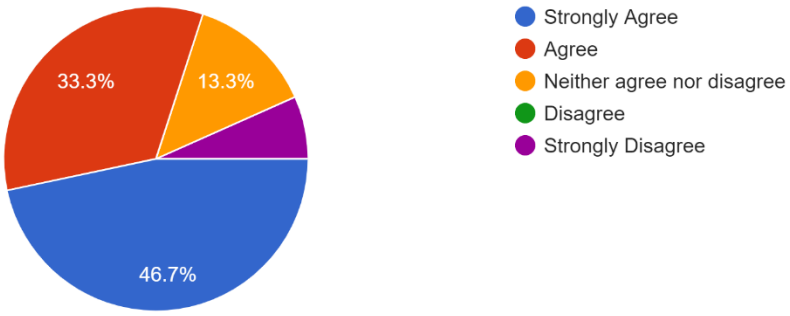
15 responses



Pre-test and Post-test

It was easier for me to finish the second test, than the first test.

15 responses



I prefer feedback to be shown for each question (like the second test), instead at the end of the test (like first test).

15 responses