Multimedia **A**uthoring and **M**anagement using your **E**yes and **M**ind

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D5.2

Initial Design and Implementation of the Prototype Interface Applications

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Abstract: This deliverable incorporates the mock-ups for the design, as well as an initial implementation for the prototype interface applications that will be used during the pre-test studies. The prototypes of interface applications will be evaluated on effectiveness. This deliverable also encompasses a description of the training cycles (of interface use) necessary for optimizing user acceptation and behaviour change.

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Executive Summary

Increasingly, persuasive technologies are used to convince, stimulate and motivate users to engage in various behaviours. WP5 focuses on how to design persuasive technology that motivates users' technology innovation acceptance and use.

For this accomplishment, the current document is divided into two objectives. The first objective pertains to the creation of the training cycle development, which is a detailed description of the user-related tasks during the pilot trials. The training cycles contain the training tasks, where users become familiar with the gaze and EEG elements as well as the MAMEM interface, called GazetheWeb~~,~~ and the dictated tasks, where user perform more advanced tasks of multimedia authoring and management, such as wanting a video and using social media (i.e., Twitter). In addition, usage scenarios are developed, where the user-system interaction is broken down into single steps. The overall goal of this objective is to help the user to become familiar with the capabilities of the interface, to enhance own performance in using MAMEM, and to increase various determinants of behaviour related to technology acceptance, such as ease of use and liking due to the intentionally designed gradual difficulty of the training cycles.

The second objective is related to the design and development of the MAMEM prototype. This builds upon the training cycle development and the persuasive strategies generated using the Intervention Mapping (IM) framework, which is used and reported in D5.1. Another important aim of this document is to translate the theoretical persuasive strategies (derived from IM) to an applied persuasive framework for the MAMEM prototype with the use of design patterns. As a result, the first part of the training tasks has been translated into a persuasive game, and within this gamified environment we incorporated previously selected persuasive strategies. In addition, the report reflects the effort to tailor the persuasive design to relevant user characteristics as they have been described in the user profiles and personas. Lastly, this deliverable describes how the evaluation of the persuasive design is planned to take place during the pilot trials. Based on such evaluation, the persuasive design is planned to be updated in M27 to reflect the user-system interaction in more optimal ways.

Abbreviations and Acronyms

API	Application Programming Interface
BCI	Brain Computer Interface
EEG	ElectroEncephaloGram
GSR	Galvanic Skin Response
NMD	Neuromuscular Disorder
PD	Parkinson's Disease
IM	Intervention Mapping
SCI	Spinal Cord Injury
UTAUT	Unified Theory of Acceptance and use of technology
TAM	Technology Acceptance Model
UI	User Interface

***Additional abbreviations are spelled out within the document**

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1 Introduction

Individuals who suffer from loss of voluntary muscular control while preserving cognitive functions are marginalized and unable to keep up with the rest of the society in a digitized world. The goal of MAMEM is to integrate these people back into society by increasing their potential for communication. In this direction, MAMEM aims to deliver the technology which enables interface channels to be controlled through eye-movements and mental commands. Three different cohorts of patients will be engaged, in order to demonstrate enablement of the MAMEM system: Spinal Cord Injury (SCI), Parkinson's Disease (PD) and Neuromuscular disorders (NMD).

The previous deliverable of WP5 (D5.1) described the MAMEM patient groups' attributes in the form of user profiles and personas (part 1 of D5.1); and the design and selection of the persuasive strategies to motivate these users to accept, learn and finally use the MAMEM system (part 2 of D5.1) [1]. A crucial purpose of D5.1 was to help the MAMEM consortium team members to recognize the real users of MAMEM (SCI, PD, and NMD). The described user profiles and personas are used as input for several WP's and tasks. Briefly, the user profiles include user characteristics such as demographics, relevant medical information, computer interaction behaviour and attitudes towards novel assistive devices. The other critical goal of D5.1 was to present the most important insights into how to motivate individuals with disabilities to learn to operate the MAMEM system and to use it in order to increase their social participation. This investigation presented an overview of a plethora of tailored strategies using the IM framework, taking into consideration the needs and requirements of each of the three groups. Overall, deliverable D5.1 proposed the persuasive design of the MAMEM system using theoretical insights. This persuasive design has two phases (in line with the pre-test trials protocol described in WP6) with two different objectives: user acceptance and engagement, and social inclusion.

In the current deliverable D5.2, these insights are translated into design specifications and implemented into the MAMEM technology. This is done by describing the design patterns, including example User Interface (UI) mock-ups for visual inspection, as well as an initial implementation of the prototype interface applications that will be used during the pre-test studies. The effectiveness of these prototypes of interface applications is firmly rooted in scientific evidence. The deliverable also encompasses a description of the training cycles (of interface use) necessary for optimizing user acceptance and behaviour change.

Overall, D5.2 begins by explaining the creation training cycle development for the pilot trials with real users, which is based on a strong theoretical foundation (Chapter 2). The training cycle is divided into basic training (training tasks) and more advanced training (dictated tasks). Next, based on the training steps identified, a persuasive design of the training tasks has been generated, which incorporated the previously identified persuasive strategies (see D5.1) and gamification mechanisms within a gamified training environment (Chapter 3). Such persuasive design pertains only to the training cycles, because this is considered to be the most crucial stage where users forming attitudes and make decision to go further to more advanced tasks such as the dictated tasks. For such attitude and behaviour change, tailoring of persuasive strategies to user characteristics

was also taken into account (section 3.3 and 3.4). Lastly, Chapter 4 pertains to how the evaluation of the persuasive design during the pilot trials.

2 Training cycle development

As it has been described in previous deliverables describing the pre-test trials [7, 8], phase I of the clinical trials includes two training cycles. In the first part, users are introduced to the platform, the application of the EEG headset and eye tracker, and provided with the basic skills to operate the MAMEM system. The second part of the training refers to multimedia managing, authoring and sharing using dictated tasks such as writing an e-mail and photo editing.

Within D5.1, user acceptance and engagement are core goals of the MAMEM framework [1]. Training plays a central role in influencing user acceptance as it is the first interaction between a user and MAMEM. The training cycles have been initially described in D5.1 together with the identification of performance objectives. Performance objectives are defined as the detailed breakdown of what the participants must do to express a behavioural outcome (i.e., user acceptance and engagement). However, when D5.1 was generated, the MAMEM prototype was still under development. Thus, the performance objectives that were generated reflected the training cycles in a more abstract and theoretical way (see [1] p49).
In this chapter of D5.2, the training cycles and the performance objectives became were updated and further specified, reflecting the procedure and goal of the pre-test trials. Section 2.1 describes the theoretical background on which the training cycles were based on; section 2.2 describes how the theory is translated into practice, resulting in the creation of the training cycles for both the training and dictated part.

2.1 Theoretical background of training

The saying “practice makes perfect” cannot be directly applied to high-performance training. Scientific research shows the conditions under which training is effective for which kinds of tasks (see e.g., [2]). In some cases practice does not lead to perfection and no improvement in the performance can be found [2]. Oftentimes, instead of focusing solely on practicing the same tasks over and over again it is better to break down the task in different components and let the learner practice the individual components. Additionally, it is important to take into account how to overcome the gap between an expert and novice in a training task. For more complex tasks, novice and expert performances diverge more widely [3]. Going into more detail, the Dreyfus model [4] explains the five stages a learner passes through when learning new skills, eventually becoming an expert (see Figure 1).

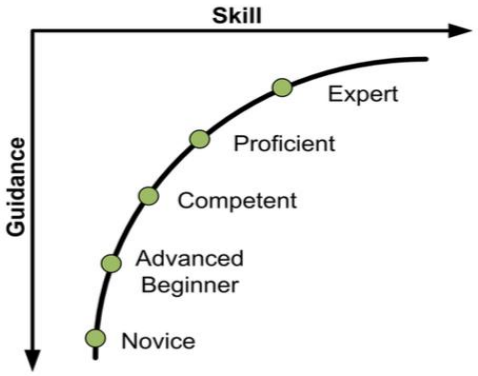


Figure 1 Dreyfus model of skill acquisition

Therefore, in the design of the training tasks for the MAMEM system, in line with the suggestion by [2], the training tasks were broken down into smaller components. In order to maximize learning effectiveness, and minimize the developmental effectiveness gap between users without prior experience with comparable technology (novices) and users with prior experience (experts), the training starts with easy tasks and builds them slowly up to more difficult tasks.

The training is therefore divided into three main parts:

- Basic - training basic-level MAMEM interface skills (see Table 2)
- Intermediate - training intermediate-level MAMEM interface skills (see Table 3)
- Advanced - training advanced level MAMEM interface skills (see Table 4)

Each task has different sublevels, again building up from easy to difficult. This structure application minimizes the gap between experts and novices, and trains the skills in the right, logical order.

Next, to allow and also require the user to have enough skills to make use of the MAMEM system, the mastery learning system was used (see [5] and [6]). In the mastery learning system, before users can proceed to the next level, they have to possess a specified mastery of content knowledge and skills. This is implemented in two different ways. First, users are advised to redo a level if their score is on the low side. Secondly, users acquire new skills in a training phase, and apply these during a dictated phase, where they will have to apply the skills for operation of programs [5, 6].

As described in D6.3 [8], Phase I trials are divided into two parts: training tasks (e.g., train how to select a web link within the MAMEM GazeTheWeb browser) and dictated tasks (e.g., send an e-mail).

The first part (training tasks) of Phase I will be 1-2 hours of setup and training. This will include an introduction to the platform, donning the wearable sensors and training them. These training cycles are described in the current document (section 2.2), and consist of a variety of subtasks.

To guide users through the training cycles a coherently structured set of subtasks has been developed. These tasks form three gamified sets of tasks as described in chapter 3 (MAMEM interface design and development specification of the training tasks) of this deliverable.

Users are guided through the tasks based on rules following the concept of learning curves (see [8] and Figure 2). Learning curves are useful learning performance measures,

and enable us to understand if users exhausted their capacity to learn [9]. In general, learning curves have an initial slow beginning, followed by steep acceleration and an ultimate plateau of optimal performance. In this final phase, execution time and error rate decrease linearly with the skill level of the user. In case execution time and/or error rate do not further decrease, users can be assumed to have reached a 'plateau' in their capacity to improve their performance.

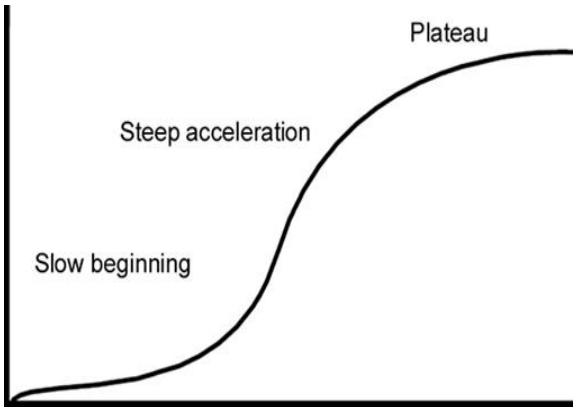


Figure 2 The learning curve

These rules guide the user through the series of tasks, from one subtask to the next, and provide feedback on progress and performance. Guidance rules depend on user performance (in becoming skilful in performing an action) which is assessed (online, during execution) within each task based on the following metrics:

- execution time
- error rate

Only when user performance (execution time and/or error rate) does not substantially increase anymore, the user will be advised to move on to the next task. This is the core of the guidance rule used in the MAMEM interfaces for all subtasks. Research on learning curve slopes [9] propose that when slopes do not present evidence anymore for an increase in performance, learning is limited, ineffective and (potentially) deteriorating motivation. As a general rule [9], an increase in performance (faster execution time and/ or lower error rate) is not substantial anymore when it falls below 30%.

Therefore, within each subtask developed in this deliverable, a simple and effective learning algorithm determines (dependent on task specific characteristics) whether the decrease in execution time and/or error rate exceeds 30% of the prior assessment within the same subtask. When this criterion is met, users are advised to proceed to the next subtask. Thereby, the MAMEM training cycles are personalized (or rather, tailored) to each individual user's progress. This algorithm will be used both during the training and the dictated tasks.

In the second part (the dictated tasks) of Phase I, the feasibility and usability of the MAMEM platform for multimedia management, authoring and sharing will be tested using dictated tasks. Dictated tasks include advanced usage scenarios for managing, authoring and sharing multimedia content. Table 6 in Section 2.2.2 below shows an

overview of the dictated tasks that were implemented in the MAMEM system. As the training tasks, the dictated tasks will be presented within the GazeTheWeb browser.

2.2 Early creation of the MAMEM training cycles

In D6.2 (Clinical Requirements and Pre-test Trial Definitions), the skills that users should master and the knowledge they should have before being able to use the MAMEM system are analysed and described, and listed in Table 1 and 2. In task 5.4, we implemented these listed tasks to fit the characteristics of the MAMEM interface and technology as they were developed in the current project. For example, Table 1 of D6.1 suggested various windows operations and mouse operations oriented tasks. For example, D6.1 suggested the basic level cursor task of clicking the left mouse button. In the MAMEM GazeTheWeb interface, clicking the left mouse button is irrelevant, and selection of an item is done by focussing on it with your eyes. Therefore, the implementation of that suggestion is task 1.1.1 in Table 2 below, that is, a task in which focussing on a location (and on several locations) is trained.

2.2.1 List of the training tasks (part 1)

INTRODUCTORY STEPS		
Task number	**Task category**	**Task description**
-1.1.1	Preparatory	Several demographic questions
-1.1.2	Preparatory	Introduction
-1.1.3	Preparatory	Do the calibration with eye-tracker

Table 1 Introductory steps

BASIC TRANING TASKS		
Task number	**Task category**	**Task description**
1.1.1	Basic: Level 1	Focus long enough on several positions
1.2.1	Basic: Level 2	Focus on a sequence of locations

Table 2 Basic training tasks

INTERMEDIATE TRAINING TASKS (eye-tracker)		
Task number	**Task category**	**Task description**
2.1.1	Intermediate: Level 1	Scroll manually
2.1.2	Intermediate: Level 1	Scroll automatically
2.1.3	Intermediate: Level 1	Use the finger-pointer button
2.1.4	Intermediate: Level 1	Use the backward button
2.2.1	Intermediate: Level 2	Use the zoom button
2.2.2	Intermediate: Level 2	Use the keyboard (T)
2.3.1	Intermediate: Level 3	Select a line of text
2.3.2	Intermediate: Level 3	Copy the line of text
2.3.3	Intermediate: Level 3	Paste the text

Table 3 Intermediate training tasks with eye-tracker

INTERMIDIATE TRAINING TASKS (EEG)		
Task number	**Task category**	**Task description**
2.4.1	Intermediate: Level 5	EEG ErrPs calibration: Type a set of sentences with the keyboard
2.4.2	Intermediate: Level 5	EEG SMR calibration: Think right/left with cues
2.4.3	Intermediate: Level 5	EEG SMR user training: Think right/left with cues and screen feedback

Table 4 Intermediate training tasks with EEG

ADVANCED TRAINING TASKS		
Task number	**Task category**	**Task description**
3.1.1	Advance: Level 1	Go to the setting button
3.1.2	Advance: Level 1	Go to the general menu
3.1.3	Advance: Level 1	Change the gaze visualization to Toggle Gaze Visualization
3.1.4	Advance: Level 1	Go back
3.1.5	Advance: Level 1	Go to general menu
3.1.6	Advance: Level 1	Cancel the Toggle Gaze Visualization
3.2.1	Advance: Level 2	Go to tab overview
3.2.2	Advance: Level 2	Add a new tab
3.2.3	Advance: Level 2	Type in **www.mamem.eu** not making use of the text predictor
3.2.4	Advance: Level 2	Abort action
3.3.1	Advance: Level 3	Go to tab overview
3.3.2	Advance: Level 3	Edit URL
3.3.3	Advance: Level 3	Type in www.mamem.eu making use of the text predictor
3.3.4	Advance: Level 3	submit (ok)
3.4.1	Advance: Level 4	go to tab overview
3.4.2	Advance: Level 4	Bookmark the tab
3.4.3	Advance: Level 4	Add a new tab
3.4.4	Advance: Level 4	Visit the bookmark manager
3.4.5	Advance: Level 4	Visit a bookmark of choose

Table 5 Advanced training tasks

2.2.2 List of the dictated tasks (part 2)

DICTATED TASKS		
Task number	**Task category**	**Task description**
E-mail		
1.1.1	Email	Go to tab overview
1.1.2	Email	Add a new tab
1.1.3	Email	Visit the bookmark manager
1.1.4	Email	Find the e-mail program
1.1.5	Email	Open the e-mail program
1.1.6	Email	Open an unread e-mail
1.1.7	Email	Respond to this e-mail
1.1.8	Email	Send the e-mail
1.1.9	Email	Close e-mail program
Photo editing		
2.1.1	Photo editing	Go to tab overview
2.1.2	Photo editing	Add a new tab
2.1.3	Photo editing	Visit the bookmark manager
2.1.4	Photo editing	Go to photo editor
2.1.5	Photo editing	Start photo editing program
2.1.6	Photo editing	Go to the menu in order to open a picture
2.1.7	Photo editing	Choose a picture of choice
2.1.8	Photo editing	Resize the picture
2.1.9	Photo editing	Share the picture on google
2.1.10	Photo editing	Close the photo-editing program

Social media		
3.1.1	Social media	Go to tab overview
3.1.2	Social media	Add a new tab
3.1.3	Social media	Visit the bookmark manager
3.1.4	Social media	Go to Twitter
3.1.5	Social media	Log into your Twitter account
3.1.6	Social media	Type MAMEM project in the search field
3.1.7	Social media	Follow MAMEM project
3.1.8	Social Media	Post a textual message on MAMEM Twitter page
3.1.9	Social Media	Close Twitter page

YouTube		
4.1.1	YouTube	Go to tab overview
4.1.2	YouTube	Add a new tab
4.1.3	YouTube	Visit the bookmark manager
4.1.4	YouTube	Visit the webpage of YouTube
4.1.5	YouTube	Search for a video of choice
4.1.6	YouTube	Select the video
4.1.7	YouTube	Pause the video
4.1.8	YouTube	Play the video
4.1.9	YouTube	Close the YouTube page

Table 6 Dictated tasks

2.3 EEG related training tasks

During the pilot trials, there will be also training with the EEG element. Table 4 above provides and overview of the EEG training tasks, which take place after the intermediate task with an eye tracker (when the user would be already familiar with the MAMEM UI and its various functions) and before the advanced tasks. Overall the EEG training contains the system calibration and the user training. The following subsections explain these EEG tasks in more detail.

2.3.1 System calibration for ErrPs

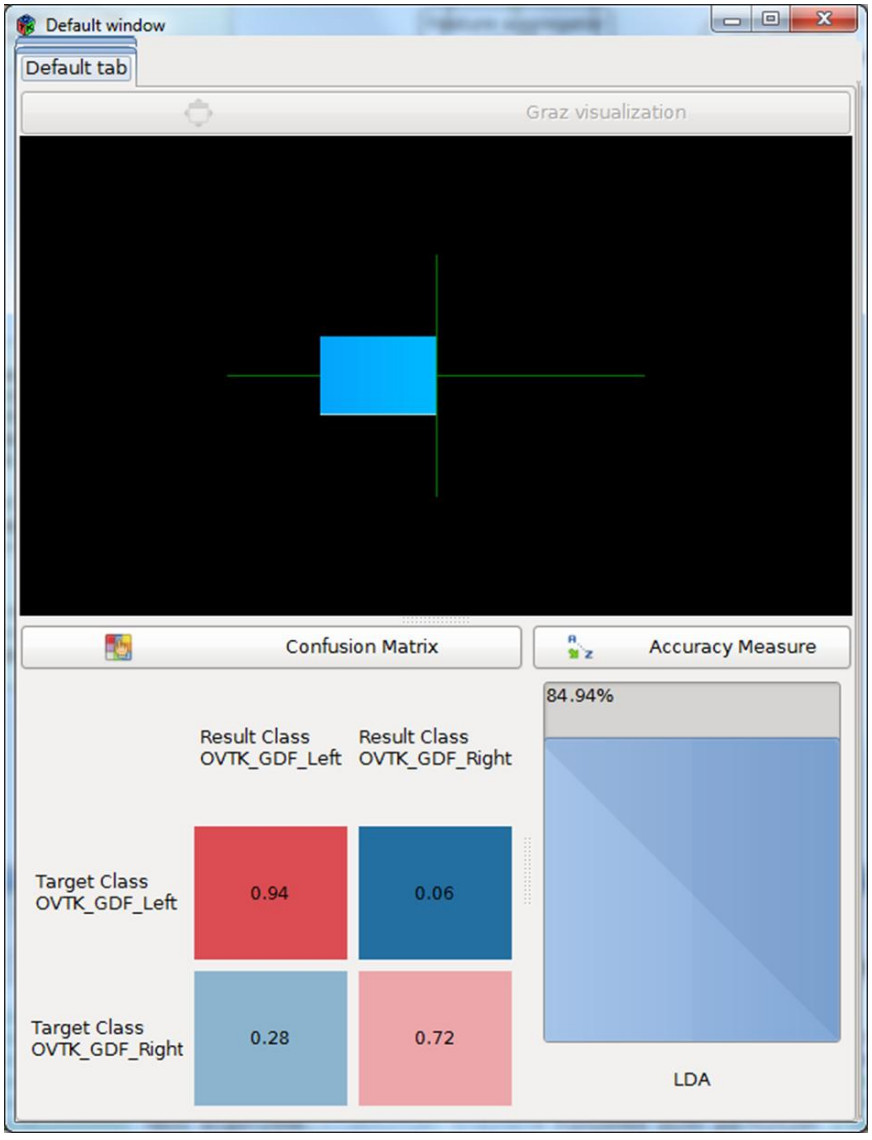
For this task, the caregiver opens the ErrP-designed keyboard. The difference of this keyboard with the previously used one is that it has different parametric settings (e.g. dwell time might be reduced, there is a preview of the selected letter, etc., see the image below as an example). The caregiver asks the participant to type a set of pre-defined sentences. During this task the EEG signals of the participant are captured in order to calibrate the system to detect their personal error-related signals.

2.3.2 System calibration for SMR

For this task, the caregiver opens the OpenVIBE calibration program. The user is asked to imagine left or right body movements using on screen cues. This is repeated 40xx times for each condition. During each trial, the EEG signals of the user are recorded in order to calibrate the system to detect their personal signals when thinking left and right.

2.3.3 User training for SMR

For this task, the caregiver opens the OpenVIBE user-training program. The user is asked to think left or right using on screen cues. In contrast to the previous condition, the user also sees a feedback bar on the screen (see image below) showing them what the system (calibrated in the previous task) has detected based on their thinking. This is used to train the user so that they can optimize their mental strategy in order to produce useful EEG signals for detecting their intentions. This is repeated 40xx times for each condition.



2.4 MAMEM usage scenarios

Within this section the usage scenarios for the MAMEM system will be discussed in detail. A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. Use cases should contain all system activities that have significance to the users [9]. The following section contains the usage scenarios for MAMEM training cycles.

2.4.1 Usage scenarios of the training tasks (part 1)

Use case 1: Introduction

Name: *Understanding the concept of MAMEM multimedia management/sharing and authoring using your eyes and mind and experiencing the benefits of MAMEM* (D5.1 performance objectives 1 & 2); conveying to the user the purpose of learning how to operate the MAMEM system with the gaze and EEG elements; and giving an overview information of the procedure of the pilot trial.

Pre-condition: Caregiver starts the program and fills demographic questions

Post-condition*:* The user is aware of the perceived usefulness of MAMEM and has an idea of what is meant with operating thee system with their eye. Trust in the system and the MAMEM project is increased. Furthermore, they have an understanding of the procedure of the training tasks and they recognize the benefits of using MAMEM. Lastly, calibration is successfully performed.

Sequence 1

Initial:

1. Caregiver starts the program
2. Caregiver fills demographic questions

Main:

1. The user gets introduced to MAMEM project (i.e., MAMEM team, purpose of MAMEM, benefits of system use).
2. The user gets information on the procedure of the pilot trial
3. The user performs the calibration with eye-tracker

Usage scenario 2: Basic tasks

Name: User learns the basic skills to use the eye tracker

Pre-condition: The user receives introductory information on the training, performs the calibration and wears the EEG cap.

Post-condition: the user develops sufficient skills related to using the gaze for computer operation, so as to be able to perform more advanced tasks.
User perceptions such as those of liking, usefulness and effort in using the system are increased (based on the change objectives identified in D5.1)

Sequence 1

Initial:

1. Caregiver starts the program
2. User gets introduction
3. User does the calibration
4. The user wears the EEG cap with the help of the technical staff
5. Training overview page is shown on-screen with level 1 to be unlocked

Main:

1. User proceeds to level 1 (unlocked)
2. User has to focus on several locations
3. Level 1 is completed
4. User proceeds to level 2 which becomes unlocked
5. Focus long enough on sequence of locations
6. Level 2 is completed
7 Basic task is completed
8. User goes to the overview and proceeds to the next task (intermediate level) which becomes unlocked

Alternative 1:
1. Level 1 is completed but his score is inadequate according to levels score threshold (i.e. related to time)
2. User is suggested to redo level 1
3. User has to repeat the level focusing on several locations
4. Level 1 is successfully completed
5. User proceeds to level 2 which now becomes unlocked

Alternative 2:

1. User has completed level 1
2. User can proceed directly to level 2
3. User quits the program

Alternative 3:

1. User has not completed level 1
2. User is suggested to redo level 1
3. User quits the program

Alternative 4:
1. Level 1 is not completed
2. User is not suitable for the training

3. User has to quit the training

Alternative 5:

1. Level 1 is completed
2. Level 2 is completed but his score is inadequate according to levels score threshold (i.e., related to time)
3. User is suggested to redo level 2 focusing on sequence of locations
4. Level 2 is successfully completed
5. User goes to the overview and proceeds to the next task (intermediate level) which becomes unlocked

Alternative 6:

1. User has completed level 2
2. User can proceed directly to the next task which is unlocked
3. User quits the program

Alternative 7:

1. User has not completed level 2
2. User is suggested to redo level 2
3. User quits the program

Usage scenarios 3: Intermediate Tasks

Name: Learning the user the different elements of GazetheWeb and keyboard typing

Pre-condition: Basic tasks are completed

Post-condition:

The user develops sufficient skills related to using effectively the GazetheWeb interface and keyboard, so as to be able to perform more advanced tasks.

User perceptions such as those of liking, usefulness and effort in using the system are further enhanced (based on the change objectives identified in D5.1):

Sequence 1

Initial:

1. Training overview is shown with basic tasks to be completed and level 1 of the intermediate tasks to be unlocked

Main:

1. User proceeds to level 1 (use of scrolling, finger-point button)
2. Level 1 is successfully completed (i.e., in time and errors)
3. User proceeds to level 2 which now becomes unlocked (use of zooming and keyboard typing)
5. Level 2 is successfully completed (i.e., in time and errors)

6. User proceeds to level 3 which now becomes unlocked (use of zooming and keyboard typing)
5. Level 2 is successfully completed (i.e., in time and errors)
6. User proceeds to level 3 which now becomes unlocked (use of select, copy and paste)
Level 3 is successfully completed (i.e., in time and errors)
7. User proceeds to level 4 which now becomes unlocked (use of forward, backward)
8. Level 4 is successfully completed (i.e., in time and errors)
9. User proceeds to the intermediate tasks with EEG

Alternative 1 (this sequence follows the same logic for all 4 levels of intermediate tasks)**:**

1. Level 1 is completed but user's score is inadequate according to levels score threshold (i.e., related to time and error)

2. User is suggested to redo level 1
3. Level 1 is completed with sufficient score
4. User proceeds to level 2 which now becomes unlocked

Alternative 2 (this alternative is the same for all 4 levels of intermediate tasks)**:**

1. User has completed level 1
2. User can proceed directly to the next level
3. User quits the program

Usage scenarios 4: Intermediate Tasks with EEG

Name: Learning the user EEG-related tasks

Pre-condition: Basic and intermediate tasks are completed. The user has the EEG cap on.

Post-condition: The system is calibrated to detect ErrPs and left/right thinking. The user develops sufficient skills related to providing effective EEG signals for SMR so as to be able to use it on more advanced tasks.

Initial:

1. The user gets an introduction of EEG-related tasks
2. The user wears the EEG cap with the help of the technical staff.

Main:

1. The caregiver opens the ErrPs-designed GTW keyboard
2. The user types a set of sentences (predefined, asked by the caregiver) (system calibration)
3. The caregiver opens the OpenVibe-based interface used for the SMR
4. The user is asked to think left/right for 40/40 times by a visual cue on screen (system calibration)
5. The user is asked to think left/right for 40/40 times by a visual cue on screen and feedback on screen (user training)
6. Intermediate tasks with EEG are successfully completed

7. User proceeds to the advanced tasks

Usage scenarios 5: Advanced Tasks

Name: Learning the user extra functionalities of the system such as settings, links and page bookmarking

Pre-condition: Intermediate tasks are completed. The user wears the cap; calibration tasks with the eye-tracker and EEG are performed.

Post-condition: The user has acquired sufficient skills to be able to later complete the dictated tasks. User perceptions such as those of liking, usefulness and effort in using the system are further enhanced (based on the change objectives identified in D5.1).

Sequence 1

Initial:
1. The user wears he EEG cap with the help of the technical staff and calibration with Eye-tracker and EEG has been done

Main:
1. User proceeds to level 1
2. User focuses on the setting button
3. User goes to the general menu
4. User has to change the gaze visualization to Toggle Gaze visualization
5. User goes back
6. User goes to the general menu again
5. User cancels the Toggle Gaze visualization
6. Level 1 is completed with sufficient score
7. User proceeds to level 2
8. The user goes to the tab overview and opens a tab
9. The user types in www.mamem.eu without making use of the text predictor
10. User aborts action
11. The user goes to tab overview
12. Level 2 is completed with sufficient score
13. The user proceeds to level 3
14. The user goes to tab overview
15. The user make use of edit URL
16. The user types in www.mamem.eu making use of the text predictor (note: the ErrP are used here in an implicit manner since they will be captured and acted upon during typing)
17. The user submits URL
18. Level 3 is completed with sufficient score
19. User proceeds to level 4
20. The user goes to tab overview
21. The user bookmarks the page
22. The user adds a new tab

23. The user visits the bookmark manager
24. The user visits a bookmark of choose
25. The user is requested to switch between the reading and navigation mode by thinking left or right and making use of the generated SMR.
26. Level 4 is completed with sufficient score
27. Advanced training is completed
28. User proceeds to dictated tasks

Alternative 1 (this sequence follows the same logic for all 4 levels of advanced tasks)**:**
1. Level 1 is not completed or is completed but user's score is inadequate according to levels score threshold (i.e., related to time and error)
2. User is suggested to redo level 1
3. Level 1 is completed with sufficient score
4. User proceeds to level 2

Alternative 2 (this sequence follows the same logic for all 4 levels of advanced tasks)**:**
1. User has completed level 1
2. User can proceed directly to level 2
3. User quits the program

Alternative 3 (this sequence follows the same logic for all 4 levels of advanced tasks)**:**
1. User has not completed level 1
2. User is suggested to redo level 1
3. User quits the program

Alternative 6:
1. User has completed level 4
2. User can proceed directly to the dictated tasks.
3. User quits the program

2.4.2 Usage scenarios of the dictated tasks (part 2)

Use case 6 Using E-mail

Name: Learning how to use an e-mail client (level 1)

Pre-condition: Training tasks are completed

Post-condition: The user is able apply the skills learned during the training tasks and can now perform basic tasks in an e-mail client. *Furthermore, he or she knows how to contact for assistance in case of system difficulty and has a plan on how to overcome the barriers and improve skills.*

Sequence 1

Initial:

1. Caregiver starts the program
2. User performs calibration
3. 2. The user wears the EEG cap with the help of the technical staff (if not already on)
4. Experimenter is near to instruct user on how to be perform this task
5. User has an email account (or have been given a mail account)

Main: User goes to programs

1. Users finds the e-mail program

2. User opens the e-mail program

3. User reads an email

6. User responds to an email

8. User sends the e-mail

9. User closes the program

11. User proceeds to next task

Alternative 1:

1. User did not complete level 1

2. User is suggested to redo level 1

3. Users finds the e-mail program

4. User opens the e-mail program

6. User responds to an email

8. User sends the e-mail

12. Level 1 is completed

13. User proceeds to task 2

Alternative 2:

1. User did not complete level 1

2. User is suggested to redo level 1

3. User proceeds to task 2

Alternative 3:

1. User has completed level 1

2. User can proceed directly to tasks 2

3. User quits the program

Alternative 4:

1. User has not completed level 1

2. User is suggested to redo level 1

3. User quits the program

Use case 7 Using Photo editing

Name: Learning how to edit a photo (level 2)

Pre-condition: Calibration is performed and EEG cap is on. Training tasks are completed

Post-condition: The user has more experience in applying the skills learned during the training tasks and is able to edit a photo. *Furthermore, he or she can practice skills to skills to overcome the barrier* (D5.1 performance expectancy E)

Sequence 1

Initial:

1. User is on the GazeTheWeb interface
Experimenter is near to instruct user on how to be perform this task

Main:

1. User goes to tab overview
2. User adds a new tab
3. User visits the bookmark manager
4. User goes to photo editor
5. User starts the photo-editing program
6. User goes to menu in order to open a picture
7. User chooses a picture of choice
8. User resizes the picture
9. User uploads the picture
10. Level 2 is completed
11. User proceeds to task 3

Alternative 1:

1. User did not complete level 2
2. User is suggested to redo level 2
3. User goes to tab overview
4. User adds a new tab
5. User visits the bookmark manager
6. User goes to photo editor
7. User starts the photo-editing program
8. User goes to menu in order to open a picture
9. User chooses a picture of choice

10. User resizes the picture

11. User uploads the picture

12. Level 2 is completed

13. User proceeds to task 3

Alternative 2:

1. User did not complete level 2

2. User is suggested to redo level 2

3. User proceeds to task 3

Alternative 3:

1. User has completed level 2

2. User can proceed directly to tasks 3

3. User quits the program

Alternative 4:

1. User has not completed level 2

2. User is suggested to redo level 2

3. User quits the program

Use case 8 Using Social media

Name: Learning how to access a social media platform (level 3)

Pre-condition: Calibration is performed and EEG cap is on. Training tasks are completed

Post-condition: The user is able apply the skills learned during the training tasks and can now apply these skills to communicate with others trough social media platforms.

Sequence 1

Initial:

1. User is on the GazeTheWeb interface

2. User has a twitter account (or one has been created for the user)

3. Experimenter is near to instruct user on how to be perform this task

Main:

1. User goes to tab overview

2. User adds a new tab

3. User visits the bookmark manager

4. User goes to Twitter

5. The user logs into his or her Twitter account

7. The user searches and follows MAMEM project

6. The user posts a textual message on MAMEM's Twitter page

8. Level 3 is completed

9. User proceeds to task 4

Alternative 1:

1. User did not complete level 3

2. User is suggested to redo level 3

3. User goes to tab overview

4. User adds a new tab

5. User visits the bookmark manager

6. User goes to Twitter

7. The user logs into his or her Twitter account

7. The user searches and follows MAMEM project

6. The user posts a textual message on MAMEM's Twitter page

10. Level 3 is completed

11. User proceeds to task 4

Alternative 2:

1. User did not complete level 3

2. User is suggested to redo level 3

3. User proceeds to task 4

Alternative 3:

1. User has completed level 3

2. User can proceed directly to tasks 4

3. User quits the program

Alternative 4:

1. User has not completed level 3

2. User is suggested to redo level 3

3. User quits the program

Use case 9 Using YouTube

Name: Learning how to use YouTube (level 4)

Pre-condition: Calibration is performed and EEG cap is on. Training tasks are completed

Post-condition: The user is experienced in applying the skills learned during the training tasks and is able to watch a video on YouTube.

Sequence 1

Initial:

1. User is on the GazeTheWeb interface
2. Experimenter is near to instruct user on how to be perform this task

Main:

1. User goes to tab overview
2. User adds a new tab
3. User visits the bookmark manager
4. The user visits the webpage of YouTube
5. The user searches for a video
6. The user selects a video
7. The user pauses the video
8. The user plays the video
7. The user closes the YouTube page
8. Level 4 is completed
10. End of training tasks

Alternative 1:

1. User did not complete level 4
2. User is suggested to redo level 4
3. User goes to tab overview
4. User adds a new tab
5. User visits the bookmark manager
6. The user visits the webpage of YouTube
7. The user searches for a video
8. The user selects a video
9. The user pauses the video
10. The user plays the video
11. The user closes the YouTube page
12. Level 4 is completed

13. End of dictated tasks

Alternative 2:

1. User did not complete level 4
2. User is suggested to redo level 4
3. User quits program

Alternative 3:

1. User has not completed level 4
2. User is suggested to redo level 4
3. User quits the program

2.5 Pre-test of the training tasks (part 1)

A pre-test was conducted in order to get feedback on the training tasks itself but also on the order of the training tasks. For this participants were chosen with an age group that reflected the characteristics of the personas introduced in D5.1. This contains participant's aged from 18-20, participant's aged 40-50 and participants aged above 65. Three of the participant was female and one of the participants was a male.

2.5.1 Description of the pre-test

Below the training tasks that were carried out during the pre-test study, as well as the procedure and the results are described.

Sequence of training tasks in the pre-test:

Basic tasks

1. Focus on the big T but as soon as the circle has almost filled stop focusing at it
2. Press the pause button to pause the screen
3. Press the pause button to start the screen

Intermediate

1. Use the finger-pointer button
2. Cancel the previous function (finger-pointer button)
3. Use the finger-pointer button
4. Select a link
5. Scroll manually
6. Use the ◊ button
7. Press the zoom button
8. Return by using the <- button

9. Go back by using the -> button
10. Return by using the <- button
11. Focus on the big T
12. Type in a letter using the virtual keyboard
13. Type in a word beginning with that letter using the virtual keyboard
14. Type in a sentence beginning with that word using the virtual keyboard
15. Select submit
16. Select a line of text
17. Copy the line of text
18. Paste the text

Advanced

1. Go to the setting button
2. Go to the general menu
3. Change the gaze visualization to Toggle Gaze visualization
4. Go to tab overview
5. Bookmark a tab
6. Add a new tab
7. Type in a URL of the website that you want visit
8. Go to tab overview
9. Open a tab
10. Go to tab overview
11. Remove all the open standing tabs

Procedure:

Participants were welcomed by the researcher and asked to be placed behind the laptop. They first got an introduction on what an eye tracker is; this was followed by the calibration of the eye tracker. After the calibration was successfully completed, participants were instructed to conduct a set of tasks in the gaze the web browser. The researcher guided the participant while conducting the set of tasks. After all the tasks were completed questions were asked about the usability and perceived usefulness of the eye tracker. After this the participants were thanked for their time.

Results:

Overall participants relatively quickly learned how to use the eye tracker. However, the typing was challenging for them in the beginning. To fluently operate the eye tracker it is important to be patient when focusing, this was something that several participants had

to get used to. It occurred that they did not focus long enough, leading to for example a button not being selected. Participants also needed to get used to the fact that the eye tracker focuses wherever they look, therefore if they do not use the pause button it occurs that they accidently open the virtual keyboard or other buttons are pressed. The pause button can help in this case, but in some cases it was observed that participants used the pause button and forgot to un-pause it, leaving them unable to operate the browser before focusing on un-pause.

Overall, all participants were able to complete the tasks with instructions of the researcher. Additionally, participants improved throughout the tasks. There were differences however in this improvement, it seems that younger participants or more technically experienced participants had less difficulties learning and operating the system. Additionally compared to older participants, young people had an idea and stood open of how the eye tracker could be of use for them during their daily live. While young participants focused more on how the eye tracker could be applied in their lives, participants with a higher age found the system more suitable for people who are not able to use their hands anymore.

There were also some limitations for this pre-test. Due to reflections participants with glasses encountered some difficulties operating the eye tracker. It would for example occur that they had to focus longer to select a button on the right side while the same operation went fluently on the left side of the screen. In order to overcome this obstacle the lighting of the room has to be adapted. Also the sample size of the pre-test was on the low side.

2.6 Requirements, Claims and Measures

Requirements

In D5.1 [1], a behaviour change matrix was created according to the Intervention mapping framework (see Appendix B) [15]. Within this behaviour change matrix, change objectives (specific goals stating what a user should change) were formulated by crossing performance objectives with the behavioural determinants (see [1], p57).

In the current report, after specifying the exact performance objectives (training steps), the change objectives identified in D5.1 were further elaborated and updated to fit the training cycles. All in all, the previously identified change objectives and the new objectives derived from the usage scenarios constitute the functional requirements, which are specific functionalities the MAMEM technology should provide to the users during the training phase. Therefore, the following requirements or core functions for MAMEM during training tasks are:

1. System shows how a user is doing on a number of clear and quantifiable criteria;
2. System shows users' status, progress and achievements;
3. System encourages or discourages user's behaviour with the use of praises or rewards and punishments (absence of rewards);
4. System provides positive, evaluative feedback of user's performance;
5. System provides means for comparing performance with the that of other users;
6. System provides a clear structure among the various levels and tasks;
7. System provides challenging (though attainable) assignments with clear short-term and long-term goals;

8. System provides assignments and levels which increase gradually in difficulty, following the training tasks;
9. System provides task instructions in a clear manner;
10. System provides opportunities for the user to learn functionalities of the system and develops competences and skills;
11. System provides suggestion for carrying out tasks during the system use process;
12. Provide opportunities for the training tasks to be fun**.**

Claims

In D5.1, behavioural determinants have been generated based on the performance objectives. Determinants are those factors that have been found associated with the performance of the behaviour of the target population (see [1] p49).

In this report, in accordance with the above requirements, the behavioural determinants have been further broken down and translated to specific claims, which are the underlying objectives of these requirements. All in all the following claims have been formulated:

- Computer anxiety
- Computer self-efficacy
- Perceived external control
- Perceived ease of use
- Perceived enjoyment
- Knowledge
- Performance
- Perceived usefulness
- Social influence
- Task relevance

Measures

The evaluation of the effectiveness of the training cycles and persuasive design will be based on the above claims (see Chapter 3 for more information on the evaluation).

3 MAMEM INTERFACE DESIGN AND DEVELOPMENT SPECIFICATION OF THE TRAINING TASKS

3.1 MAMEM gamified environment of training tasks

The first part of MAMEM's the training cycles is decided to be gamified and thus to borrow elements of gamification. Gamification refers to the relatively new trend of using game thinking, game mechanics and design elements characteristic for games in non-game contexts to drive user motivation and participation [11]. The use of gamification is on the rise in many industries, such as marketing, business processes, learning, fitness, health and wellbeing. Gamified applications typically incorporate elements of game, but it does not turn the whole application into a full-fledged game.

Often, gamification has been seen as just adding goals, levels and trophies into applications. However, it is difficult to get any long-lasting benefits or effects out from gamification just by adding these types of superficial elements on top of the application. More lasting effects can be achieved by utilizing a deeper-level gamification framework and by enhancing intrinsic motivation rather than using extrinsic motivators [12].

Juul (2005) defines the "classic game model" like this: "A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable " [13]. As Juul states, no part of this definition in its own constitutes a game. For a good game, they all need to come together in a unified and appealing way. Hamari et al. (2014) presented a review of quantitative studies related to the effects of gamification. According to a majority of the reviewed studies, gamification does produce positive effects and benefits, and most of the papers reported positive results for some of the motivational affordances [14].

Within the MAMEM gamified environment game mechanics were used in combination with the persuasive strategies that have been identified in D5.1, so as to increase the effectiveness of persuasive design in succeeding the overall goal of user acceptance. Specifically, in D.5 1, a behaviour matrix was created based on the Intervention mapping framework, resulted in the generation and selection of persuasive strategies to be used for influencing user acceptance and engagement during the pre-test trials (see [1] p54). In the current report, design patterns (section 2.7) were created to in order to further how, when, where and which persuasive strategies and game mechanics will be incorporated.

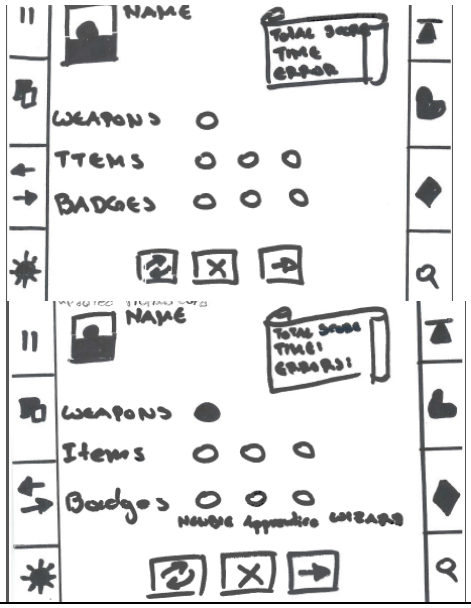
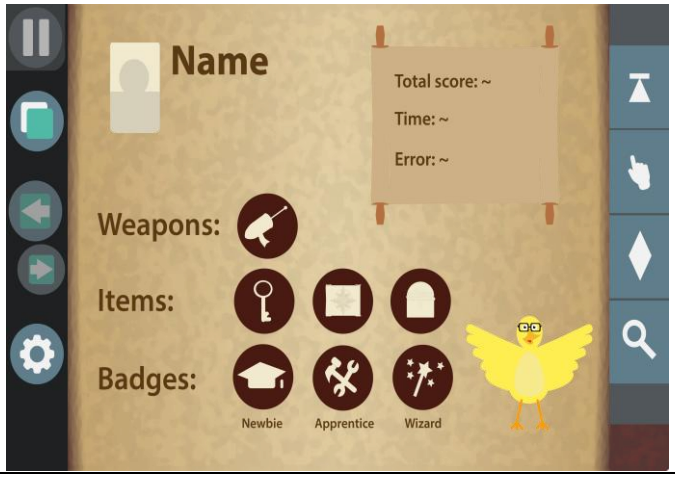
In conclusion the game mechanisms were used to gamify the first part training cycles. As a result a game-like environment with different stages following to the tripartite division of training tasks (basic, intermediate, advanced) was created. Besides such games mechanics, the persuasive strategies identified in D5.1 using the Intervention mapping framework were implemented. The below section describes the gamified persuasive design with the use of design patterns.

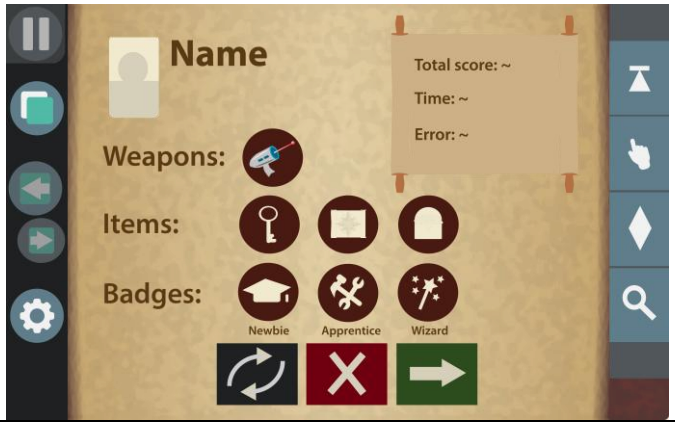
3.2 Design patterns for training tasks

The design patterns helps us further to contextualize the interaction between the user and the system as well as to formulate and evaluate the design.

A design pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem. According to the definition, design patterns should be proved-reusable patterns. To get to these proved design patterns formats should be used during the design phase. In such a format, the name, design problem, context and design solutions are requested for each design pattern. In this way, sketches as visual examples followed by example mock-up were created. Appendix A contains all the design patterns for each of the three training tasks (basic, intermediate and advance) in detail. Appendix C contains flow charts of the sequence of the gameplay according to the design patterns. Note that the examples of the mock-ups, include dint he design patterns, are designed to foster the communication amongst the partners and thus the graphic design of the final prototype was based on these but without being similar. Below, we included a design pattern of the overview page as an example (overview page of the three tasks presented first to the user).

NAME	**OVERVIEW PAGE**
DESIGN PROBLEM (what)	Overview page: The user has access to information about all levels and his score or rewards on each of them. Updated overview page: The user achieves goals, receives updates of his/her performance and gets rewards (all shown in the overview page).
CONTEXT (USE WHEN…)	Related usage scenarios: Use case 2 Every rectangle in the Tasks grid has 3 states: • Locked – Gray color, the user has no access to this level yet. • Unlocked – White color with a gray border, the user can play the level but his performance is not so good. • Unlocked – White color with a yellow border, the user has completed the level and achieved the trophy. That means that his performance was very good. Basic training tasks Requirements: • System shows how a user is doing on a number of clear and quantifiable criteria; • System shows users' status, progress and achievements; • System encourages or discourages user's behavior with the use of rewards
DESIGN SOLUTIONS (HOW)	This is the first page of each level where a user can see the key elements of the game: • The user's name; • The type of the level (Basic, Intermediate, Advanced). • Score for each level (points). • Reward status for each level (trophy active / inactive).

	• Each level's time • Completion status for levels and trophies
DESIGN RATIONALE (WHY)	• The user gets insights of his performance and what remains to be done in each level, which help to regulate or adapt his/her actions accordingly. • The user's motivation and engagement can be enhanced by providing external rewards after reaching his/her goals. • User's motivation is enhanced by changes in status (i.e., trophies) • Based on the updated performance measurements, a user can self-regulate and adapt his/her actions to increase performance.
VISUAL EXAMPLES	
PSYCHOLOGICAL MECHANISMS	self-monitoring, performance feedback, goal setting, extrinsic motivation, conditioning, self-regulation
EXAMPLE MOCK-UP	



3.2.1 Selected game mechanics and persuasive strategies

The game mechanics that were used are:

- Points – basic currency of most games. Different activities will earn varying amounts of points.
- Trophies – formal ways to recognize player accomplishments. Part of their appeal is the meaning they have within a social group.
- Levels – gameplay often advances through different levels of increasing difficulty. This allows players to quickly advance to a level that is appropriately challenging. Levels also create exclusivity and reward proficiency, giving players the impression that they are belonging to a select few.
- Scoreboards – show how players are doing on a number of quantifiable criteria.
- Leaderboards – show players' ranking relative to other players, feeding into our need to compete with others.
- Assignments – structured ways to shape gameplay and provide players with immediate, short-term goals (as opposed to the games' long-term goals) [11].

With regard to persuasive strategies, the ones that were proposed in accordance with the ones identified in D5.1 are:

- Evaluative feedback
- Social influence
- Rewards and praises
- Positive reinforcement
- Goal setting
- Self-monitoring
- Suggestion
- Autonomy
- Tunneling
- Tailoring

Section 3.3 will further elaborate the tailoring of the persuasive design in accordance with the user profiles and personas created in D5.1.

3.3 Theoretical background on Tailoring of communication

One of the advantages of MAMEM system is that it can adapt to the user and its situation, because it can take advantage several variables. In this way the system can be personalized, situated or tailored. The latter term is used within the health domain, and within this domain, tailoring is recognized as one of the basic behaviour change methods, because it turned out to be useful for almost any determinant at the individual level [15]. Tailored communication is defined as any combination of information or change techniques intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest and have been derived from individual assessment [16].

Hawkins et al., (2008) proposed three categories of strategies of achieving tailoring goals: **Personalization, feedback and content matching.** These three categories most frequently are used in combination [17].

Personalization has been found to increase attention effortful processing and self-referencing and the most common personalization techniques are:

a) **Identification**: this involves identifying the receiver in the message, for example by mentioning the name, including pictures of the recipients or recognizing recipient's birthdays.

b) **Contextualization**: this involves framing the message in a context that is meaningful to the recipient, for example using demographic characteristics of patients to select age and sex matched images, or a massage from which the source matches the receiver's demography of preferences. Other contextualization variables were family structure (e.g. family dietary messages differently for parents of children in different age categories), residential status (e.g. framing messages differently on home injury prevention differently from owners versus renters) ethnicity cultures and personal interests.

Feedback category includes the three following strategies:

a) **Descriptive feedback:** Tailored communication often reports back to individual's summaries of their beliefs, attitudes or behaviours. Descriptive feedback ranges from simply restating or acknowledging information to providing information on more complex processing of their responses. Descriptive feedback may influence determinants of behaviour by stimulating self-referential thinking about or otherwise focusing attention on specific beliefs/behaviours related to the outcome of interest.

b) **Comparative feedback:** By comparing beliefs/attitudes or behaviours to those of others, tailored feedback is generally assumed to provide social comparison information that may focus effortful processing on self-evaluation and normative comparison to stimulate changes in perceived norms, attitudes, beliefs. The authors highlighted that the reference group used in comparative feedback can itself be tailored (i.e., comparative feedback given to patients with PD were other PD users are used as the referent group). Lastly, comparative feedback

can be within-user by gathering information over time and messages report on the progress over time (self-comparison).

C) **Evaluative feedback:** It involves feedback that makes interpretations, judgements or inferences based on what is known about the receiver's attitudes, beliefs or behaviours (Hawkins et al., 2008).This type of information is used to change behavioural beliefs through providing new insights to a person's behavioural or psychological state, because the tailored agent may be perceived credible. An example of evaluative tailored information is "your physical activity level is well below the recommended level of 30 minutes of moderately intense activity on at least 5 days of the week" or "you said you intended to start exercising regularly. That could be a good way to lower your blood pressure".

The third category of tailoring communication is **content matching.** Content matching attempts to direct messages to individual's status on key theoretical determinants. For any given individual, content matching seeks to act on those intermediate determinants of intentions on which change is more needed or most likely to produce success. Deciding which, how many and what combinations of determinants need to be measured and utilized in a tailored communication requires a detailed understanding of factors that influence the behavioural outcome of interest.

The following section (3.4) translates the theoretical background of tailoring into the MAMEM applied setting, explaining how the tailoring communication will be used for the MAMEM training phase.

3.4 Incorporation of tailoring into MAMEM persuasive design

The tailoring strategies mentioned above can be applied to influence user's behavioural intention and use towards the MAMEM system. An explanation follows below on how to apply the theoretical tailoring strategies to the MAMEM training tasks (part 1).

Tailoring category	Tailoring strategy	User characteristic	Application context
Personalization	Identification	Usage of user's name (demographic)	• The game features users' full name at the top right. • The overview page include user's information about each level. • When praise user call with name (i.e., "Wow, Mark great score). This praises are found in the final cards after each level.
Personalization	Contextualization	Usage of user's ethnicity culture (Greece, Israel) (demographic)	Quiz game questions

Table 7. Personalization tailoring communication for MAMEM

Tailoring category	Tailoring strategy	User characteristic	Application context
Feedback	Descriptive feedback	Usage of user interaction with MAMEM system	Time, errors, and points both during the games, as also the summative scores provided in final cards, are tailored to user's performance. (i.e., it took you 3 minutes to finish this level).
Feedback	Comparative feedback	Usage of social comparison based on the belonging to a patient group (SCI, PD and NMC disorder)	At the final card, the rankings are presented, in which user performance from the same patient group are compared. The user is only compared with others who have the same disorder.
	Comparative feedback	Usage of user's progress based on assessment at different points of time	Subsequent final card contain feedback based on the progress of users (I see that you are become faster/ you are not that fast compared to the previous game)
Feedback	Evaluative feedback	Performance evaluation	This is providing an insight on the descriptive feedback (i.e., it took you three minutes to finish this level; you are very fast)

Table 8. Feedback tailoring communication for MAMEM

The MAMEM persuasive design, as has been sketched in the D5.1 is based on the Unified Theory of Acceptance and Use of Technology model (UTAUT) [18]. Figure 3 shows a graphical representation of this model. For the content matching tailoring strategy, the four core determinants and the three moderators (gender age, experience) will be used. Table 9 illustrates the 4 core determinants of technology acceptance and specifies the role of the key moderators,as derived from the UTAUT model of Venkatesh et al. (2003).

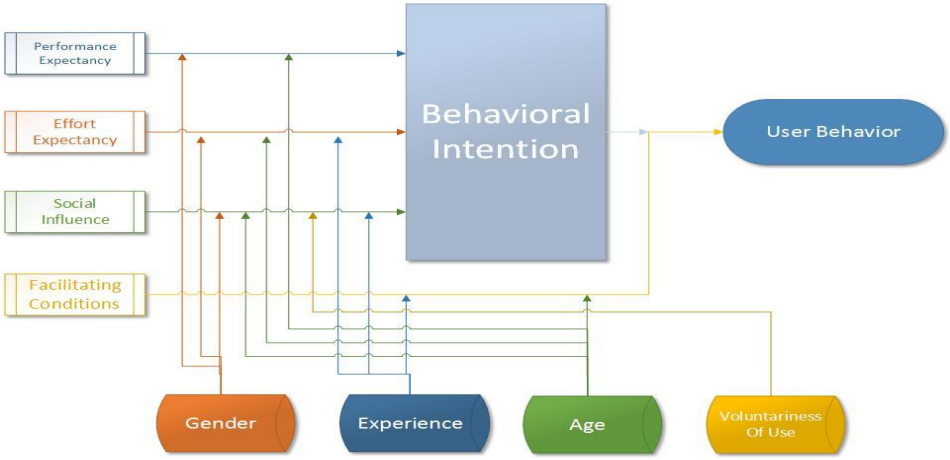


Figure 3. UTAUT model (adapted from Venkatesh et al., 2003)

Determinants / Moderators	Performance expectancy	Effort expectancy	Social influence	Facilitating condtions
Age	Younger	Older	Older	Older
Gender	Men	Women	Women	-
Computer Experience	-	Ealry stage	Ealy stage	Increasing experience

Table 9. Moderators' effect on determinants of technology acceptance (adapted from Venkatesh et al., 2003)

Thus, the content of textual messages that MAMEM provides the users with could be as following:

- **For young male users:** the evaluative feedback could primary include elements that increase performance expectancy. This is, highlighting more on users' performance (i.e., praises for time and accuracy scores, task effectiveness) and extrinsic reward (i.e., trophies obtained, high scores, stages unlocked etc.) accomplishments. Based on the user profiles, created in D5.1, NND patients fit in this category as they are young and mostly males. Also, some SCI patients also fall in this category.

- **For older male users:** In addition to the performance expectancy (task accomplishments, extrinsic rewards) facilitating conditions are of great importance for users with these characteristics. Therefore the guide used in the games, should have a more prominent role by explaining the instructions in more details compared to other users. Also more encouragement should be provided, in case users are not as successful in their interaction with MAMEM, so as users to feel that they are in control over using the system. Mainly PD patients fall in this category and some SCI patients.

- **For older female users:** For these group of users, apart from facilitating conditions applications (similar to the older men) effort expectancy beliefs should be also be the

focus. This means that the evaluative feedback provided should primarily highlight perceptions of effort and skill acquisition ratio (i.e., “you are very fast learner”, “well done for becoming so skilful in such a short use time”). Lastly, social influences could play an important role for such users (i.e., your family would be proud, your doctors would be recommend to use it). PD patients fall in this category according to the user profile.

- **For younger female users:** Performance expectancies (task accomplishments and extrinsic rewards) and effort expectancies could be of primary importance when considering the content of the evaluative feedback. According to the user profiles, NMD female patients and some of SCI patient group fall in this category.

4 EVALUATION OF PERSUASIVE DESIGN

Evaluation of the effectiveness of the training cycle's setup (incorporating the persuasive design and the personalized learning curves algorithm) is described in D6.3 [8] that describes the Pre-test Trial Protocols. Specifically, section 2.3.4.1 of that document describes in detail the testing of the persuasive design. In general, pre-test trials Phase I pertains to the user training and familiarity with the system and thus, the goal of including persuasive design strategies is twofold: 1) to affect users' performance; and 2) to influence perceptions of acceptance and use. In other words, next to influencing actual performance (speed and accuracy) during training, the persuasive design also aim to optimize perceptions of the user regarding the MAMEM technological system (i.e. perceived usefulness, perceived ease of use, usage intention).

To test the effect of MAMEM persuasive design on user perceptions and actual performance, both quantitative and qualitative methods will be used to assess the effectiveness of the Phase I trials. These effectiveness analyses will be based on the data logged during the trials (for each participant, all relevant use data will logged, see D6.3) and also a questionnaire filled out after using the MAMEM system, and also stress-levels measures based on the tonic and phasic changes in the GSR signals, and based on assessing HRV from the ECG signal. Both these two stress-related signals will be recorded in synchronization with the recording of the computer use performances (training and dictated tasks alike) (for details see D6.3) [8].

As described in D6.3 each clinical site will employ 6 able-bodied participants and 6 patients (spinal cord injury, Parkinson's disease, or Neuromuscular disorders), to test both the usability of MAMEM system and the effectiveness of the persuasive design of the training cycles. Therefore, the actual performance improvements will be tested by dividing the able-bodied participants into two groups.

Half of both able bodied and disables participants will receive the system with the inclusion of the persuasive design and half of will be working with the same system that has been modified such that persuasive design elements have been stripped from the user interfaces. This will provide data with regard to their performance and their learning curve (i.e. time and errors) and allow a comparison and indication of the effectiveness of the persuasive design elements. With regard to perceptions of acceptance, after the trials, a questionnaire (see below) will be administered measuring participant's perceptions. Due to the statistical limitations of the small sample used, quantitative comparisons of the two groups can only be limited in value, and additionally qualitative methods will be employed. These analyses will deliver more insights into the user perceptions and any differences of these perceptions as they stem from the inclusion or not of the MAMEM persuasive design and are related to the personalization of the persuasive design.

So, the evaluation of the MAMEM system's feasibility and the effectiveness of the MAMEM system and the persuasive design elements incorporated into it will be done based on these two types of data (performance data and questionnaire after using the system). In additional, stress-related psychophysiological measures are taking while users are using the MAMEM system, and these will be used for further exploration of the effects of the MAMEM technology and persuasive design elements.

The questionnaire that participants fill out after using the system (as described in D6.3, will measure user's assessment of following characteristics of the MAMEM technology:

- Perceived usability
- User technology satisfaction/acceptance
- User evaluation of the persuasive design

This questionnaire will consist of a maximum of 27 questions, such that all participants can answer these questions within approximately 10 – 15 minutes. That is, after participating in tasks of pre-test trials Phase 1, participants will immediately fill out this questionnaire to be able to assess their direct evaluation of the system. Assessing their evaluation at a later moment in time will lead to suboptimal assessment. However, right after participation, participants will be tired and additional tasks can only be limited.

In line with the evaluation of the MAMEM system after using it at home in Phase 2 trials, after using the MAMEM system in Phase 1 trials, we will assess user evaluations of the system's usability, user satisfaction, and user acceptance, using the TAM3 questionnaire items [19]. As described in D5.1 and D7.1 an often-used model for understanding technology acceptance is the Technology Acceptance Model. Venkatesh and Bala, (2008) have proposed a model (TAM3) that predicts technology acceptance, and which has been very widely used and supported by literature. According to this model, the behavioral intention to use technology is determined by two beliefs: perceived usefulness, defined as the extent to which a person believes that using a software will enhance their performance with a task at hand, and perceived ease of use, defined as the degree to which a person believes that using the software will be free of effort. The TAM3 model also postulates that the effect of external variables (e.g., design characteristics) on behavioral intention will be mediated by perceived usefulness and perceived ease of use [20, 21]. That is, determining the attitude towards using and subsequent behavioral intention to use, culminates in actual system use (Wu & Wang, 2005).

The TAM3 questionnaire items that we will use to evaluate the MAMEM system's acceptance will be comparable to the questions that will be used after pre-test Phase 2 trials, as they are described in D7.1 [22].

SI-TAM3 DETERMINANTS OF PERCEIVED USEFULNESS	QUESTIONNAIRE ITEMS 7 POINT LIKERT SCALE	DIGITAL INCLUSION INDICATORS
Perceived Usefulness	Using MAMEM will result in my interacting more, and better, with people and groups, online and off	PARTICIPATION AND SOCIAL CAPITAL
	Using MAMEM will improve my ability to carry out tasks effectively Using MAMEM will make it easier to search for jobs and/or customers online Using MAMEM will enhance my ability to take online courses and pursue professional and educational interests	EDUCATION AND EMPLOYMENT
	Using MAMEM I can access easier and better health resources online that are important to me Using MAMEM will facilitate my ability to pursue my hobbies and to generate and upload content of value to me	EMPOWERMENT AND WELL BEING
Ease of use	My interaction with MAMEM is clear and understandable I find MAMEM to be easy to use I find it easy to get the system to do what I want it to do	DIGITAL EMPOWERMENT
Subjective norm	People in my support system (doctors, care takers) think it is important to be using MAMEM	DIGITAL EMPOWERMENT
Image	Potential employers/customers would think highly of my using MAMEM Friends and people in my networks would think highly of me	
Digital inclusion relevance	MAMEM will be important in making me feel better able to pursue interests, opportunities and connections online and off	SOCIAL CAPITAL
Output quality	With MAMEM using my computer becomes more efficient, especially for tasks that are important for me, like connecting with people online and off	
Digital inclusion demonstrability	The result of using MAMEM in becoming less isolated and more of a part of society are apparent to me	
	I have no difficulty explaining what the impact of using MAMEM is	
Behavioral intention	Assuming I had access to MAMEM, I intend to use it	

Table 10 The TAM3 questionnaire items to evaluate the MAMEM system's acceptance (as described in D7.1)

5 CONCLUSIONS

In this document we completed two tasks. The first task was related to the training cycle development for the pilot trials, while the second task pertained to the persuasive design of the prototype interface applications.

In more detail, the training cycle development, it was divided into two parts: in the first part, users are introduced to the platform, the application of the EEG headset and eye tracker, and provided with the basic skills to operate the MAMEM system. These are called training tasks, and have been divided into sublevels, namely basic, intermediate and advanced with increased difficulty according to relevant theory and the rationale of MAMEM. Thus, users first become familiar with using the eye-tracking element; then become accustomed to the GTW interface elements; next users get acquainted with the EEG element so as to proceed with more advanced learning of the GTW. Users are guided through the tasks based on rules following the concept of learning curves, where performance is assessed using two metrics: execution time and error rate. Performance is measured using a learning algorithm with a 30% rule. After the basic training take place, users are considered to be able to continue with the second part of the training, which is about multimedia managing, authoring and sharing using dictated tasks such as writing an e-mail and photo editing. After the training cycle specification, the next step was to design usage scenarios where the sequences of user-system interaction during the training were fully described. This was a crucial step because it lead to the generation of the functional requirements that the system must satisfy as well as the claims and the derived measures.

The next task of this document refers to the persuasive design of the prototype interface for the training tasks. This was considered important because this is the learning phase time and the time that users form the first perceptions of the system and decisions of initial acceptance. The ultimate goal of the persuasive design was to meet the underline objectives of technology engagement and acceptance (mentioned in section 2.6 requirements, claims and measures). To increase technology engagement and acceptance it was designed that the most optimal way was to include multiple persuasive strategies (identified in D5.1) together with gamification mechanics within a gamified learning environment. Design patterns were created to further to contextualize the interaction between the user and the system and to decide on issues related to persuasive strategies such as the specific context and the timing. To foster the communication initial handmade sketches leading to exemplary mock-ups, which formed the basis for the final design of the prototype. This task culminates with a description of tailoring persuasive characteristics to relevant user characteristics. All in all, such tailoring was divided into three categories, namely, personalization, feedback and content matching. Due to the fact that the there is a huge heterogeneity both within and between the patient groups and given the preferred unobtrusiveness of any intervention, actual user performance and the demographics were mostly taken into account. This part will be updated after the results of the pilot trials. Lastly, the document includes information on how the evaluation of the effectiveness of the persuasive design will take place during the pilot trials.

In sum, the deliverable covers the training cycle development and the persuasive design of the MAMEM prototype drawing direct lines to D5.1 [1] which is the precursor to the current

document, as well as to deliverables generated by other partners such as D6.2 [7] D6.2 [8] and D7.1 [22].

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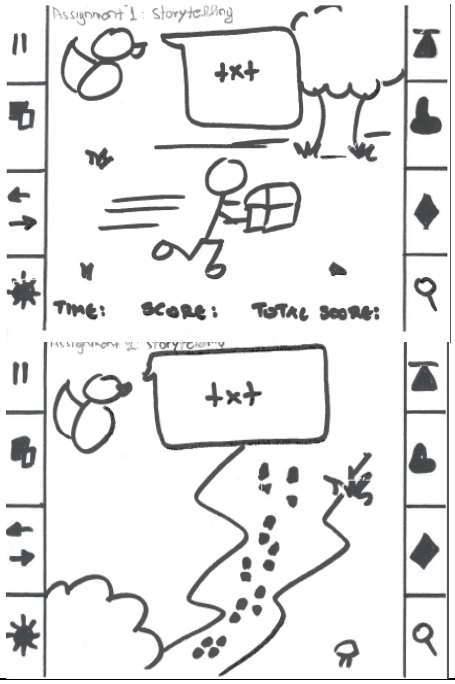
Appendix A. Design patterns for training tasks

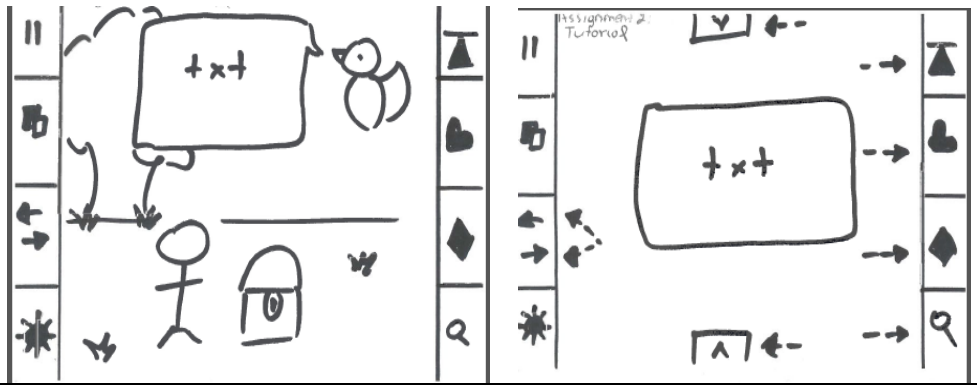
NAME	STORYTELLING
DESIGN PROBLEM (what)	The user is introduced to the gameplay, and the main game characters. The user gets to know the assignment to be performed.
CONTEXT (use when…)	Use case 2 (basic tasks), use case 3 (Intermediate tasks), use case 4 (advanced tasks). • View this card before the outset of each assignment. • Skip this step when the user replays the assignment. Related requirements: • System provides a coherent and structured gameplay among the various levels and assignments; • System provides challenging, attainable assignments with clear short-term and long-term goals. •
DESIGN SOLUTIONS (how)	Assignment 1: • The two main characters are introduced: the guide (i.e., an animated cat) and a villain (i.e., a dark elf). • The guide narrates the plot and explains the assignment (i.e., “A villain took your treasure; you have to stop him”). Assignment 2: • The guide introduces the user to the second assignment and the new characters (i.e., “the villain has escaped with your treasure; I know a wizard who can help you to find the villain and take back what is yours”). Assignment 3: A user already has obtained a map with the location of the villain. The introductory story challenges the user to go through a maze with (four) different challenges along the way, in order to reach the villain. Background and characters: • The assignments have different background scenes • The characters are “fantasy” characters (i.e., guide is a talking bird, villain is an elf)
DESIGN RATIONALE (why)	• Coherent story between assignments, with new challenges being introduced each time can increase users’ motivation. • Pre-defined assignments provide users with clear goals which can affect user’s performance.

EXAMPLES (as seen on…)	
PSYCHOLOGICAL MECHANISMS	Goal-setting, intrinsic motivation, physical cues
EXAMPLE MOCK-UP	

NAME	TUTORIALS (for basic and intermediate tasks)
RELATED TRAINING TASKS	<u>Basic training task (assignment; level 1a, 1b)</u> • Learn to focus on one position. <u>Intermediate training task (assignment; level 2a, 2b, 2c)</u> <u>Learn to:</u> • Scroll manually • Use the ◊ button • Use the finger-pointer button • Use the backward/forward • use the zoom button • use the keyboard (T) • Copy/paste
DESIGN PROBLEM (what)	• The user is provided with instructions on the UI elements, needed to successfully finish the assignments. • The user practices the elements before the actual gameplay. Repetition increases the retention and helps the establishment of the learning curves.
CONTEXT (use when…)	Related usage scenarios: usage scenarios 2, and 3 <u>Related requirements:</u> • System provides task instructions in a clear manner; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills;

	• System provides suggestion for carrying out tasks during the system use process;
DESIGN SOLUTIONS (how)	• The system provides a brief tutorial according to the gameplay requirements (i.e., if the game requires the scrolling function to be used, small tutorial is offered prior to the game action); • The tutorial is provided when a user has to perform an action for the first time; • The tutorial is interactive; • Provide a background in-game tutorials (i.e., tutorial assimilation in the screens that tell the story before starting each level) • The tutorial is perceived by the user as part of the game. <u>Assignment 1. Tutorial:</u> • The guide instructs the user to focus on the target (i.e., villain) and observe the result (i.e., the target gets hit). • The guide gives tips for gaining more points (“to get more points, hit as fast as you can”) <u>Assignment 2. Tutorial:</u> • The guide explains the UI elements needed each time for the gameplay (before each level) and the user has to practice them. • Indication of each button provided while the guide gives instructions (i.e., arrows that shows the button being described). • Tips for gaining more points are provided (i.e., “do it as fast and accurately as you can and gain more points”). *Attention: more explanation of the specific tutorials are described before each specific gameplay action.*
DESIGN RATIONALE (why)	• The user understands the basic functionalities of the UI elements. • Provision of interactive tutorial has a positive effect on the user’s retention. • Provision of brief tutorials during the game, increases the fun without overwhelming the user. • Background-in game tutorials allow the user to have a direct access to the gameplay, making the tutorials seem as part of the actual game.

EXAMPLES (as seen on…)	
Psychological Mechanisms	Knowledge, competence, cause and effect, feedback, suggestion , retention
EXAMPLE MOCK-UP	

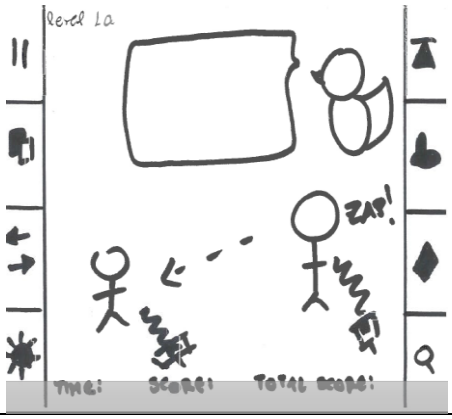
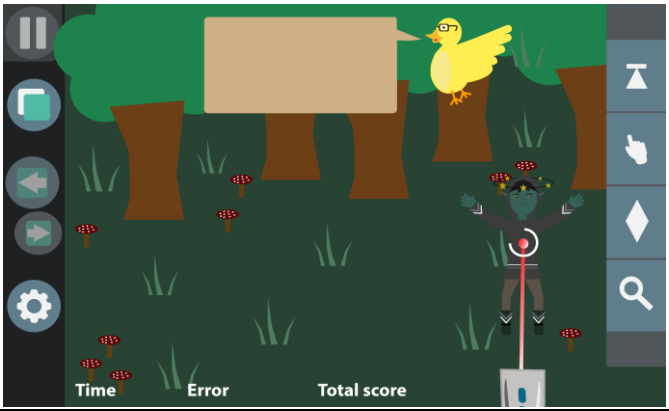
NAME	**FINAL CARD**

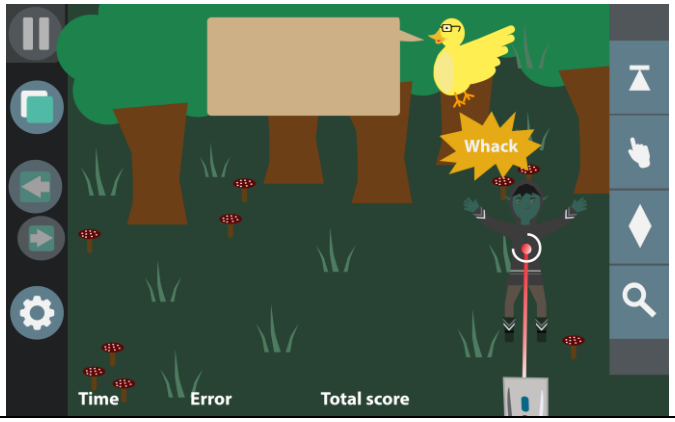
DESIGN PROBLEM (what)	The user gets insights of his overall performance, which is compared to that of other players.
CONTEXT (USE WHEN…)	Related usage scenarios: Use case 2, 3, 4 Every time that that the assignment is competed. <u>Related requirements:</u> • System shows how a user is doing on a number of clear and quantifiable criteria; • System shows user's status, progress and achievements; • System provides positive, evaluative feedback of user's performance • System encourages or discourages user's behavior with the use of rewards, or punishments (absence of rewards); • System provides means for comparing performance with the that of other users (social comparison); • System provides suggestion for carrying out tasks during the system use process.
DESIGN SOLUTIONS (HOW)	This is the last page of each assignment, wherein the user is informed of the overall results of the performance. Specifically: • Feedback is given (good, very good, and awesome), according to the user's performance. • The guide is also shown having different emotions (happy, neutral, and sad) according to the performance feedback. • Scoreboards have been updated to reflect the performance. • The user receives rewards (i.e., trophies). • Comparison among other players is shown. • Three options are provided: replay (i.e., to score higher or get a trophy) go to overview (to start the second assignment) and proceed to next level.
DESIGN RATIONALE (WHY)	• The user has a better understanding of his performance when compared to that of the other users. Competition can increase motivation. • Suggestions to repeat task and gain more points (in case that the performance can be improved) makes a task to be perceived as less tedious. • Showing the different emotions of the guide is a form of feedback based on social cues, which can motivate the user to repeat a task.
VISUAL EXAMPLES	

PSYCHOLOGICAL MECHANISMS	Rewards, social influence, evaluative feedback, social cues
EXAMPLE MOCK-UP	

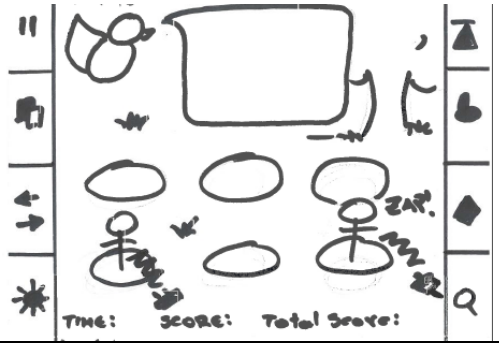
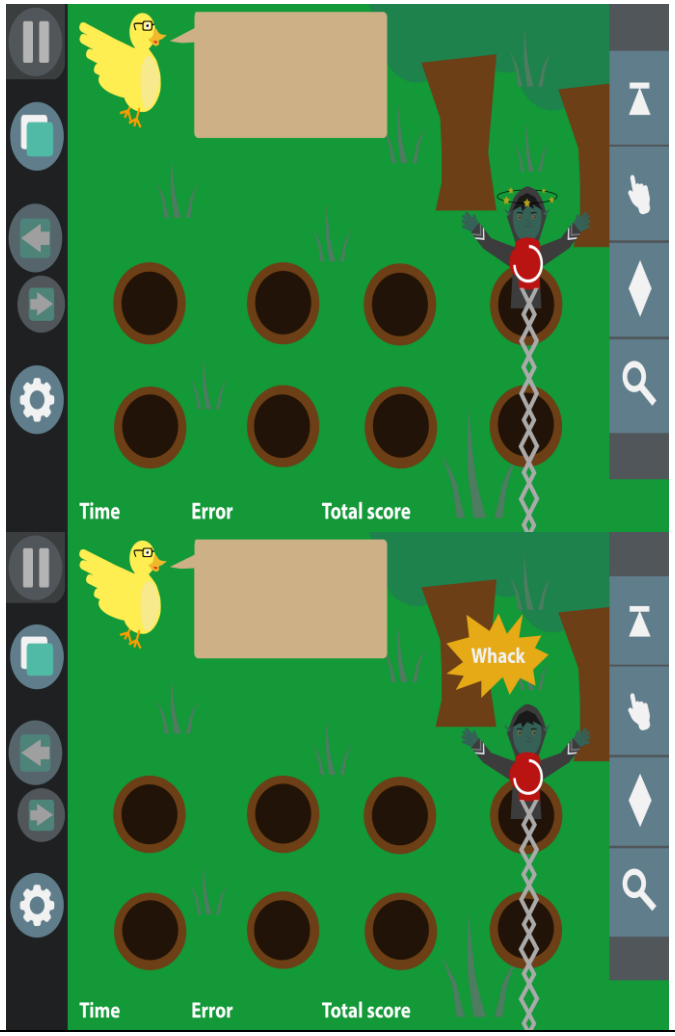
Mock-up design patterns for basic tasks: Assignment 1

NAME	**LEVEL 1a**
RELATED TRAINING TASK	Focus long enough on several positions.
DESIGN PROBLEM (what)	User becomes familiar with the gaze-based UI
CONTEXT (USE WHEN…)	Related usage scenarios: use case 2 This is 1st level of assignment 1. Related requirements: • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System shows how a user is doing on a number of clear and quantifiable criteria;

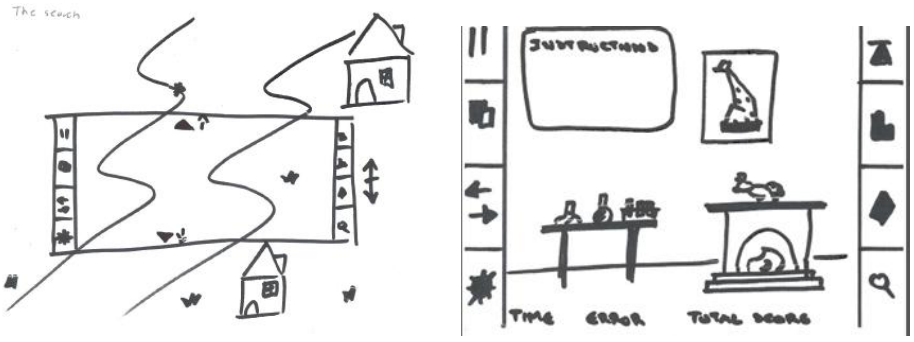
	• System provides positive, evaluative feedback of his performance after completing a task level; • Provide opportunities for the training tasks to be fun; • System provides suggestion for carrying out tasks during the system use process. •
DESIGN SOLUTIONS (HOW)	• A target (i.e., a villain) appears on several positions on the screen. • The task of the user is to focus on the target so as for the target to get hit. • Audio and visual feedback (sounds and signs) can be provided in a way that gives a feedback of either success or failure of user's performance. • The scoreboards are shown on screen • Evaluative feedback is provided after the user completes the level. • When it is considered that the user can improve further his performance the systems suggests that the user will play again to gain more points.
DESIGN RATIONALE (WHY)	This game follows the tutorial and increases in difficulty, since the target changes location on the screen. The user learns to focus on different location on the screen.
VISUAL EXAMPLES	
PSYCHOLOGICAL MECHANISMS	Self-monitoring, intrinsic motivation, competence, evaluative feedback, suggestion
EXAMPLE MOCK-UP	

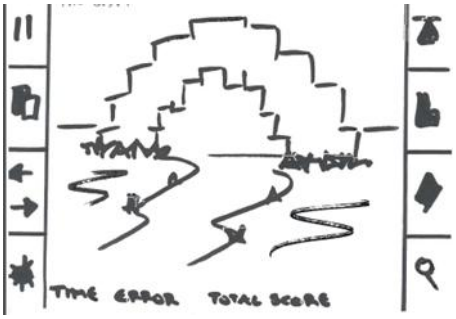
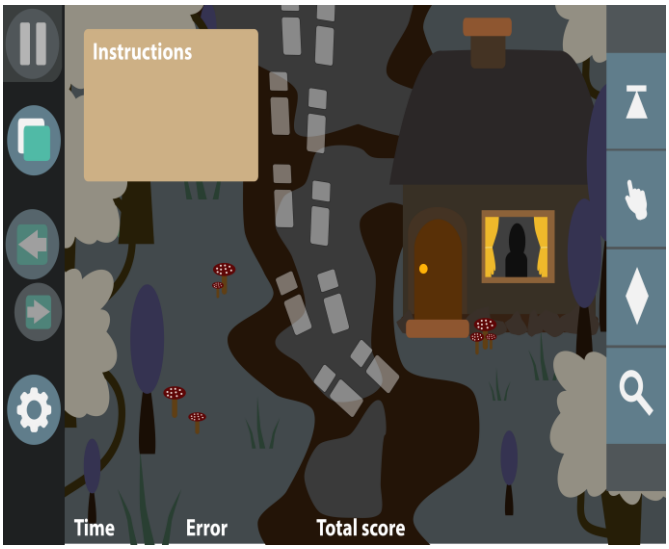
	

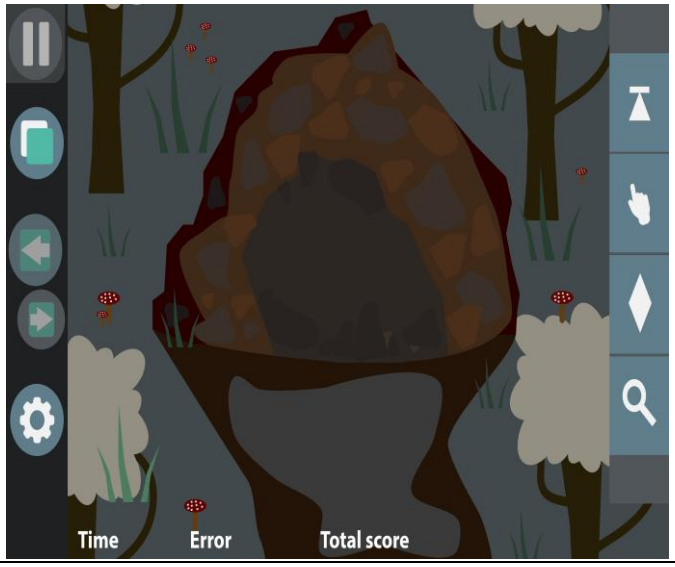
NAME	LEVEL 1b (whack a mole)
RELATED TRAINING TASK	Focus on a sequence of locations
DESIGN PROBLEM (what)	User becomes familiar with the gaze-based UI
CONTEXT (USE WHEN…)	Related usage scenarios: use case 2 This is 2nd level of assignment 1. Related requirements: • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System shows how a user is doing on a number of clear and quantifiable criteria; • System provides positive, evaluative feedback of his performance after completing a task level; • Provide opportunities for the training tasks to be fun; • System provides suggestion for carrying out tasks during the system use process.
DESIGN SOLUTIONS (HOW)	• This is similar to “whack a mole” game. • A villain appears on a sequence of locations (moles). • The task is to focus on the target (i.e., villain) fast enough. If user is successful, the villain gets hit with a leaser (reward from the previous level); if not, the villain escapes. • Audio and visual feedback (sounds and signs) can be provided in a form that shows either success or failure according to the user’s performance. • The scoreboards are shown on screen. • Evaluative feedback is provided after the user completes the level.

	• When it is considered that the user can improve further his performance the systems suggests that the user will play again to gain more points.
DESIGN RATIONALE (WHY)	• User become familiar with using his gaze in a fun way. • With the visual and audio feedback user gets an immediate result of his/her performance and can adjust his/her actions accordingly.
VISUAL EXAMPLES	
PSYCHOLOGICAL MECHANISMS	Self-monitoring, intrinsic motivation, competence, evaluative feedback
EXAMPLE MOCK-UP	

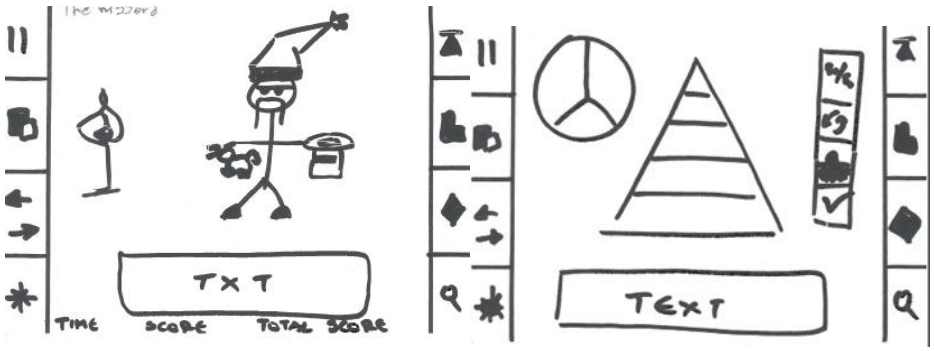
Mock-up design patterns for intermediate tasks: Assignment 2

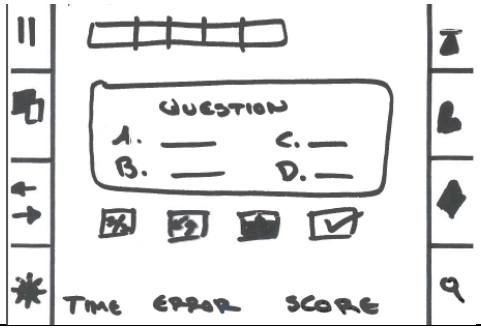
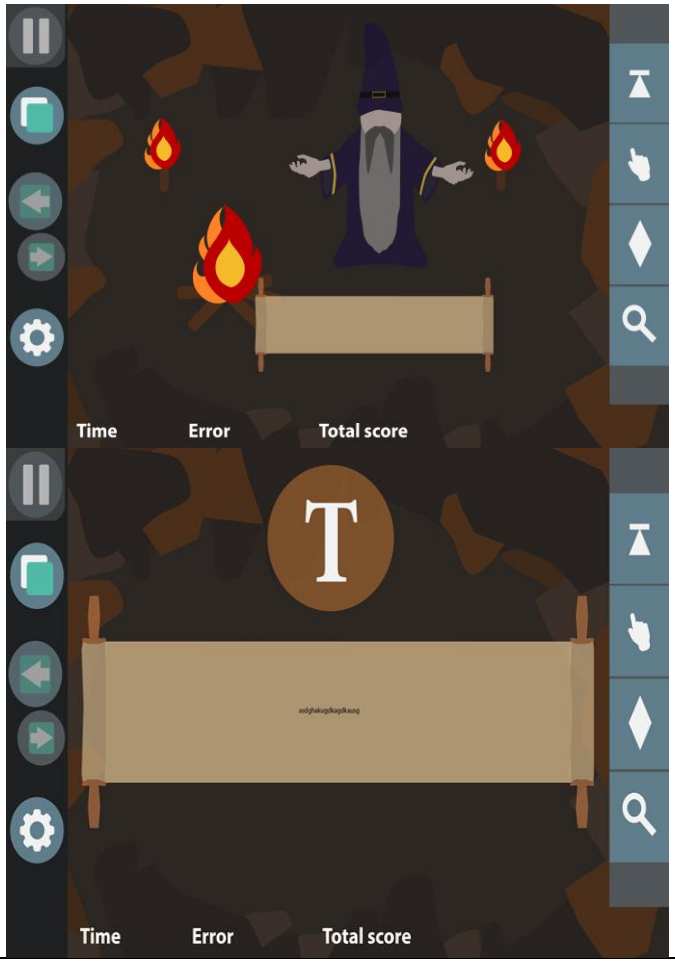
NAME	THE SEARCH (level 2a)
RELATED TRAINING TASK	Scroll manually Use the ◊ button Use the emulation button Use of backwards
DESIGN PROBLEM (what)	User learns to scroll up and down manually and automatically and also learns to use the emulation and backward button.
CONTEXT (USE WHEN…)	Related usage scenarios: UC 3 (intermediate tasks level 2a) Related requirements: • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • Provide opportunities for the training tasks to be fun; • System shows how a user is doing on a number of clear and quantifiable criteria.
DESIGN SOLUTIONS (HOW)	• The guide suggests to start the wizard search. • The user has to scroll up and down to find the wizard. • The user practices the two scrolling options during the tutorial; in the gameplay he/she can decide the preferred option. • The user continues scrolling until he finds a tower. • The tower is positioned in the opposite direction of the initial user's scrolling. • The user uses the emulation button to go inside the tower. • The wizard is not there so the user uses the backward button to continue the search (scrolling) and using the emulation button to go inside a cave he found.
DESIGN RATIONALE (WHY)	• User learns how to use the system in a playful way. • Autonomy to choose preferred options increases the motivation. • User monitors his/her performance via the scoreboards.
VISUAL EXAMPLES	

	
PSYCHOLOGICAL MECHANISMS	Playfulness, competence, self-monitoring
EXAMPLE MOCK-UP	 

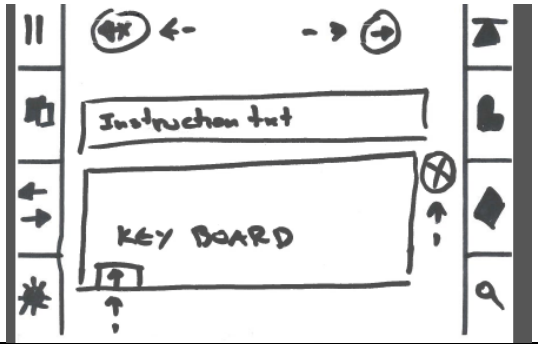
	

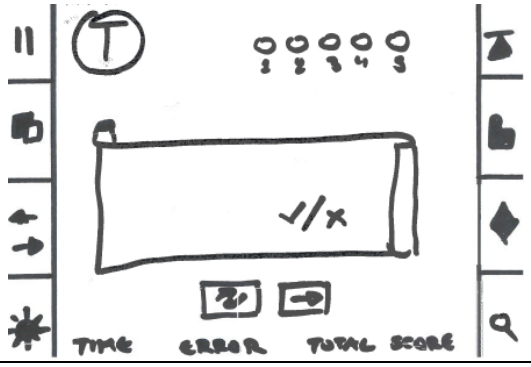
NAME	THE WIZARD – QUIZ GAME (level 2b)
RELATED TRAINING TASK	Zoom element, T element, keyboard
DESIGN PROBLEM (what)	User is introduced to another mission that leads to the keyboard practice, via text input and use of the zoom button. A brief tutorial of the quiz rules and explanation of the use of the zoom and T (keyboard symbol) element. Suggestions on how the user can get more points are also provided.
CONTEXT (USE WHEN…)	Related usage scenarios: UC 3 (intermediate tasks) Related requirements • System provides assignments and levels which increase gradually in difficulty, following the training tasks; • System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System provides positive, evaluative feedback of his performance; • Provide opportunities for the training tasks to be fun.
DESIGN SOLUTIONS (HOW)	• The wizard congratulate the user for his/her successful search. • The wizard introduces a new task to the user, in order to reveal the location of the stolen treasure: the user has to successfully answer quiz questions of various categories (i.e., history, geography, science). This task is similar to a quiz game. • The user is instructed to type his/her answer on the keyboard by

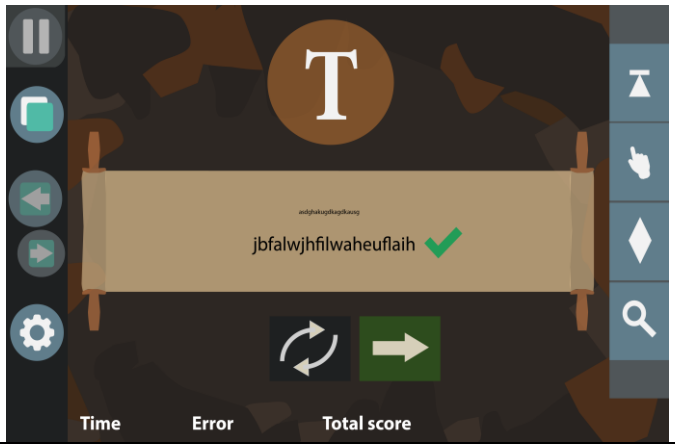
	focusing on the T element. **Quiz Game rules:** ○ The user must answer 5 multiple choice questions of increased difficulty, by typing on the keyboard. ○ The user has 4 help options throughout the game, each to be used only once (i.e., right answer given, 50/50, change the question, expert help). • There is a graphical representation of the question structure (i.e., a pyramid) with the three different pillars of increased difficulty illustrated (i.e., 2 easy questions, 2 medium and 1 difficult). The help options are also illustrated. • Tips of the point increase are also provided (i.e., "be fast and accurate in typing and earn more points"). • A multiple choice question is presented (randomized order of categories); there are 5 questions of three categories (thus 15 questions in total). • The user is given four choices of the potential right answer (i.e., A, B, C, and D). • However, the 4 options are written with very small letters; the user is urged to use the zoom button to read better. • The user can also choose one of the four help options. • The user focuses on the T to write the answer. • Points that correspond to each question and scoreboards are also visible to the user.
DESIGN RATIONALE (WHY)	• A challenging task is introduced to the user • The user becomes familiar with the game in a playful way. • The user has a clear understanding of the game rules. • The user has a clear understanding on how to increase his points. • The graphical representation of the questions decreases the number of text explanation, so as not to bore and overburden the user with additional text. • A randomized choice of questions makes the game more interesting. • Multiple choice questions work as triggers for the user to find the correct answer. • Having help options increases the chances of success; the game must evoke users with feelings of success and increased self-efficacy.
VISUAL EXAMPLES	

	
PSYCHOLOGICAL MECHANISMS	Autonomy, positive feedback, knowledge, goal setting, outcome expectations, playfulness, self-monitoring
EXAMPLE MOCK-UP	

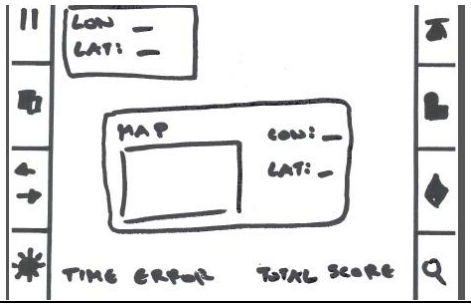
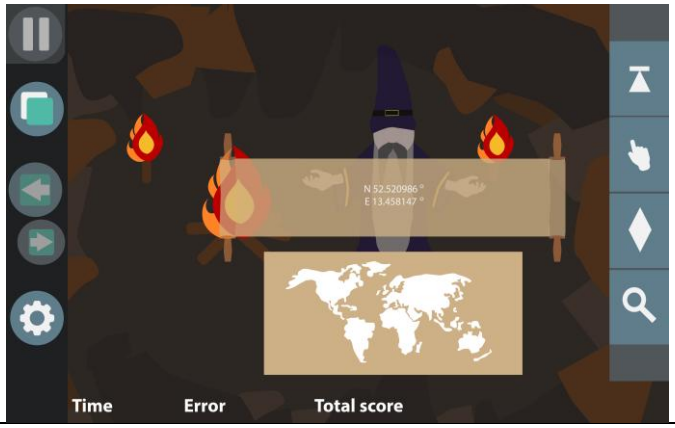
NAME	**KEYBOARD INSTRUCTION**
RELATED TRAINING TASK	Keyboard elements

DESIGN PROBLEM (what)	A tutorial on the keyboard elements.
CONTEXT (USE WHEN…)	Related usage scenarios: UC 3 (intermediate tasks) Related requirements: • System provides task instructions in a clear manner; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills.
DESIGN SOLUTIONS (HOW)	• The tutorial is based on the observational learning; that is demonstration of the keyboard elements. Thus, the user can observe the function of the various keyboard elements. • After the tutorial, the user is presented with the first multiple choice question. • The user focuses on the T to open the keyboard, so as to type the answer.
DESIGN RATIONALE (WHY)	User learns by observation. This is a powerful learning method which also increases the user's performance and the outcome expectations. Such behavior modelling also helps retention.
VISUAL EXAMPLES	
PSYCHOLOGICAL MECHANISMS	Self-efficacy, outcome expectation, retention, vicarious reinforcement,
EXAMPLE MOCK-UP	

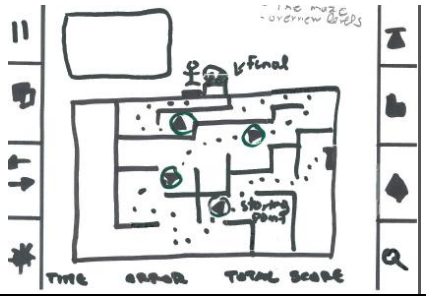
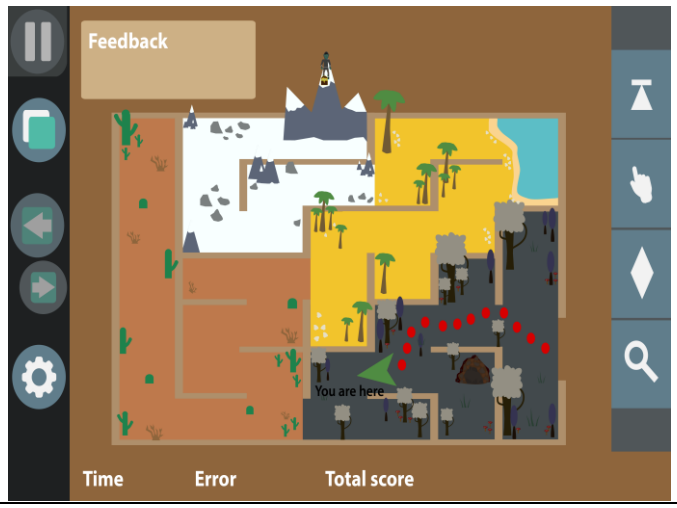
NAME	PAPUROUS WITH ANSWER
RELATED TRAINING TASK	Keyboard
DESIGN PROBLEM (what)	User views the outcome of his typing performance.
CONTEXT (USE WHEN…)	• System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System shows how a user is doing on a number of clear and quantifiable criteria; • System encourages or discourages user's behavior with the use of praises or rewards; • System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides suggestion for carrying out tasks during the system use process.
DESIGN SOLUTIONS (HOW)	• The user views a page with the typed word. There is either a positive sign if the answer is correct (i.e., a green ✓) or a negative sign if the answer is wrong (a red ✖). • If the answer is correct the user goes to the next question, where he/she follows the same procedure (use the zoom, focus on T, type, and submit). If the answer is wrong or mistyped, the user has to replay. • A diagram of the question structure (updated based on the user progress) and scoreboards are visible to the user.
DESIGN RATIONALE (WHY)	• Signs of performance, question representation and score bars provide the user with an immediate feedback. • Praises increase the motivation and self-efficacy of the user and increase feelings of success. • Encouragement is provided in case of mistyping or wrong answer, to decrease the chances of frustration. • The user is always provided with another question until he/she successfully completes the task.
VISUAL EXAMPLES	

PSYCHOLOGICAL MECHANISMS	Praise, self-monitoring, encouragement, playfulness, competence, goal-setting
EXAMPLE MOCK-UP	

NAME	**TREASURE MAP AND COORDINATES**
RELATED TRAINING TASK	Select Copy-paste function
DESIGN PROBLEM (what)	User learns to select and to copy/paste using gaze
CONTEXT (USE WHEN…)	Related usage scenarios: UC 3 (intermediate tasks) <u>Related requirements:</u> • System provides challenging, attainable assignments with clear short-term and long-term goals; • System encourages or discourages user's behavior with the use of praises or rewards; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System shows how a user is doing on a number of clear and quantifiable criteria.
DESIGN SOLUTIONS (HOW)	• The wizard congratulates the user for his success on the quiz task and offers him both a map and the coordinates of the treasure location, as a reward. • However, the wizard asks for one last task: the user has to select and then copy and paste the coordinates onto the map. • Scoreboards are always visible to the user.
DESIGN RATIONALE (WHY)	• User learns how to select- and copy-paste and gets immediate extrinsic reward (the location on the map).

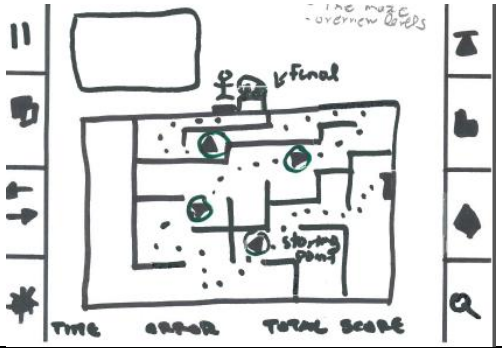
VISUAL EXAMPLES	
PSYCHOLOGICAL MECHANISMS	Extrinsic motivation (reward), praise, self-monitoring
EXAMPLE MOCK-UP	

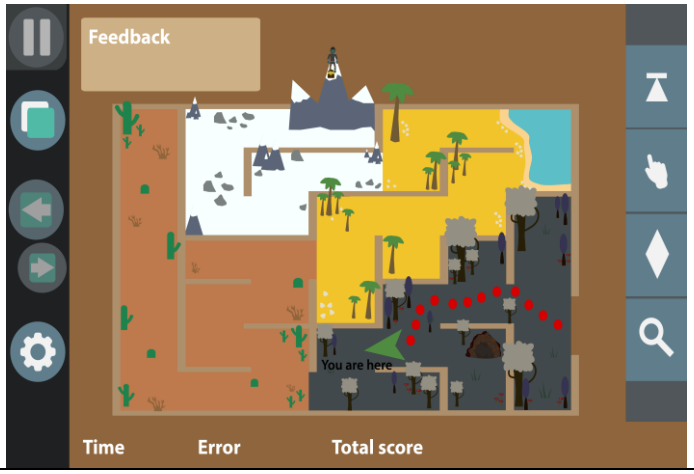
NAME	**THE MAZE**
TASK DESCRIPTION	Conclusion of the second assignment and Introduction to the third assignment (advanced tasks).
DESIGN PROBLEM (what)	The user receives the reward of the second assignment (journey map), which will be the starting point of the third assignment.
CONTEXT (use when…)	Related usage scenarios: UC 3 (intermediate tasks) <u>Related requirements:</u> 1. System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides assignments and levels which increase gradually in difficulty, following the training tasks; • System provides positive, evaluative feedback of user's performance • System shows users' status, progress and achievements; • System provides a coherent and structured gameplay among the various levels and assignments; • System provides assignments and levels which increase gradually in difficulty, following the training tasks.

DESIGN SOLUTIONS (how)	• There is a journey map that shows the user the path that has to travel so as to reach his end-goal. • User receive positive feedback.
DESIGN RATIONALE (why)	• Feedback helps user to feel successful and competent. User learns how to copy-paste and gets immediate extrinsic reward (the location on the map). • Introduction to a new task
EXAMPLES (as seen on…)	
RELATED PATTERNS	Extrinsic motivation, Intrinsic motivation, feedback
EXAMPLE MOCK-UP	

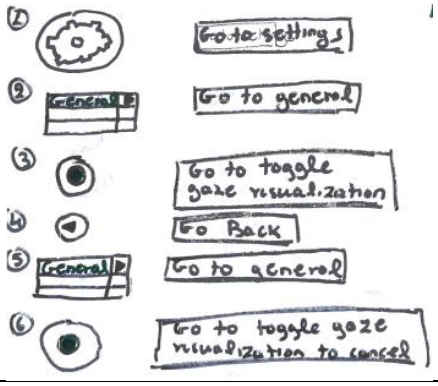
Mock-up design patterns for advanced tasks

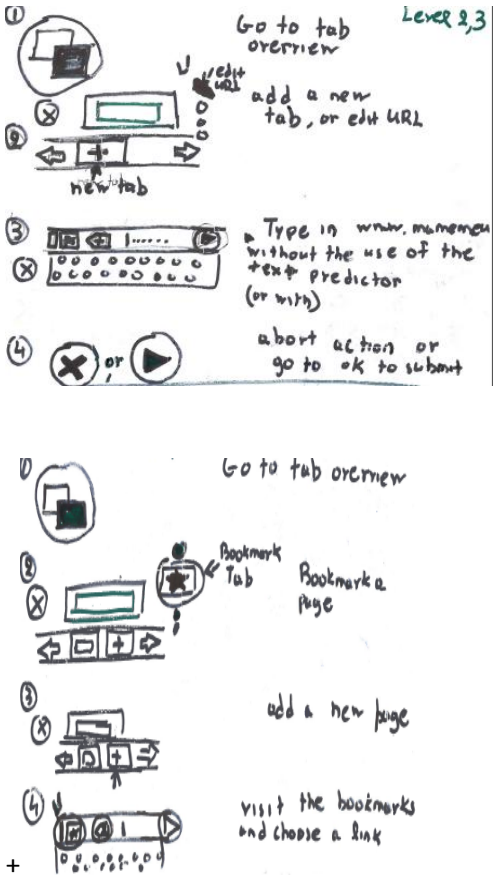
NAME	LEVEL OVERVIEW
RELATED TRAINING TASK	Advanced training tasks
DESIGN PROBLEM (what)	User is introduced to a new final assignment.

CONTEXT (USE WHEN…)	Usage scenarios: Use case 4 Use it as the first page of the third assignment. <u>Related requirements:</u> • System shows users' status, progress and achievements; • System provides a coherent and structured gameplay among the various levels and assignments; • System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides assignments and levels which increase gradually in difficulty, following the training tasks; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • Provide opportunities for the training tasks to be fun.
DESIGN SOLUTIONS (HOW)	• This page introduces the user to the gameplay of the last assignment. • The system briefly explains the gameplay (i.e., "you have to do some tasks that will bring you closer to the end-goal"). • The user is presented with his/her current location and with the journey to be traveled before he reaches his/her end-goal (treasure). • Both the user location on the map (starting point) and the location of the villain with the treasure (end-goal) are illustrated.
DESIGN RATIONALE (WHY)	• The training tasks do not have any specific end goal per se other that making the user familiar with the functionalities of the gaze-based UI. Such a form of a gameplay provides participants with both short-and long-term goals.
EXAMPLE SCHETCHES	
PSYCHOLOGICAL MECHANISMS	Goal-setting, knowledge, playfulness

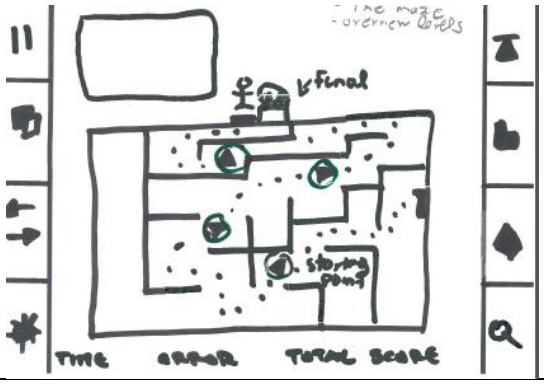
EXAMPLE MOCK-UP	

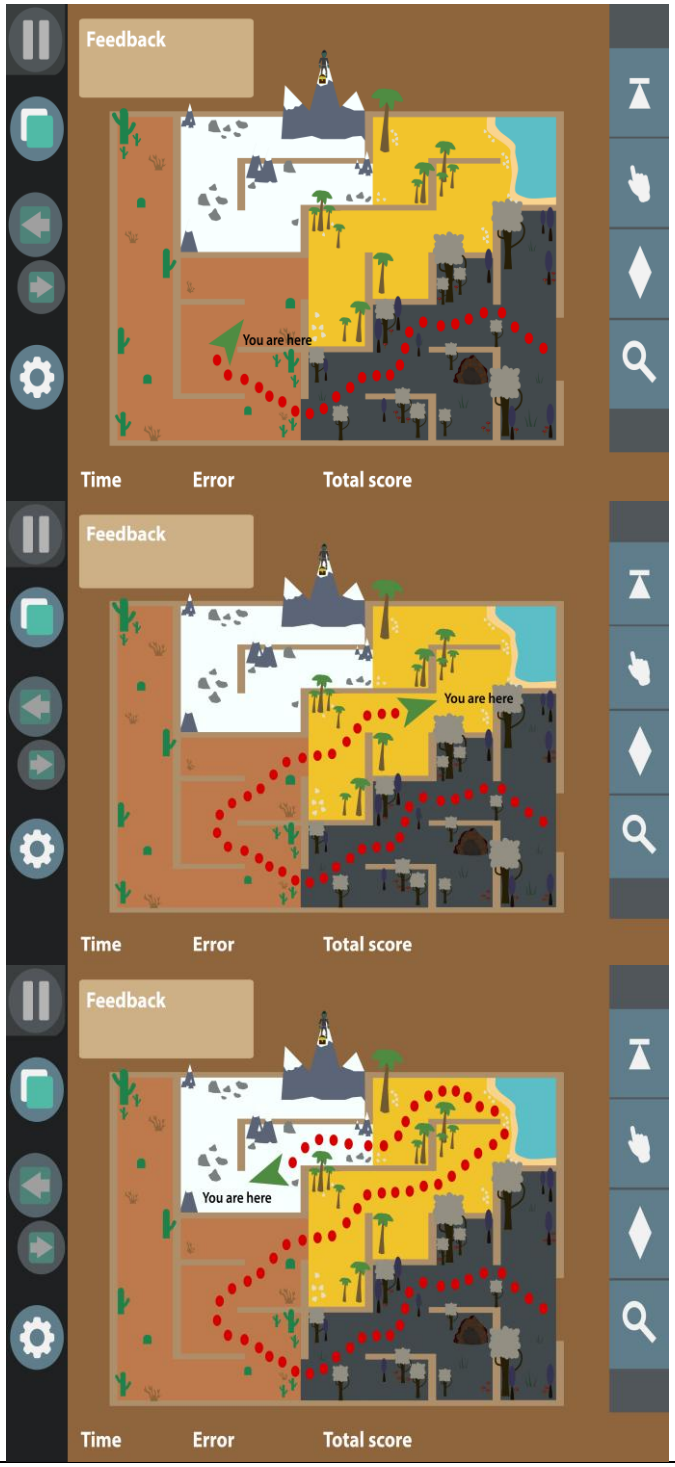
NAME	**LEVEL TUTORIALS (1,2,3,4)**
RELATED TRAINING TASK	Advanced training tasks: Level 1: 1. Go to the setting button 2. Go to the general menu 3. Change the gaze visualization to Toggle Gaze visualization 4. Go back 5. Go to the general menu 6. Cancel the Toggle Gaze visualization Level 2: 1. Go to tab overview 2. Add a new tab 3. Type in www.mamem.eu not making use of the text predictor 4. Abort action Level 3: 1. Go to tab overview 2. Edit URL 3. Type in www.mamem.eu making use of the text predictor 4. submit (ok) Level 4: 1. Go to tab overview 2. Bookmark the page 3. Add a new tab 4. Visit the bookmark manager 5. Visit a bookmark of choose

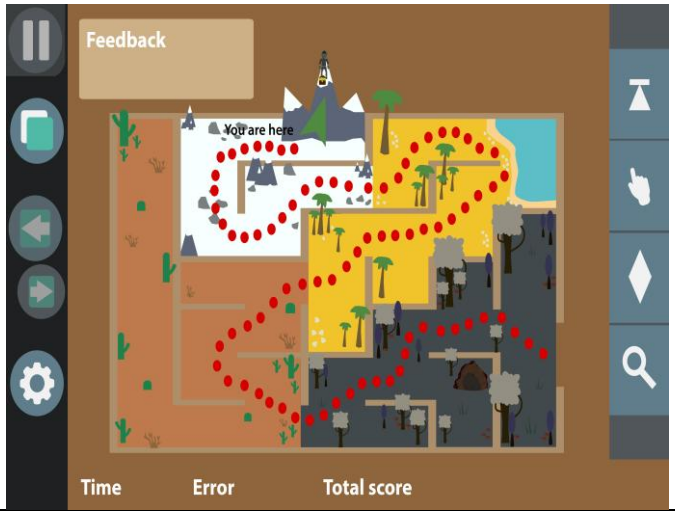
DESIGN PROBLEM (what)	User needs to know the steps of the tasks to be performed. User has be able to view these steps again in case he/she forget them.
CONTEXT (USE WHEN…)	Usage scenarios: Use case 4 Use it after each level overview and before the next level begins. <u>Related requirements:</u> • System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides assignments and levels which increase gradually in difficulty, following the training tasks; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • System provides task instructions in a clear manner; • System shows how a user is doing on a number of clear and quantifiable criteria.
DESIGN SOLUTIONS (HOW)	• Each of the 4 tutorials are presented separately and just before the user is about to perform them. • The tutorials will be in a form of an illustrated manual (specific steps in an arithmetical order, accompanied by photo-instructions). The instructive text should be restricted to as few words as possible (i.e., eight word limit per page). • User must have the option to view the page again in case he/she forgets the steps. • Information on how the user gains points is shown.
DESIGN RATIONALE (WHY)	• Illustrated steps help the user's retention and task understanding. • The words should be limited because otherwise the user can be overwhelmed or confused by the information. • The user must have a clear insight on the points he/she earns of performing each level.
EXAMPLE SCHETCHES	

	
PSYCHOLOGICAL MECHANISMS	Knowledge, competence

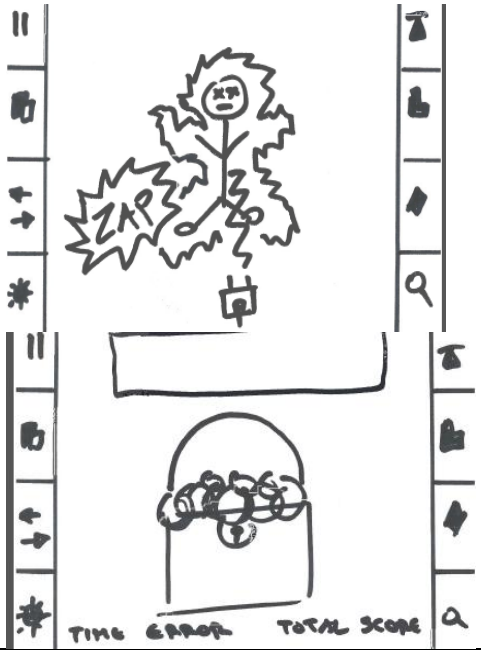
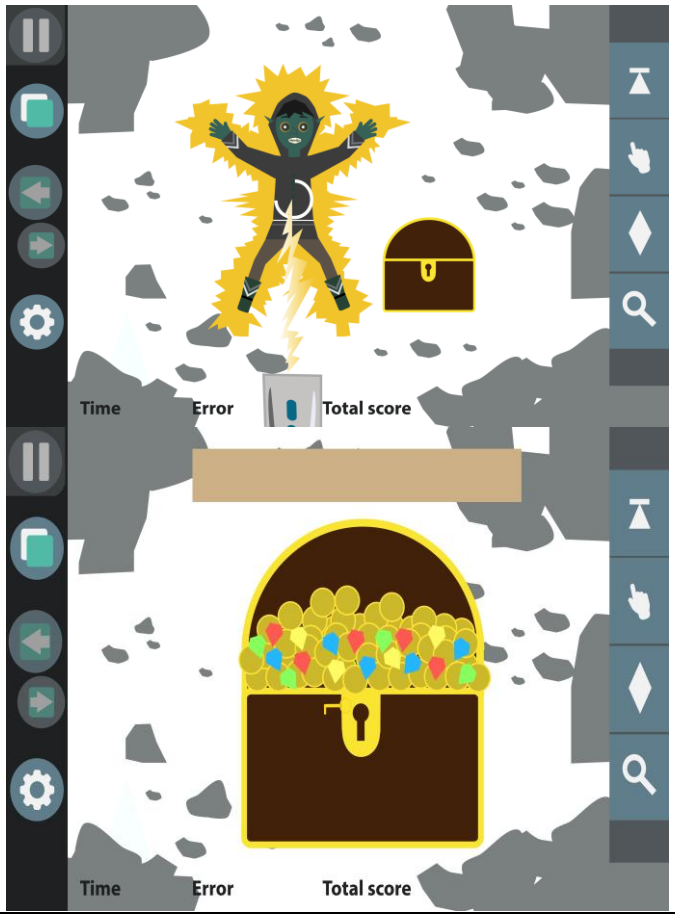
NAME	**OVERVIEW OF LEVELS 1,2,3,4**
RELATED TRAINING TASK	Advanced training tasks
DESIGN PROBLEM (what)	System provides the user with goals by placing the 4 levels within a game context.
CONTEXT (USE WHEN…)	Related cases: Use case 4 Use after the completion of each level. <u>Related requirements:</u> • System shows users' status, progress and achievements; • System shows how a user is doing on a number of clear and quantifiable criteria; • System provides positive, evaluative feedback of user's performance • System provides a coherent and structured gameplay among the

	various levels and assignments; • System provides challenging, attainable assignments with clear short-term and long-term goals; • System provides assignments and levels which increase gradually in difficulty, following the training tasks; • System provides opportunities for the user to learn functionalities of the system and develops competences and skills; • Provide opportunities for the training tasks to be fun.
DESIGN SOLUTIONS (HOW)	• Every time that the user finishes a level, the journey map appears showing how close he/she gets to the end goal. • Feedback on performance is also provided to encourage user to continue playing. • The levels that the user has to perform increase in difficulty and follow the training tasks already defined.
DESIGN RATIONALE (WHY)	• The training tasks do not have any specific end goal per se, other than making the user familiar with the gaze-based UI. The gameplay with the journey map provides participants with both short-and long-term goals. • Receiving feedback and showing scores for performing each level increases the motivation and informs the user of his/her performance.
EXAMPLE SCHETCHES	
PSYCHOLOGICAL MECHANISMS	Goal-setting, feedback, playfulness, competence, knowledge,

EXAMPLE MOCK-UP	

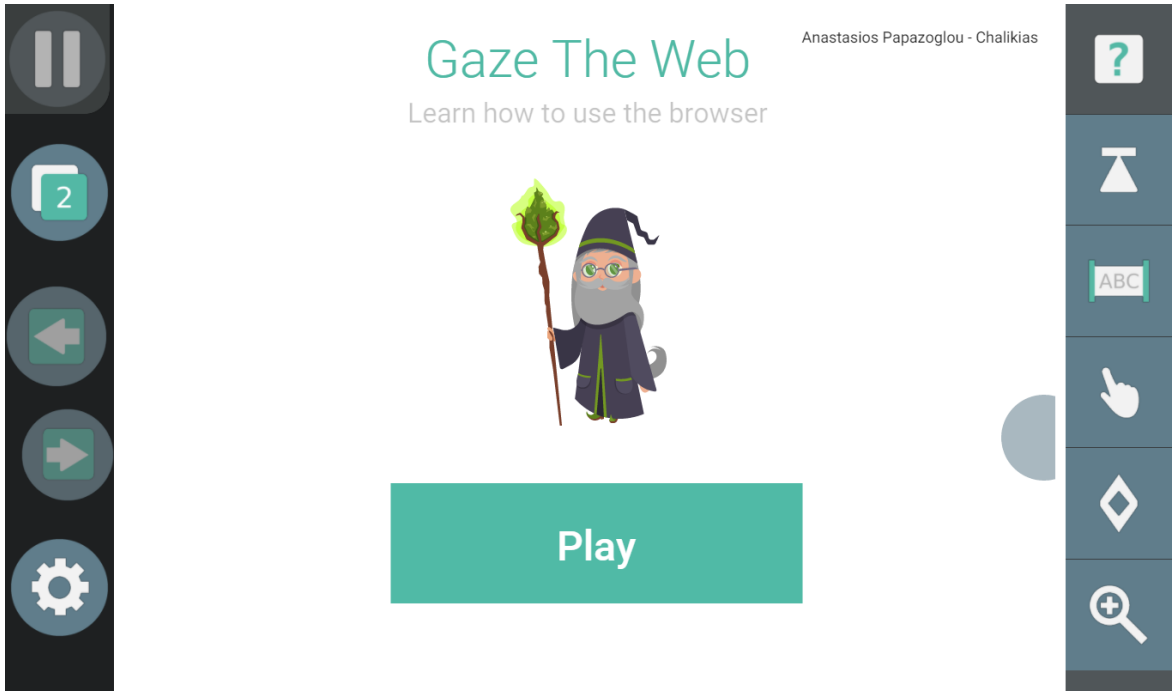
	

NAME	WINNING TREASURE
RELATED TRAINING TASK	Focus on a location Emulation button
DESIGN PROBLEM (what)	The user successfully finishes the game and reaches the end-goal.
CONTEXT (USE WHEN…)	Use at the end of the advanced training tasks. Related requirements: • System encourages or discourages user's behavior with the use of praises or rewards; • System provides challenging, attainable assignments with clear short-term and long-term goals.
DESIGN SOLUTIONS (HOW)	• The user focuses on the target (villain). The user uses the emulation button to open the treasure. • The system congratulates the user for his/her success.
DESIGN RATIONALE (WHY)	The user feels successful on completing the mission.

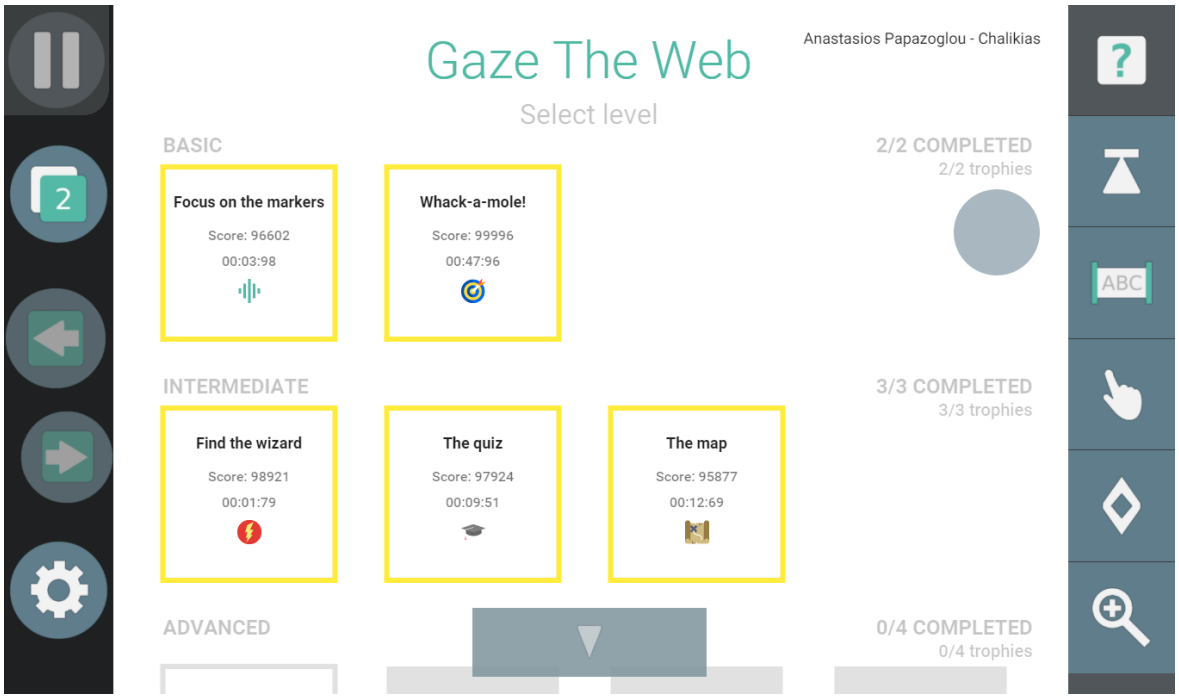
EXAMPLE SCHETCHES	
PSYCHOLOGICAL MECHANISMS	Praise, end-goal, competence, feedback
EXAMPLE MOCK-UP	

Appendix B. Screenshots from the Implemented Prototype

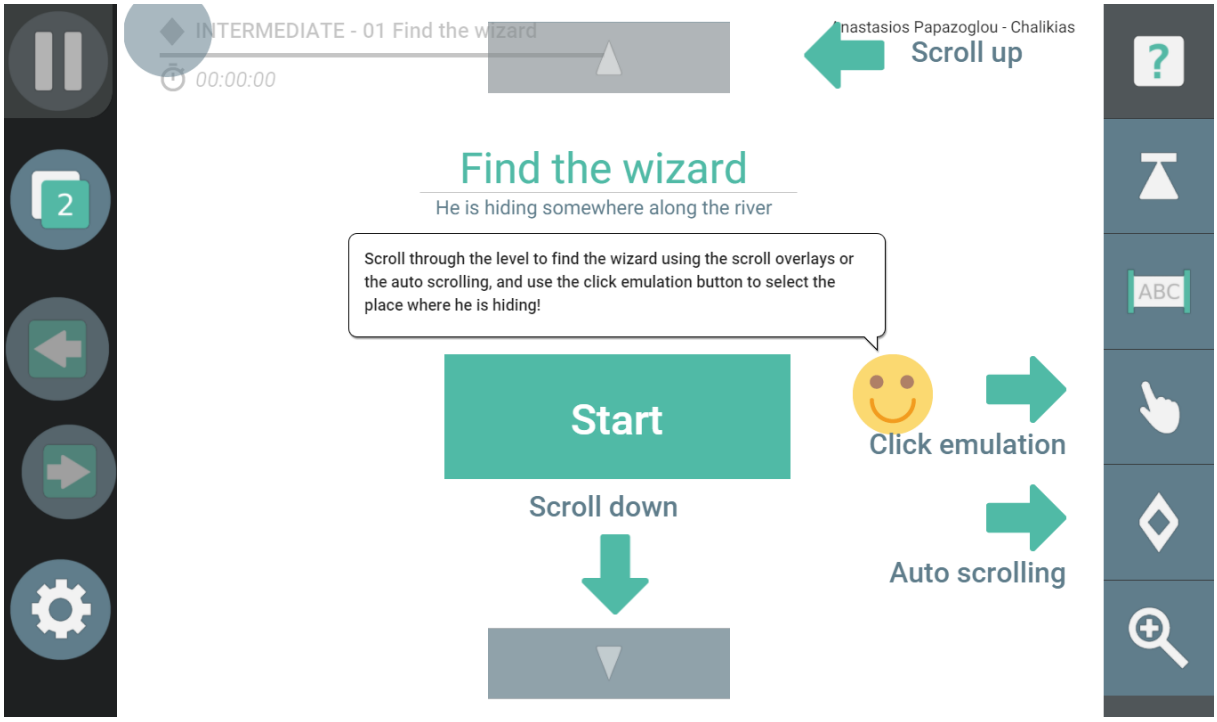
The demo of the implemented prototype can be accessed in http://augreal.mklab.iti.gr/mamem/. Important to note that some of its functionalities can only be tested through the GazeTheWeb framework.



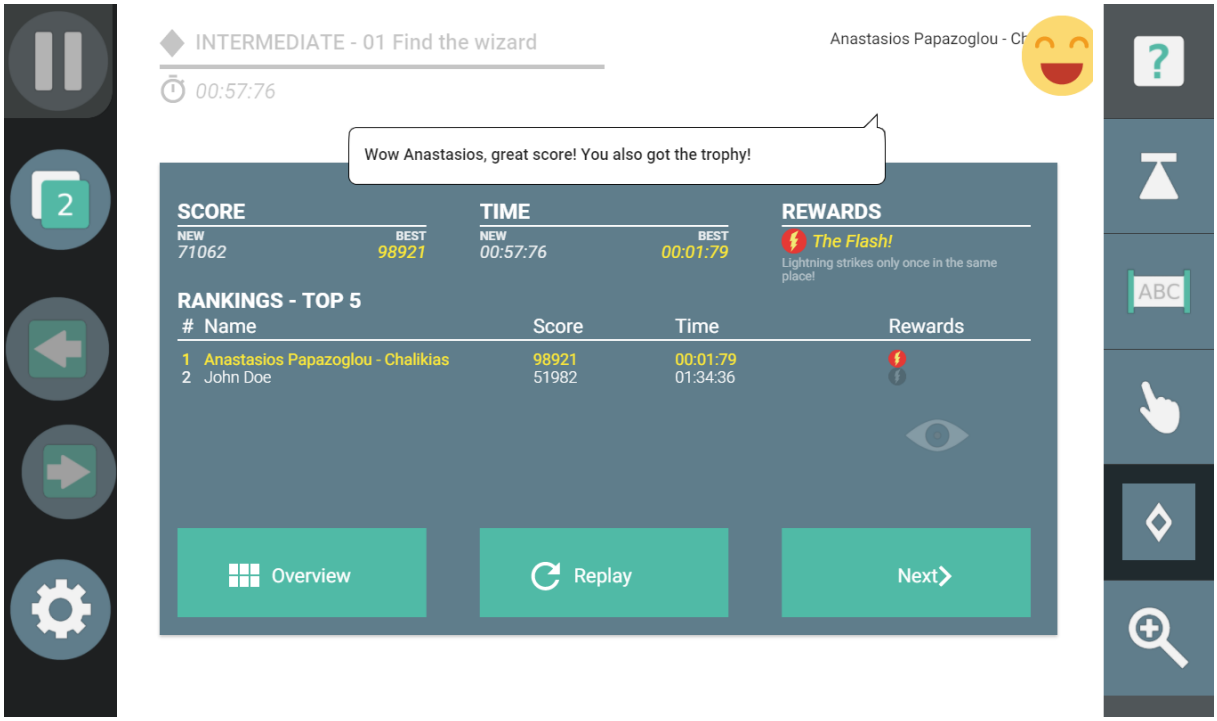
B.1 Splash screen



B.2 Overview page

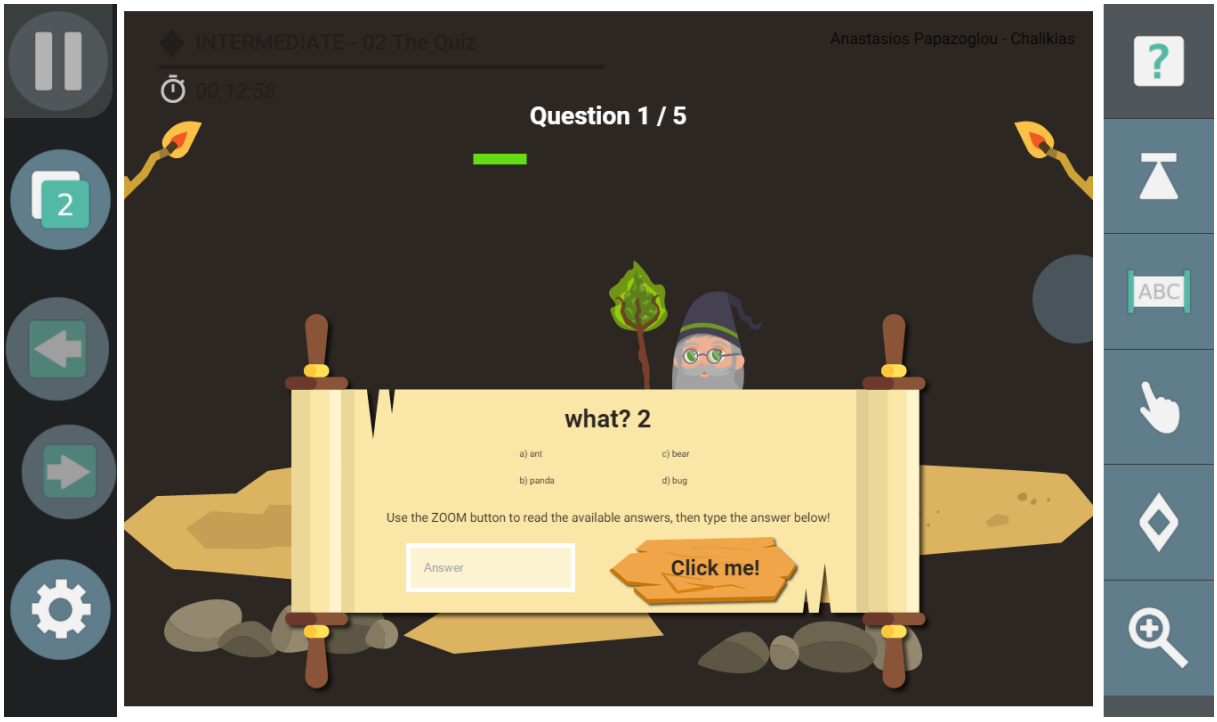


B.3 Level intro & tutorial

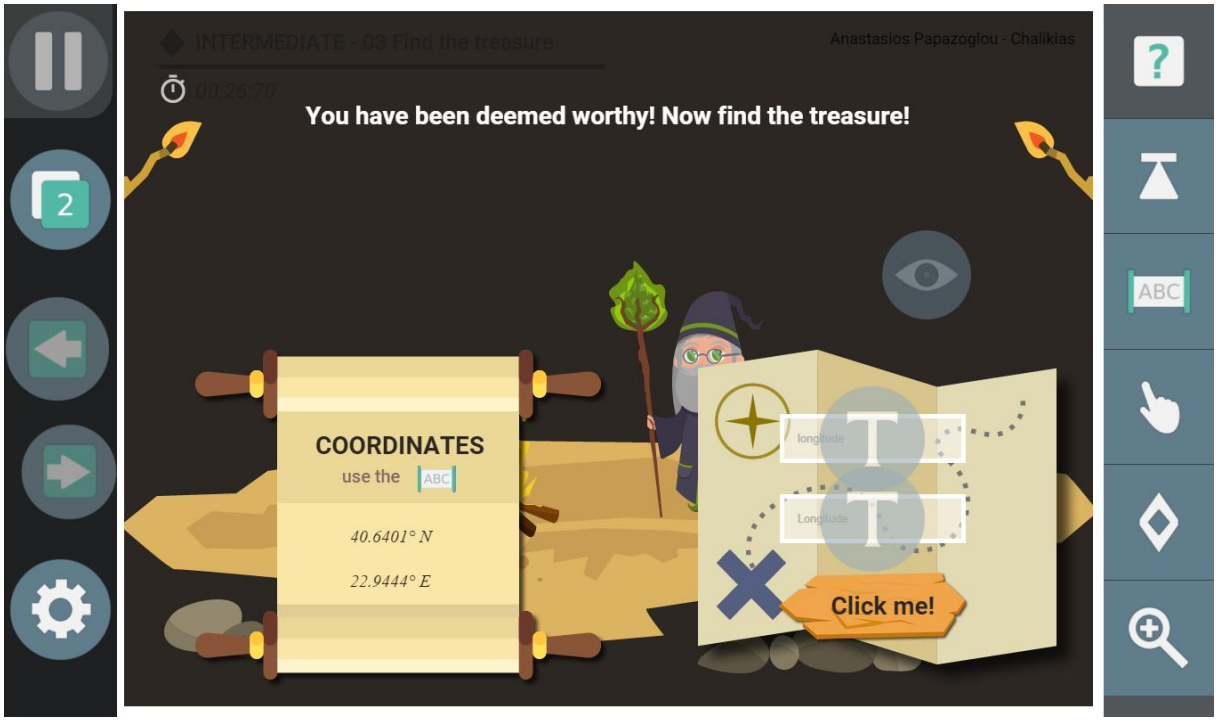


B.4 Results page & Rankings

B.5 'The search' level



B.6 'The Quiz' level



B.7 'The map' level

Appendix C. Behaviour change objective matrices

C.1 Behavioral objective: User acceptance and training of MAMEM System (taken from D5.1)

	Internal and external determinants									
	Performance expectancy			Effort expectancy		Social influence		Facilitating conditions		
Performance objectives	A. Perceived usefulness	B. Relative advantage	C. Outcome expectations	D. Perceived ease of use	E. Complexity	F. Subjective norm	G. Image	H. Perceived behavioural control	I. Facilitating conditions	J. Compatibility
1.Understanding the concept of MAMEM of multimedia management/sharing and authoring using your eyes and mind			Know what is meant with operating the system with eye and mind Correct false beliefs (ie. Fear of radiation)	identify the degree of effort required in being able to use the system						Identify the MAMEM compatibility (i.e. compatible applications)
2. Experiencing the benefits of MAMEM of multimedia		recognize the benefits of using								Experience a sense of privacy and independe

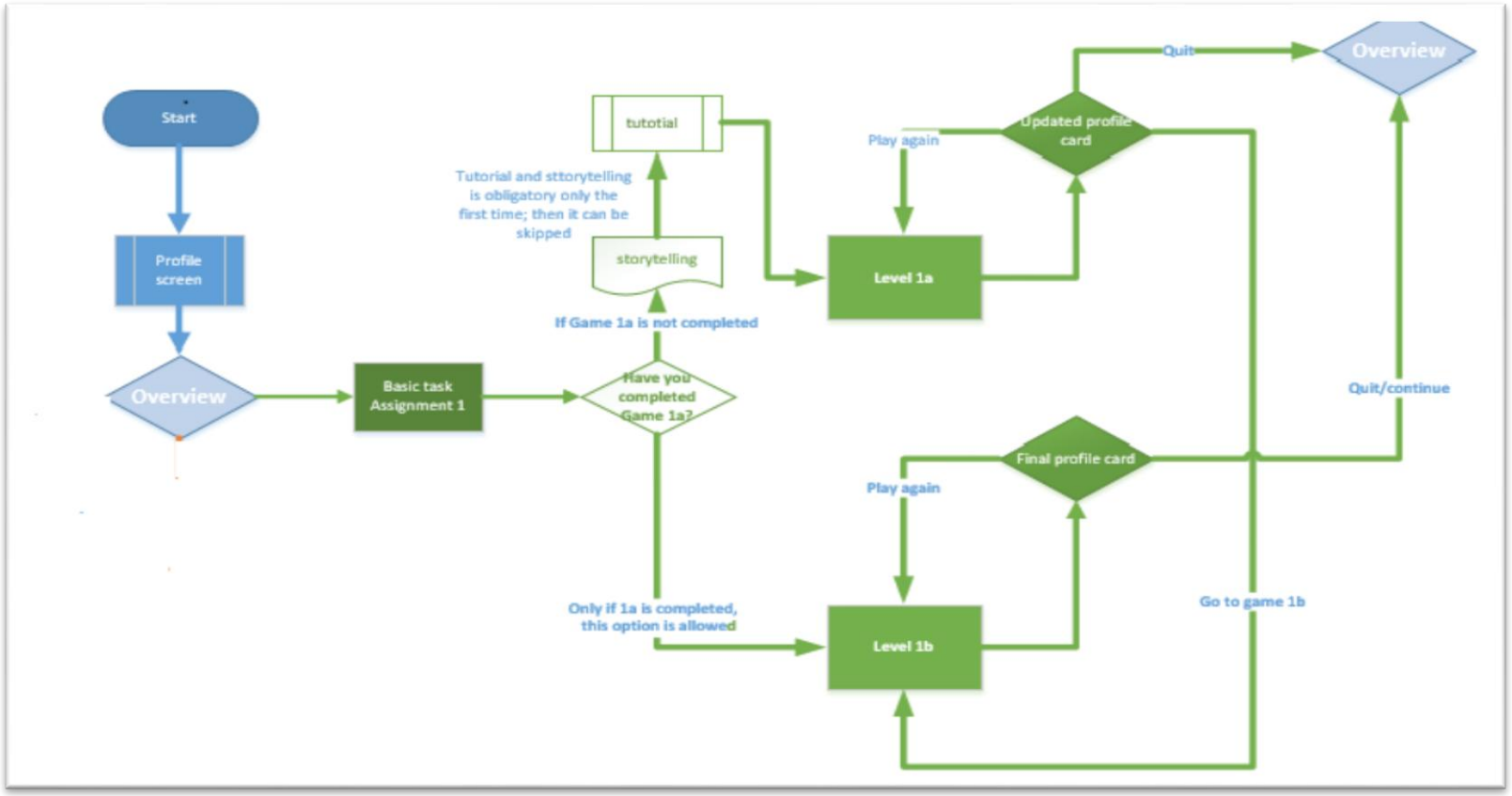
management/sharing and authoring using your eyes and mind		MAMEM								nce in computer operation
3. Performing the training and dictated task according to the objectives given			expect that engaging in training will contribute to more effective operation and to more opportunities for social inclusion	Feel that it is easy to become skilful at using the system Feel that the training is fun	perceives the training program's steps/objectives as clear and easy to understand	Recognize the need to operate a computer		Demonstrate ability to monitor and perform the training tasks, up to time and error standards	Knows who to contact for assistance in case of system difficulty Feels that specialised instruction concerning the system was available Trusts that important others show their support in using the system	
4. Creating				Demonstrate	Know how to		Have a	Feel		

realistic operation goals and setting personal targets related to these goals;				ability to state easy goals and targets	state realistic goals and tasks		plan on how to overcome the barriers and improve skills	confident that one can make a change in regard to operation goals		
5. Appling solutions for (un)satisfactory multimedia management, authoring and sharing					Practise skills to skills to overcome barriers			Feel confident that one can operate the system		
6. Evaluating the effect of solutions on multimedia operation and achievement of goals and personal targets (i.e., compared								Ask for positive reinforcement on system operation successes		

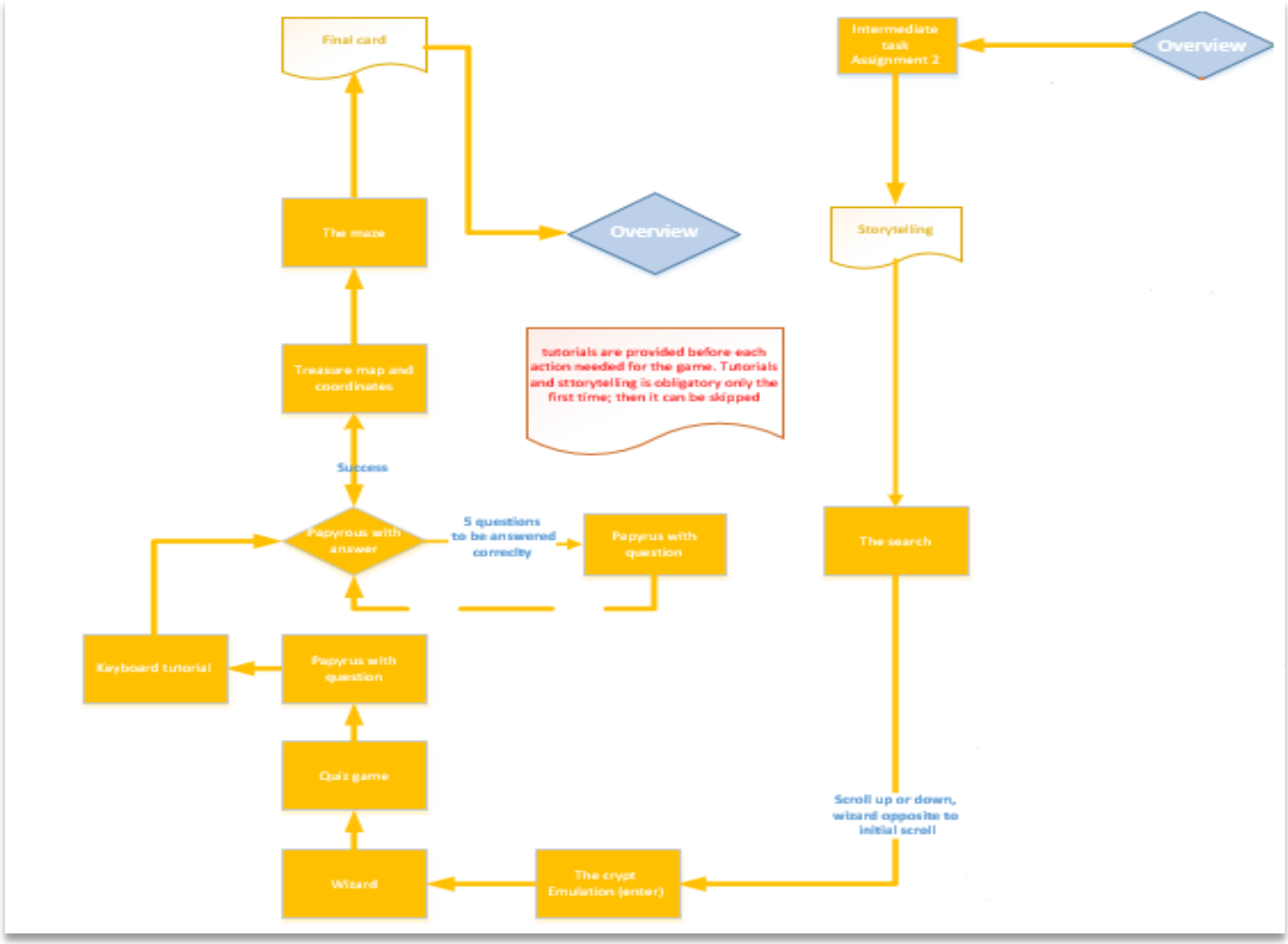
to what was planned)										
7. Comparing own behaviours with previous own performance or those of other users;						Comparing performance level with what other users do (healthy or patients)		Experience personal relevance in performance levels with what most users do	communicate with similar users about the system operation	
8. Identifying and overcoming barriers					Demonstrate ability to revise targets or setting new ones			Be able to identify barriers in own performance and demonstrate how to overcome them		
9. Maintaining progress in MAMEM multimedia management/authoring and sharing.								Be able to persist in operating the system and maintaining its use		

Appendix D. Flow chart of training tasks

D.1 Flow chart of the basic tasks



D.2 Flow chart of the intermediate tasks



D.3 Flow chart of the advanced task