D4.1 First Version of Human-Computer Interface

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Executive Summary

The SL-ReDu project aims to advance the state-of-the-art in the automatic recognition of Greek Sign Language (GSL) from videos, while focusing on the education use-case of standardized teaching of GSL as a second language. In this deliverable (D4.1), we present the first version of the SL-ReDu human-computer interface (HCI) as currently designed to be incorporated in the first version of the SL-ReDu system in WP5. The design accommodates the language material of WP3 and involves appropriate dialog management strategies, exploiting text, icons, video, or synthetic signing for interacting with the platform users. The deliverable is part of the second project milestone (MS2), and it will be updated as D4.2 corresponding to the second version of the SL-ReDu HCI.

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1 Introduction

Designing an interactive human-computer interface (HCI) for language learning, exercising, and testing represents a relatively recent trend in the sign language (SL) literature [1-3]. Compared to traditional spoken languages, the task faces additional methodological and technical challenges for SLs [4-7]. For example, self-monitoring and testing in SL as L2 require exploitation of video and image streams to build interfaces for both passive and productive language exercising. In addition, while creation of exercises to test comprehension and understanding of language elements is a relatively well-implemented task, active learner participation in SL performance introduces a completely innovative aspect in SL learning. To accomplish this task, the learners are required to create and upload their own videos of linguistic performance and provide consent to have these videos feed an SL recognition engine.

Based on earlier SL-ReDu deliverable D3.2 of WP3 [8], the design of the platform interface for the project has opted for a user-friendly and straightforward environment. The goal is to provide a platform that incorporates easy-to-use user-centric functionalities and user-supporting features, which can be run by the student equipped with a suitable computer and camera. From the educational content point-of-view, the self-monitoring and assessment modules of the platform need to incorporate the complete curriculum of L2 A0-A1. This means that, in line with the design of the platform system architecture that has been discussed in deliverable D5.2 of WP5 [9], all user interaction patterns need to be taken into account to effectively accommodate the educational content. The variation in user interaction patterns is also necessary when the tutor is setting together a new test, since the latter needs to be drawn from a large pool of available candidate exercises, in line with the accredited SL curriculum, as suggested by the Common European Framework for Languages [10]. The aim is to design a platform interface to address the needs of a large population of students objectively and accurately [11].

Deliverable D4.1 reports on the first phase of our work on Tasks T4.1 and T4.2 of WP4 of the SL-ReDu project, which combine the design of the HCI with the various interaction modes which are required to successfully perform the self-monitoring and assessment tasks in the SL-ReDu platform. D4.1 exhibits how the first version of the platform will incorporate the educational content to be tested during the first user evaluation, as defined in the project Technical Annex. In parallel, it provides a showcase of incorporating in the HCI design various insights on theory presentation principles, self-monitoring, and objective evaluation characteristics. It further demonstrates how HCI can be fed by linguistic modelling and incorporate the project recognition module communication procedures in a user-friendly manner.

For the design of the self-monitoring module, the exercising layout is such that supports the learners to improve their linguistic skills through interactive exercises in an attractive and structured way. The layout is designed to be plain for optimal concentration on the visual learning material. Use of icons, video, and synthetic signing are extensively utilized, while text is minimal in all other activities but fingerspelling, where it is required by nature. A similar approach is followed for the assessment module design, incorporating a set of pedagogically approved features which differentiate the state of learning from the state of testing.

2 The Designed Interface

As defined in D5.2 [9], which reports on technical specifications and system architecture, the SL-ReDu platform will be hosted by an Apache Web Server. A MySQL database will be used to store all educational material and exercises, as well as user progress and performance statistics, based on information exchanged between the user and the web server in order to complete the assignments. The web application is designed to incorporate a camera module to record user performance whenever required, with the submitted user recordings sent to the SL-ReDu recognition module.

In the sections that follow, indicative screenshots exhibit the adopted HCI approach to the first version of the SL-ReDu system implementation. The aim is to illustrate user account setup, educational content presentation, self-monitoring capability of the learner, and the objective evaluation (testing) options offered by the platform, as currently designed.

2.1 Initial Web-Based HCI Page

The landing page of the SL-ReDu platform is depicted in Figure 1. The "About" menu item hosts useful information about the project, while at the current stage two more menu items have been created. The "Self-Monitoring" menu contains the presentation of educational content including theory, consolidation and exercises, while the "Testing" menu provides different tests for learners to facilitate their objective evaluation. Different exercise types have been designed to fulfill the SL as L2 educational tasks, most importantly incorporating GSL recognition of live learners' performance, wherever required.

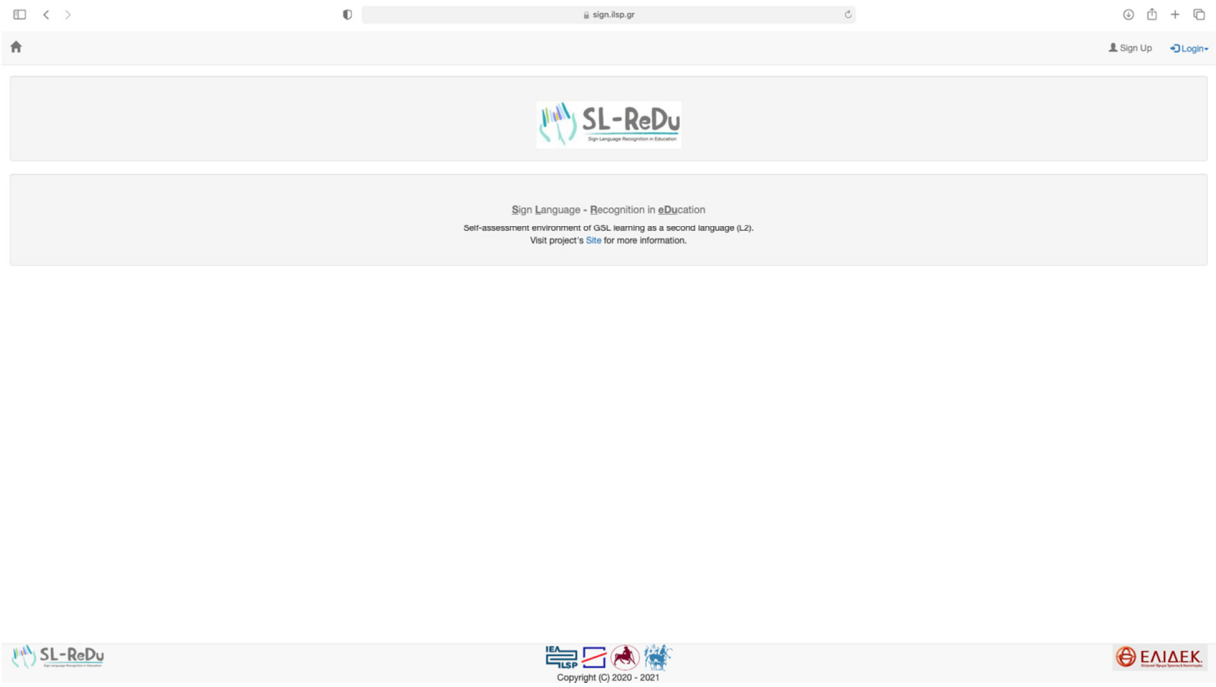

Figure 1: Landing web page of the designed SL-ReDu HCI.

2.2 User Accounts

Different types of users (instructors and learners) can either sign in (for the first time) or revisit by simply logging in, as shown in Figures 2 and 3, respectively.

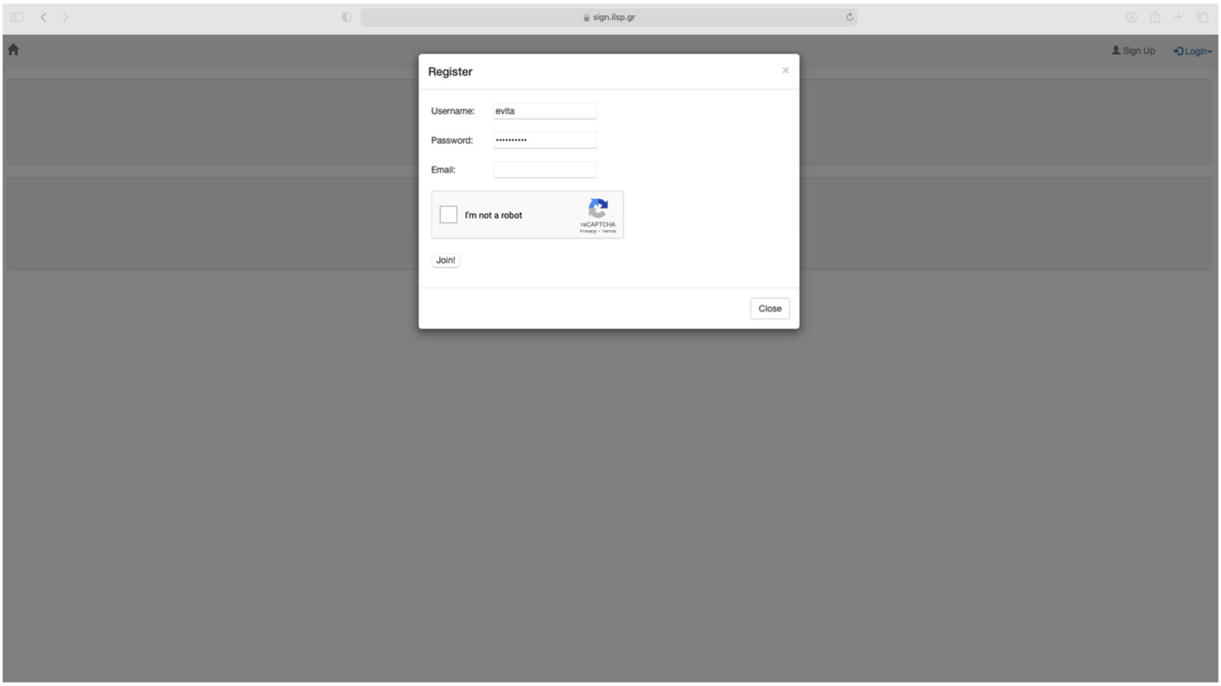

Figure 2: User registration.

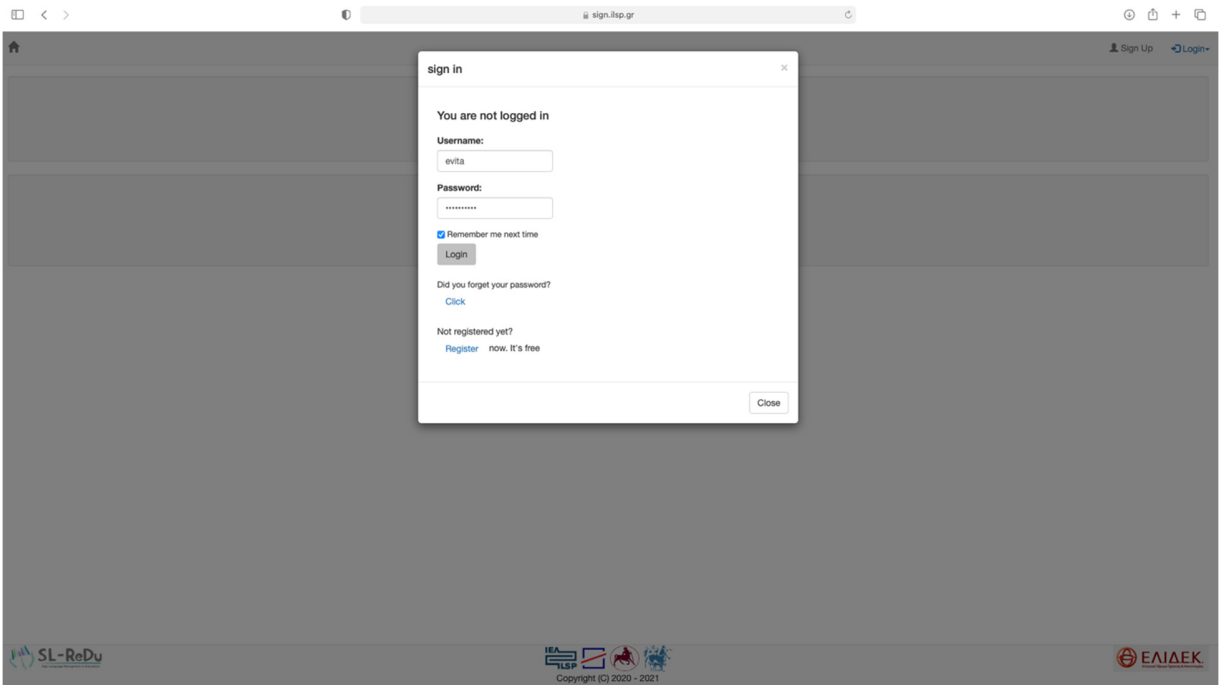

Figure 3: User log-in.

2.3 Content Presentation

The educational content of SL-ReDu, presented in deliverable D3.2 [8], is organized in a number of chapters to better facilitate the HCI design. The first chapter corresponds to the task of fingerspelling, and it is chosen in this deliverable as the showcase to illustrate the HCI design adopted by the project and its respective implementation potential. In the figures that follow (Figures 4-9), typical content presentation design screenshots are depicted for this chapter, showing the typical navigation through the specific educational material enabled by the HCI.

Figure 4: The landing page of the fingerspelling chapter (level 1).

Figure 5: The table of contents (level 2) for the case of the fingerspelling chapter, depicting the letter clusters and overall alphabet consolidation.

Figure 6: Educational sub-chapter content (level 3) for the case of fingerspelling, depicting clusters of letters that are phonologically similar.

Figure 7: Educational sub-chapter content organization (level 4) for the case of fingerspelling, showing menu choices for theory presentation, theory consolidation, and exercises, corresponding to a specific cluster of letters.

Figure 8: Example of one-to-one theory presentation of content material in the case of fingerspelling.

Figure 9: Theory consolidation example for the case of fingerspelling, presenting small groups of similar letters with their equivalent fingerspelling symbols.

2.4 Self-Monitoring

Within the self-monitoring module, the HCI allows the presentation of exercises, which the learner may repeat as many times as needed, in order to master the presented content. Such exercises are in the form of "passive"-type, multiple-choice, single-correct answer selection among a set of stimuli provided by the HCI in the form of text, icons, speech, video, or synthetic signing, as well as "active"-type exercises that require SL production by the learner, captured by a camera and fed to the SL recognition module to provide learner feedback. In Figures 10-15 that follow, typical HCI screenshots are depicted for the case of the fingerspelling task.

Figure 10: Multiple-choice, single-answer exercise in the fingerspelling chapter, concerning the selection of the correct letter in isolated fingerspelling among a set of similarly articulated letters. A static image of the manual articulation of the fingerspelled letter is provided as stimulus, while the multiple choices are shown in the form of static text images of similarly articulated letters. The HCI provides feedback in the form of a green check mark in case of a correct answer, or in the form of a red "x" mark if the learner answer is incorrect (all responses / feedback marks are shown here for better demonstration).

Figure 11: Multiple-choice, single-answer exercise in the fingerspelling chapter, concerning the selection of the correct word that corresponds to a continuous string of fingerspelled letters. The input stimulus is a signing avatar, while the multiple choices are shown in the form of static text images of words.

Figure 12: Multiple-choice, single-answer exercise in the fingerspelling chapter, concerning the selection of the correct initial letter among various words. A static image of the manual articulation of the fingerspelled letter is provided as stimulus, while the multiple choices are shown in the form of static icons depicting word meaning.

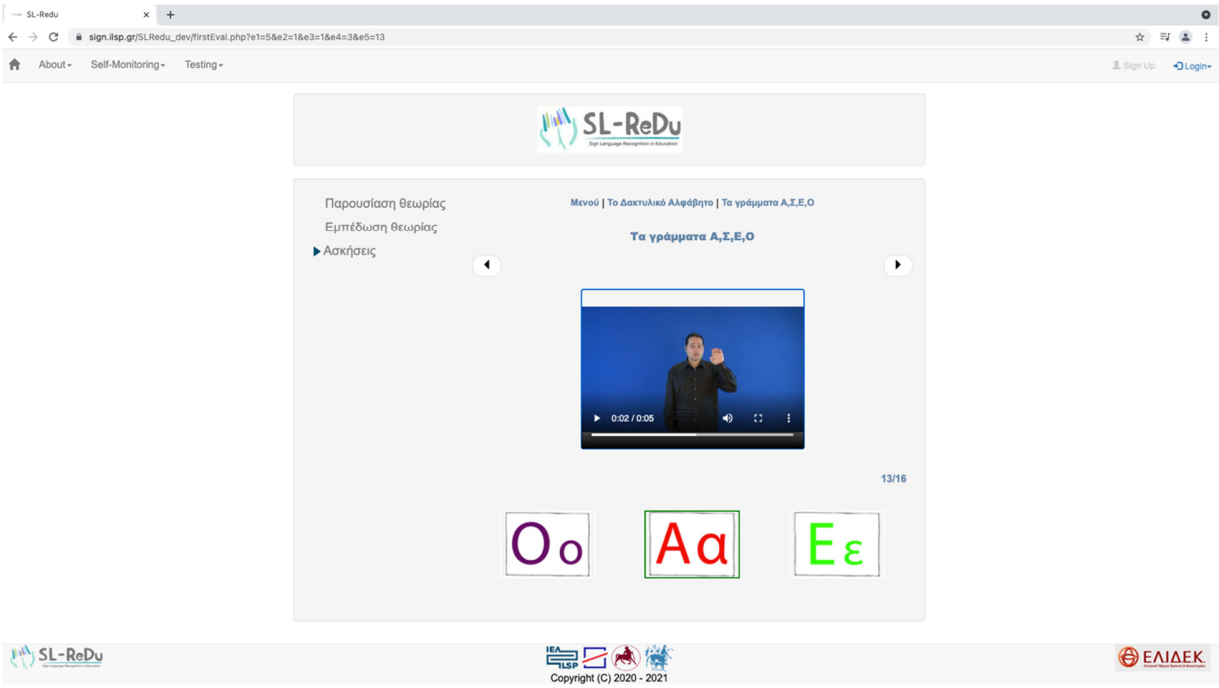

Figure 13: Multiple-choice, single-answer exercise in the fingerspelling chapter, concerning the selection of the correct letter in isolated fingerspelling among a set of letters. The input stimulus is a signing video, while the multiple choices are shown in the form of static text images of letters.

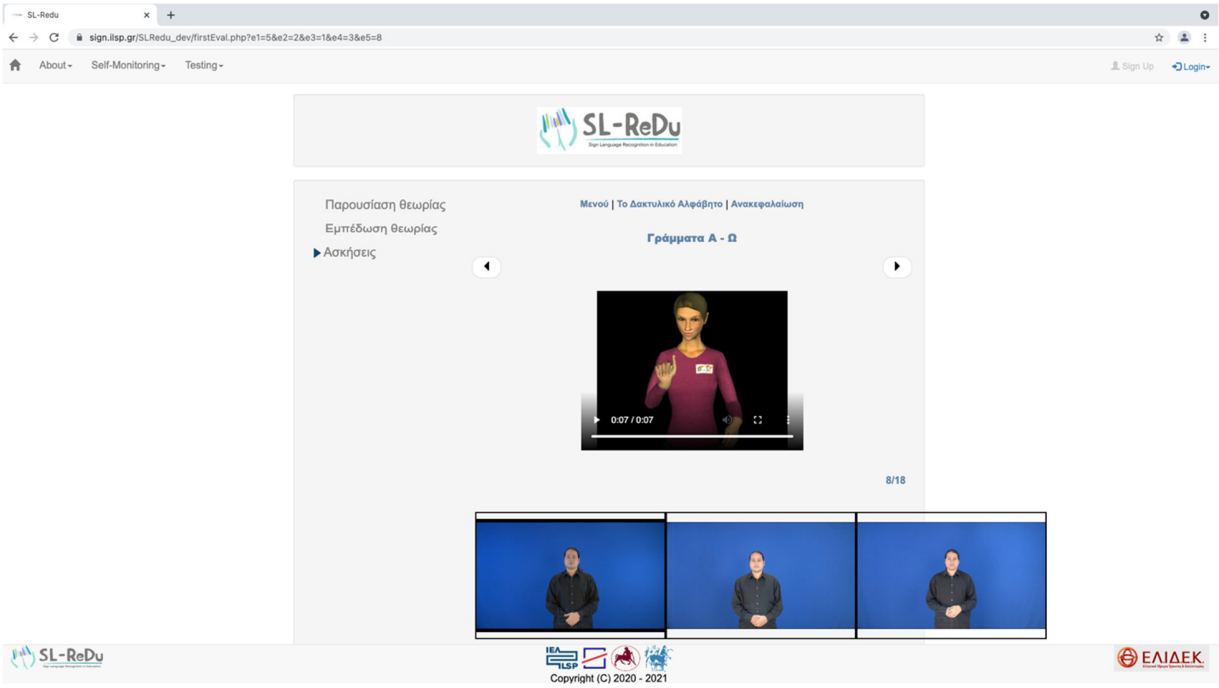

Figure 14: Multiple-choice, single-answer exercise in the fingerspelling chapter, concerning the matching of a continuously fingerspelled word (shown as a signing avatar stimulus) to the correct one among a set of videos of fingerspelled words produced by a native signer.

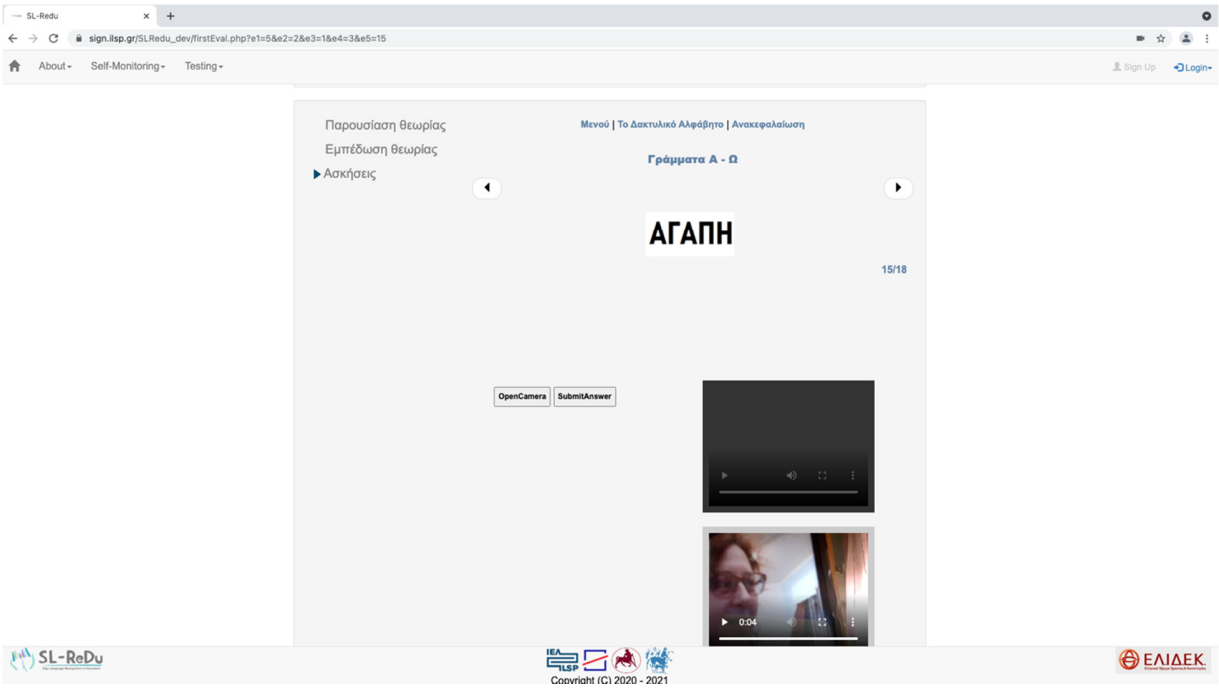

Figure 15: An active SL production exercise on continuous fingerspelling. The student is presented with a word (in the form of a text image) and is asked to fingerspell it within a pre-set time window. The HCI provides appropriate control buttons to allow recording, revising, and submitting the SL production to the SL-ReDu recognition engine.

2.5 Objective Evaluation

The objective evaluation module, in contrast to the self-monitoring one, is designed to allow a pre-defined by the instructor set of exercises. Such exercises are similar to the ones of the self-monitoring module discussed in Section 2.4, namely multiple-choice selection and SL production by the student. Further, time constraints are enforced for the completion of the module, as set by the instructor. The contribution of the various exercises to the overall score are also defined by the instructor, and the resulting grading of the learner is depicted by the HCI. All aforementioned information is entered in an Excel sheet of a specific format, as discussed in deliverable D5.2 [9], which is parsed to fill an appropriate database structure (see also Figures 16 and 17). Additional figures in this section (Figures 18-25) show typical screenshots of the objective evaluation HCI, depicted for the case of the fingerspelling task. Both multiple-choice (Figures 18-22) and SL production (Figures 23-25) exercise screenshots are depicted.

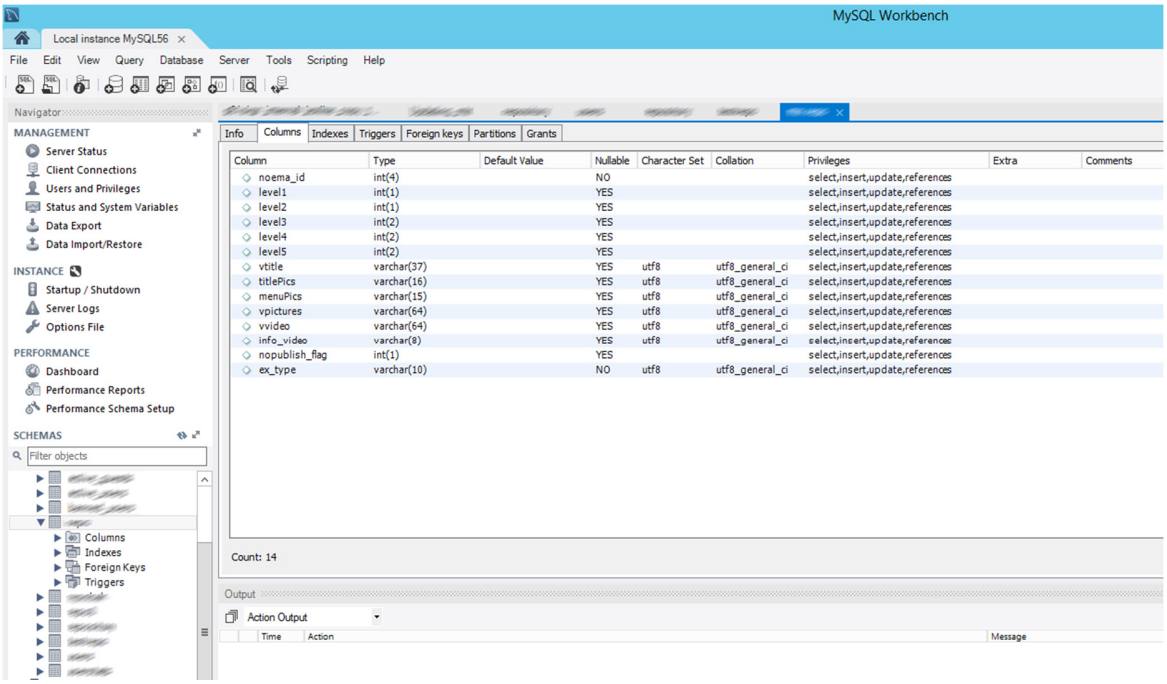

Figure 16: Structure of the objective evaluation exercises, as parsed in the database that guides the HCI.

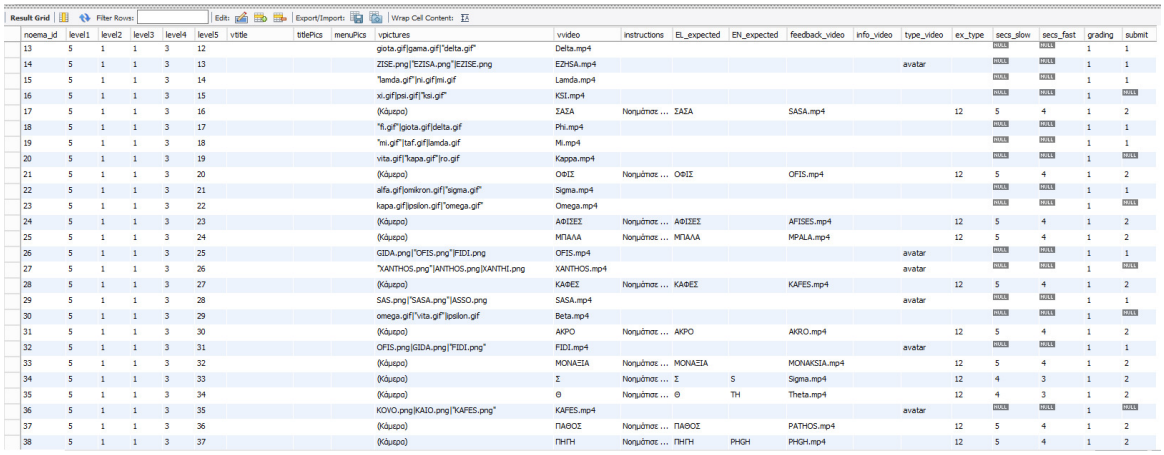

Figure 17: Sample coding of the objective evaluation exercise content in MS Excel format.

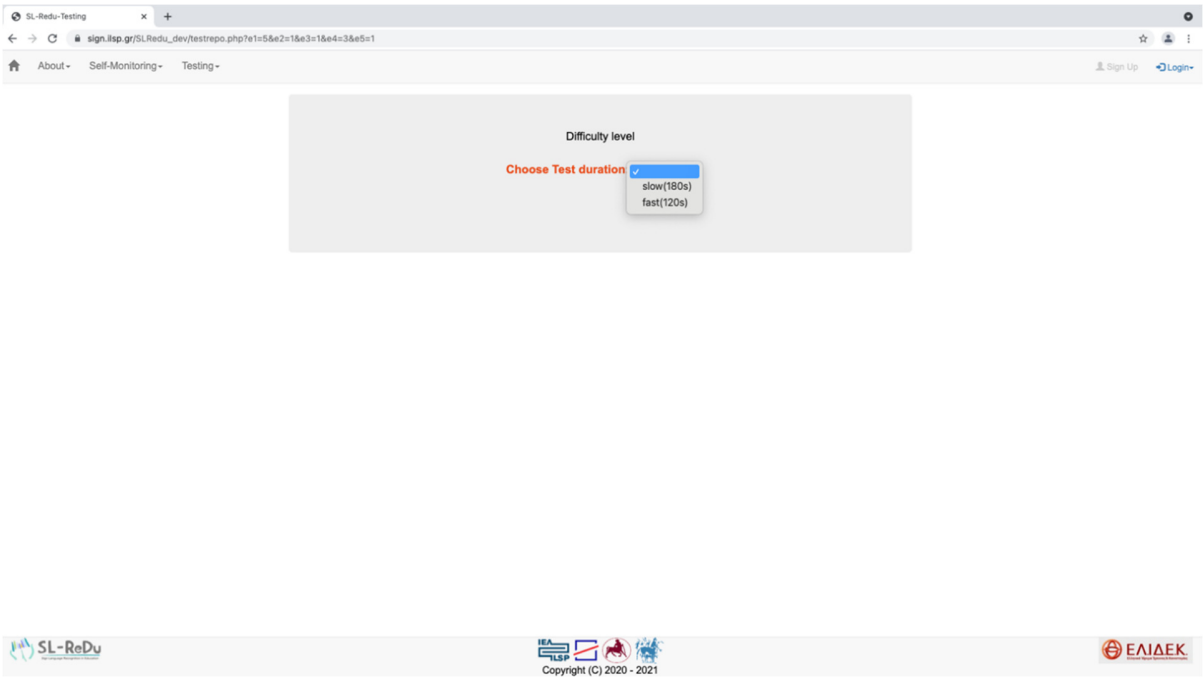

Figure 18: Setting up the overall time constraints to complete the objective evaluation, choosing from two values fixed by the instructor. Selecting the slower pace leaves room for self-practicing under simulated real-test conditions, and – when ready – the learner can perform the actual test selecting the required faster pace.

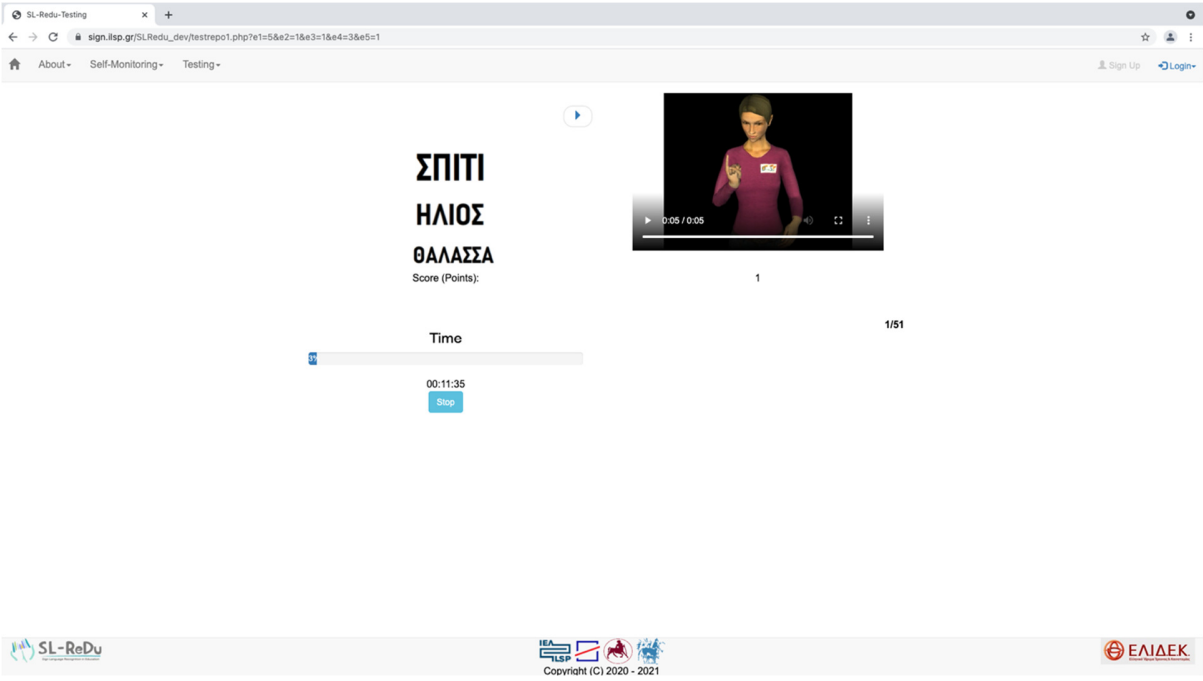

Figure 19: Multiple-choice, single-answer exercise for objective evaluation in continuous fingerspelling. The student is shown a signing video avatar fingerspelling a word as input stimulus, and is asked to select the word among multiple word choices depicted as static text images. The test time elapsed appears as a time progress bar.

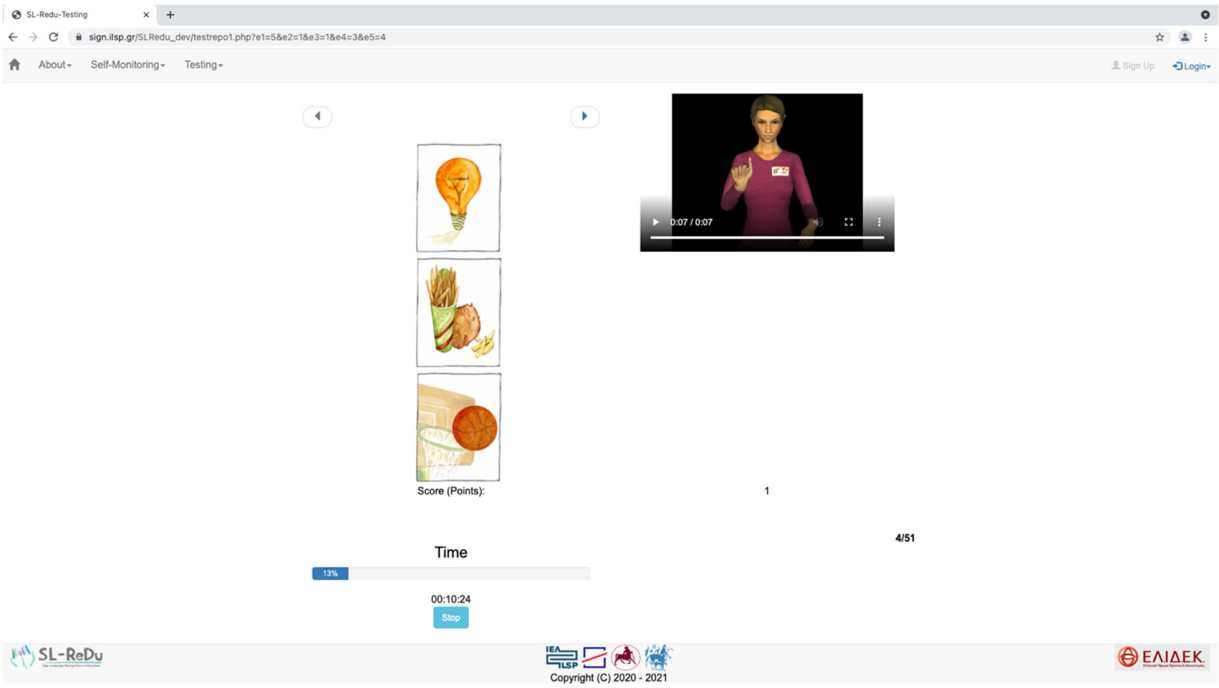

Figure 20: Multiple-choice, single-answer exercise for objective evaluation in continuous fingerspelling. The student is shown a signing video avatar fingerspelling a word as input stimulus, and is asked to select the word among multiple word choices provided as icons. The test time elapsed is also depicted.

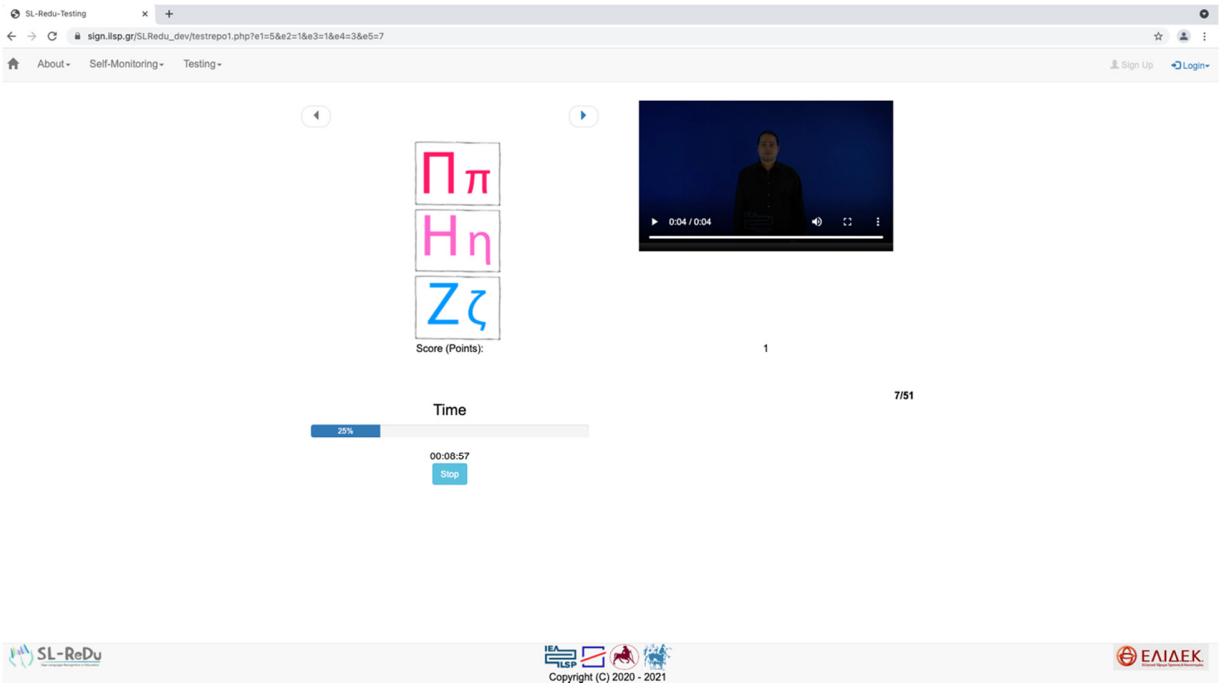

Figure 21: Multiple-choice, single-answer exercise for objective evaluation in isolated fingerspelling. The student is provided a video of a signer fingerspelling a single letter as input stimulus, and is asked to select the letter among multiple choices shown as static text images. The test time is also depicted.

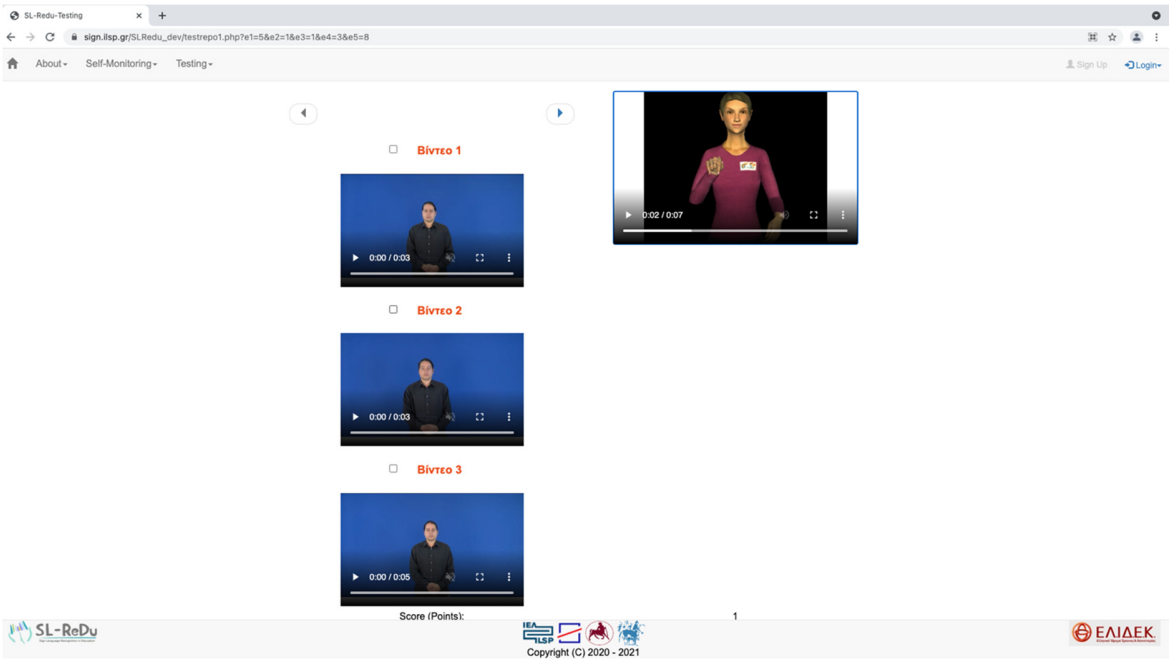

Figure 22: Multiple-choice, single-answer exercise for objective evaluation in continuous fingerspelling. The student is provided a signing avatar fingerspelling a word as stimulus, and is asked to match it against pre-recorded video sequences of words fingerspelled by a signer. The time elapsed is also shown.

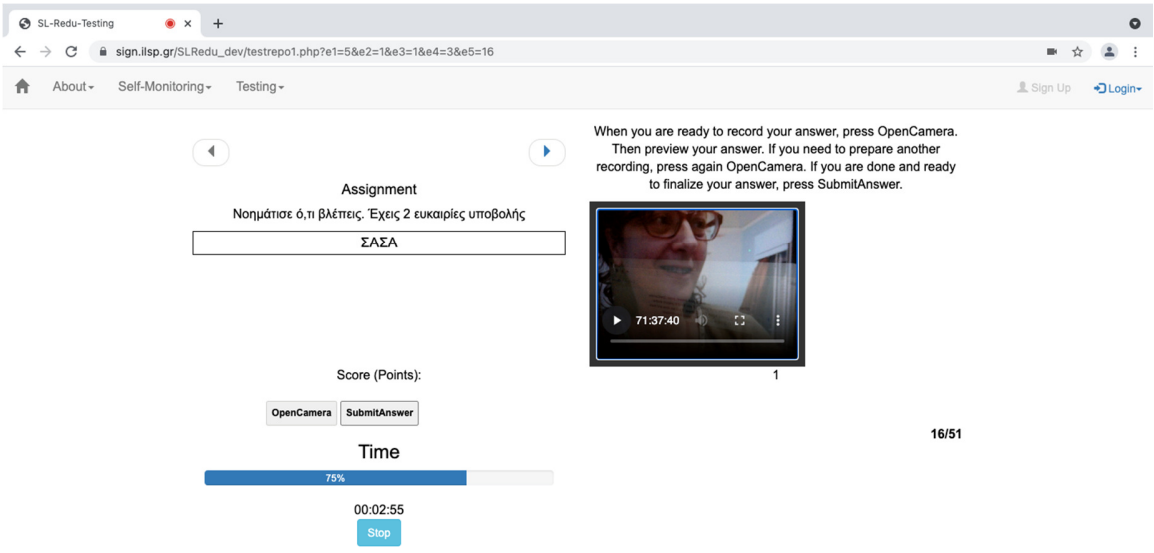

Figure 23: An active SL production exercise on continuous fingerspelling. The learner is shown a word (as text) and is asked to fingerspell it, allowing up to two attempts to accomplish the task correctly. A "turn camera on" button is used to initiate video recording of the learner's articulation, with a "submit answer" button available to upload the recorded video for processing by the SL-ReDu recognition engine. The test time elapsed is also shown. In this particular screenshot, the learner is visible during recording.

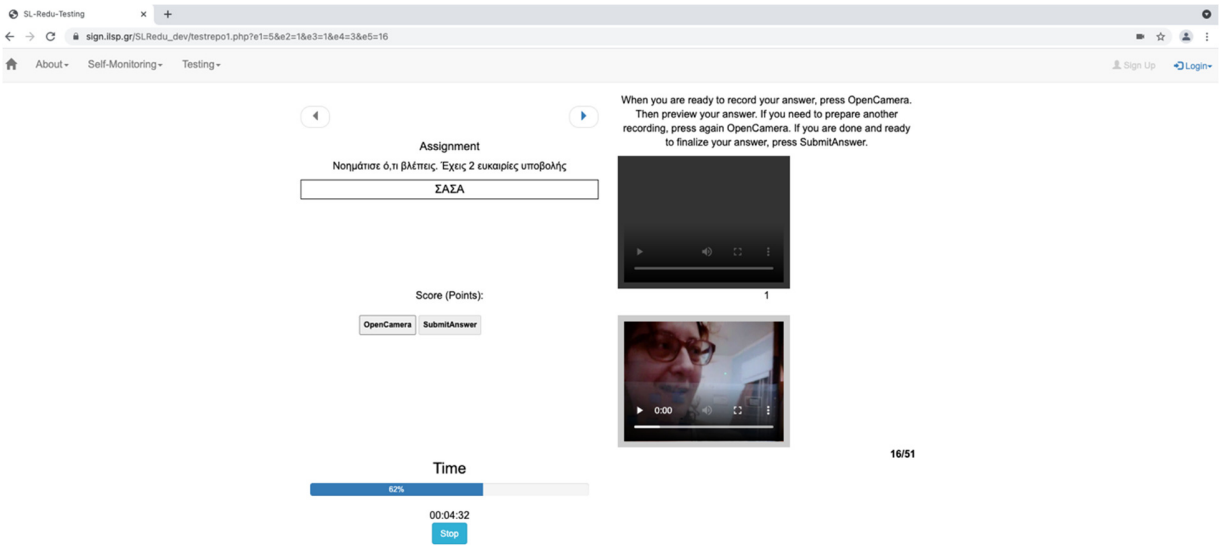

Figure 24: An active SL production exercise on continuous fingerspelling for objective evaluation of the learner (following Figure 23). In this screenshot, the learner can be seen previewing the answer (recorded video of signing production), before deciding whether to submit it to the SL-ReDu recognition engine.

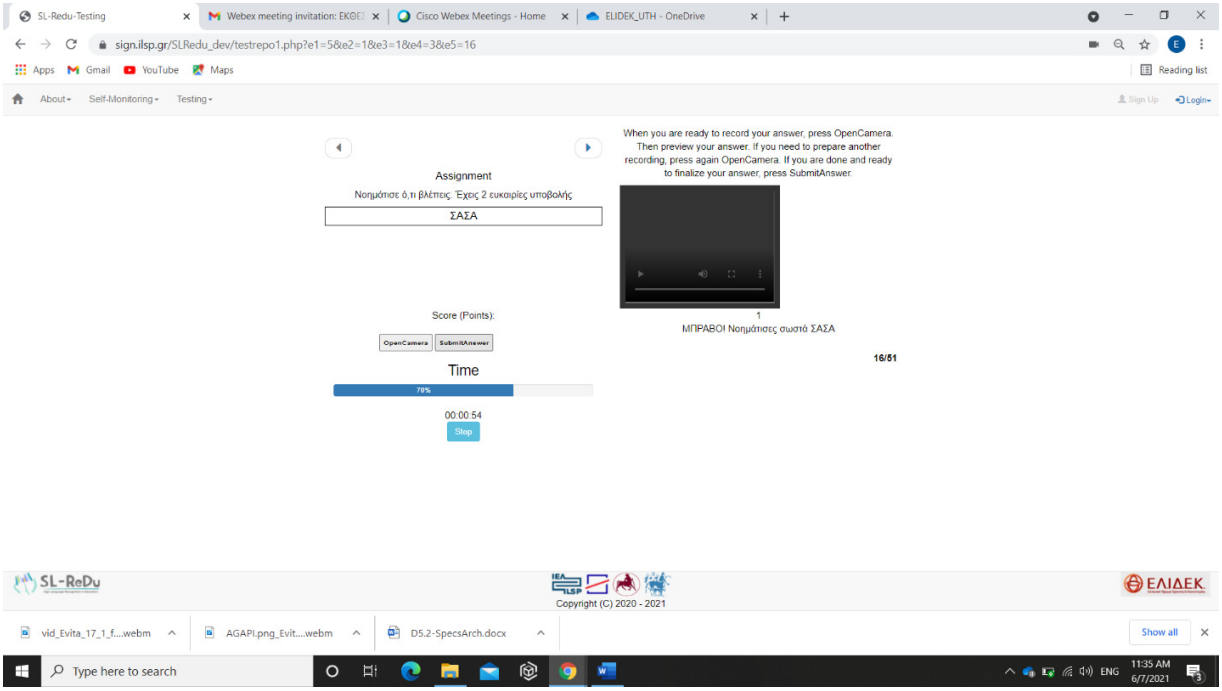

Figure 25: An active SL production exercise on continuous fingerspelling for objective evaluation of the learner (continuation from Figures 23 and 24). In this screenshot the HCI can be seen providing feedback to the learner concerning the correctness of the recorded video of the signing production, as determined by the SL-ReDu recognizer. The feedback appears as a text popup message below the recording window.

3 Conclusions

In this deliverable (D4.1), we presented the first version of the designed human-computer interface that will be implemented in the first version of the SL-ReDu system (upcoming deliverable D5.3), in accordance with the developed architecture of system integration (reported in deliverable D5.2). As discussed, the interface allows for user account setup and login, educational content presentation, learner self-monitoring, as well as learner objective evaluation, supporting this process for multiple learners and providing flexibility in these tasks in accordance with the educational material presented in deliverable D3.2. The goal of the adopted design is to successfully meet the second project milestone (MS2), designing a platform that will effectively support the first end-user evaluation that will be reported in future deliverable D5.4, as foreseen in the project Technical Annex.

References

[1] B. Berrett, "Using computer-assisted language learning in an American Sign Language course," *Innovation in Language Learning and Teaching*, vol. 6, no. 1, pp. 29–43, 2012.

[2] S.-E. Fotinea, E. Efthimiou, and A.-L. Dimou, "Sign language computer-aided education: Exploiting GSL resources and technologies for web deaf communication." In K. Miesenberger, A. Karshmer, P. Penaz, and W. Zagler (eds.), *Computers Helping People with Special Needs – ICCHP*, Part II, vol. LNCS-7383, pp. 237–244, 2012.

[3] T. Haug, "Web-based sign language assessment: Challenges and innovations", in *Proc. ALTE International Conference: Learning and Assessment - Making the Connection,* 2017.

[4] R. Campbell, P. Martin, and T. White, "Forced choice recognition of sign in novice learners of British Sign Language," *Applied Linguistics*, vol. 13, no. 2, pp. 185–201, 1992.

[5] D. Chen Pichler and H. Koulidobrova, "Acquisition of sign language as a second language," In M. Marschark and P.E. Spencer (eds.), *The Oxford Handbook of Deaf Studies in Language*. Oxford University Press, ch. 14, pp. 218–229, 2015.

[6] E. Efthimiou, S.-E. Fotinea, A.-L. Dimou, T. Goulas, P. Karioris, K. Vasilaki, A. Vacalopoulou, M. Pissaris, and D. Korakakis, "From a sign lexical database to an SL golden corpus – the POLYTROPON SL resource", in *Proc. Workshop on the Representation and Processing of Sign Languages: Corpus Mining (Satellite to the International Conference on Language Resources and Evaluation – LREC)*, pp. 63–68, 2016.

[7] M. Kemp, "Why is learning American Sign language a challenge?," *American Annals of the Deaf*, vol. 143, pp. 255–259, 1998.

[8] G. Sapountzaki, E. Efthimiou, and S.-E. Fotinea, "D3.2: Evaluation language material organization," *Tech. Report, SL-ReDu Project Deliverable*, Volos, Greece, 2021.

[9] G. Potamianos, K. Papadimitriou, E. Efthimiou, S.-E. Fotinea, T. Goulas, C. Flouda, and G. Ametoglou, "D5.2: Technical specifications and system architecture definition," *Tech. Report, SL-ReDu Project Deliverable*, Volos, Greece, 2021.

[10] *Common European Framework of References for Languages. Learning, Teaching, Assessment – Companion Volume*, Language Policy Programme, Education Policy Division, Education Department, Council of Europe, 2020 [Online]: https://www.coe.int/en/web/common-european-framework-reference-languages

[11] E. Efthimiou, S.-E. Fotinea, C. Flouda, T. Goulas, G. Ametoglou, G. Sapountzaki, K. Papadimitriou, and G. Potamianos**,** "The SL-ReDu environment for self-monitoring and objective learner assessment in Greek Sign Language," [To Appear in:] *Proc. Int. Conf. Universal Access in Human-Computer Interaction (UAHCI)*, 2021.