

D5.1 Definition of Evaluation Procedure



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Executive Summary

SL-ReDu is an innovative project that aims to considerably advance the state-of-the-art in 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. For this purpose, SL-ReDu is developing a GSL recognition prototype, integrated with a human-computer interface that is suitable for the aforementioned education use-case. The project plans to evaluate the developed system on two use-case scenarios, namely that of self-monitoring of productive learning by individual learners and that of the objective evaluation of learning performance across multiple learners by a GSL tutor. In this deliverable, we define the procedures that will be followed in such evaluation, detailing its aspects. Specifically, we present the recruitment strategy of the evaluation participants, the protocol that will be followed in the evaluation including the subjective and objective data that will be collected to judge the success of the SL-ReDu approach, as well as indicative evaluation content. The deliverable is part of Task 5.2 of the WP5 project activities, connecting directly with two evaluation reports, D5.4 and D5.6, one for each of the two versions of the prototype that are planned. The deliverable is part of the first project milestone (MS1).

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1 Introduction

In addition to the development of innovative algorithms for the automatic recognition of sign language (SL) from video content, significant effort in the SL-ReDu project regards the integration of such algorithms into a prototype demonstrator system focusing on the education use-case. Specifically, this use-case concerns the learning of Greek Sign Language (GSL) as a second language (L2), supporting the educational process in two distinct scenarios, namely the self-monitoring of productive learning by individual learners, as well as the objective evaluation of learning performance across multiple learners by a GSL tutor. Concerning the former, the prototype is planned to provide the learner with a tireless observer and self-monitoring feedback until specific objectives are achieved, thus overcoming the bottleneck of requiring frequent SL tutor physical presence. Concerning the latter, the prototype will be used in evaluating student GSL performance at the Department of Special Education of the University of Thessaly (UTH-SED) in the context of learning and testing for the introductory GSL course of the curriculum. The project aspires to greatly improve testing credibility and consistency, while significantly reducing tutor load.

Both aforementioned scenarios are critical to the evaluation of SL production by L2 learners [1, 2], albeit extremely challenging. Indeed, although validation of spoken or written language production evaluation has progressed significantly over the last decades by means of voice and text recognition technologies, in the case of SLs the lack of assessment tools is apparent, even more so when tutor supervision is excluded from the process. In addition, learning a SL from a visual-motor modality differs from learning a second spoken language significantly [3-6], thus complicating its assessment. For example, various degrees of accuracy and acceptability of the student responses need to be taken into consideration and not readily dismissed. It is therefore critical that the SL-ReDu demonstrator prototype be evaluated on the specific education use-case scenarios by its end-users, testing the platform modules and functionalities, including the ease-of-use and system overall performance, in order to judge its success and suitability in providing the desired automation and tools for GSL L2 learning.

Deliverable 5.1 defines the evaluation procedures that will take place in the SL-ReDu project, regarding the planned two versions of the system, with their evaluation results reported in future deliverables D5.4 and D5.6. Such evaluation procedures are defined on the basis of the aforementioned use-case scenarios that will be enabled by two system versions. The first prototype version (reported in D5.3) will be assessed by means of usability testing in a small-scale evaluation by end-users (Phase-A), while the second version (that will incorporate the Phase-A findings and reported in D5.5) will be assessed in the larger-scale, Phase-B evaluation. In more detail, this deliverable presents the recruitment strategy of the evaluation participants (Section 2), the protocol that will be followed in the evaluation including the subjective and objective evaluation data that will be collected (Section 3), as well as indicative evaluation content that will be used (Section 4). The deliverable is summarized in Section 6.

2 Recruitment Strategy of Volunteers

The SL-ReDu prototype evaluation will be conducted by volunteer students who are being taught, or who have recently been taught GSL at the A0-A1 level according to the Common European Framework for Languages (CEFR-L). Students at UTH-SED constitute the primary pool for volunteer candidates, due to the uniformity in their demographic and learning profile details, which is expected to facilitate the analysis and interpretation of their responses and drawing of conclusions concerning the system suitability and success for the adopted education use-case scenarios. The typical age group of such volunteers is between 20 and 23 years old, while their education level is that of the 2nd or later year of Tertiary Education. In addition to the primary UTH-SED student pool, the possibility of volunteer recruitment from other related GSL educational institutions, as well as a small control group of fluent GSL volunteers will be considered. Such volunteers are expected to exhibit a wider range in age and education level than the primary group.

As planned in the project Document of Work, system testing will be conducted in two phases: Phase-A will be a small-scale evaluation concerning the first version of the SL-ReDu prototype. As such, it will involve a small number of volunteers, within the range of five to ten, involving limited system functionalities. In contrast, Phase-B will be a full-scale evaluation of the second (final) version of the prototype with all its functionalities, also incorporating lessons learned from Phase-A and addressing possible shortcomings of the approach and other identified issues. This second evaluation will involve a population of at least twenty subjects. Recruitment of the evaluation participants will take place at the beginning of Fall 2021.

It should be noted that testing of the SL-ReDu prototype will require some degree of close interaction between the volunteers and project personnel, primarily while transferring the system device to and from the end-users, as well as during the initial stages of supervising their familiarization with its operation. This may be challenging due to unforeseeable circumstances regarding possible COVID-19 pandemic mobility restrictions during the planned evaluation periods, which can be further exacerbated concerning the volunteer recruitment depending on the UTH-SED operating protocols in the upcoming semesters.

3 Evaluation Protocol

The recruited volunteers will conduct the evaluation individually on a portable computer (laptop) provided to them by the project, testing both the self-monitoring and the objective assessment functionalities of the developed prototype. The evaluation process is further detailed, next.

- At the beginning, all participants will be informed about the project objectives and procedures via appropriate documents and will sign the corresponding release form, an example of which is shown in Figure 1. Further, the volunteers will complete an anonymous questionnaire, providing basic demographic and literacy information about their age, gender, education level, familiarity with computers, and duration of GSL education. The questionnaire is depicted in Table 1 (in Greek).
- After completing this step, the participants will proceed with the self-monitoring learning activities supported by the platform. This part will be performed at a leisure pace, with ample time available to the volunteers, thus resembling studying and L2 learning in meeting the requirements of the introductory GSL course at UTH-SED.
- Following the self-monitoring scenario of GSL learning, the participants will proceed with the objective evaluation of their learning performance. This will take place via an online exam within specified time constraints that will be automatically graded by the SL-ReDu prototype system.

Ανώνυμη Νοηματική Γλώσσα στην Εκπαίδευση
Sign Language Recognition in Education (SL-ReDu)



Έγγραφο ενημέρωσης και συνέντευξης του συμμετέχοντος στη συλλογή
και επεξεργασία δεδομένων προσωπικού χαρακτήρα

Στο πλαίσιο των δραστηριοτήτων του Ερευνητικού Έργου «Ανώνυμη Νοηματική Γλώσσα στην Εκπαίδευση – Sign Language Recognition in Education (SL-ReDu)» που χρηματοδοτείται από το Ελληνικό Ίδρυμα Έρευνας και Καινοτομίας (ΕΛΛΑΣ-Ε.Κ.Κ.) η Ομάδα Έρευνας Νοηματικής Γλώσσας, στο Ίνστιτούτο Επεξεργασίας του Λόγου (ΙΕΛ) του Ε.Κ. ΑΘΗΝΑ, που συμμετέχει στο Έργο, σας ενημερώνει ότι για την συλλογή και επεξεργασία δεδομένων προσωπικού χαρακτήρα, ως κατά την εκφορά Ελληνικής Νοηματικής Γλώσσας (ΕΝΓ) από τους στο σύνολό τους του ΙΕΛ η κατά τη διαδικασία εκπόνησης των αποτελεσμάτων του έργου στο ΙΕΛ και στο Πανεπιστήμιο Θεσσαλίας. Το συγκεκριμένο, παρόμοιο προσρόσχημα ενυπόκειται τα δεδομένα που θα συλλέγονται.

Το ΙΕΛ θα καταγράψει ερωτήσεις και θα διατηρήσει τα κάτω στοιχεία σε:

1. Όνομα και επίθετο
2. Στοιχεία επικοινωνίας
3. Ημερία
4. Φύλο
5. Εκπαίδευση και εργασία
6. Ημερία κατάταξης της ΕΝΓ

Τα στοιχεία 1-2 από την παραπάνω λίστα, θα διατηρηθούν τα επόμενα 5 έτη σε ξεχωριστό αρχείο με περιορισμένη πρόσβαση από συγκεκριμένους ερευνητές του ΙΕΛ και με μόνο σκοπό την επικοινωνία μαζί σας σχετικά με τις δικτυοκοινωνικές των δεδομένων σας. Τα στοιχεία 3-6 από την παραπάνω λίστα θα διατηρηθούν από το ΙΕΛ για σκοπούς κοινωνικο-γλωσσολογικής έρευνας αναφορικά με την γλωσσική εξέλιξη και τους ροηστικούς της παραμέτρους, για 10 έτη.

Εμπροσθέντα, η ομάδα του ΙΕΛ θα συλλέξει τα δεδομένα ήτοι της ΕΝΓ που προβλέπει το Έργο SL-ReDu και στα οποία θα καταχωρηθεί η θέση και η κίνηση των της συμμετεχόντων συμμετεχόντων στο έργο με χρήση κάμερας κατά τη διάρκεια εκφοράς ΕΝΓ.

Τα δεδομένα νοηματικού ήτοι ΕΝΓ που θα συλλέγονται θα διατηρηθούν για 20 έτη, θα χρησιμοποιούνται αυστηρά για ερευνητικούς σκοπούς, ενώ η ερευνητική ομάδα του ΙΕΛ θα λάβει κάθε αναγκαίο τεχνικό και οργανωτικό μέτρο για τη μη αποκάλυψη των προσωπικών στοιχείων σας. Τα δεδομένα ήτοι της ΕΝΓ που θα συλλέγονται, θα τύχουν επεξεργασίας μόνο από ερευνητές που συμμετέχουν στο Έργο SL-ReDu, όπως και ερευνητές που επισημάνουν και ερευνητικούς που αναπτύσσουν αλγόριθμους μηχανικής επεξεργασίας ΕΝΓ με σκοπό την ανάπτυξη τεχνητάς νοηματικής γλώσσας. Εξέταση, πληροφορίες και μηχανικής επεξεργασίας. Τα δεδομένα θα διατηρηθούν υπό την ευθύνη της Συντονίστριας της ομάδας Έργου SL-ReDu του ΙΕΛ, Δρ. Ελένης Ξεθοδίου.

Η συλλογή και η επεξεργασία των δεδομένων σας θα γίνει με βάση την παρούσα συνέντευξη σας (συμπλήρωσε με τα άρθρα 6 παρ. 1 περίπτωσης (α) και για τα προσωπικά δεδομένα ειδικών κατηγοριών (9 παρ. 2 (α) του Γενικού Κανονισμού (ΕΕ) 2016/679).

 SL-ReDu
Sign Language Recognition in Education

Για το χρονικό διάστημα που τα δεδομένα ρήτσο θα διατηρηθούν από την ομάδα του IEA, έχετε τη δυνατότητα να ασκήσετε το δικαίωμα πρόσβασης, διόρθωσης, επικαιροποίησης, περιορισμού της επεξεργασίας, αντίληξης και φορητότητας σύμφωνα με τους όρους του Γενικού Κανονισμού Προστασίας Δεδομένων Προσωπικού Χαρακτήρα 2016/679 (Ε.Ε.).

Για κάθε θέμα που αφορά τα προσωπικά δεδομένα σας ή την άσκηση των δικαιωμάτων σας μπορείτε να απευθυνθείτε στον Υπεύθυνο Προστασίας Προσωπικών Δεδομένων του ΕΚ Αθηνά στο email dro@athena-innovation.gr ή να επικοινωνήσετε με τη Συντονίστρια της ομάδας Έργου SL-ReDu του IEA:

Ελένη Ευθυμία, Διευθύντρια Ερευνών
IEA / Ε.Κ. ΑΘΗΝΑ
Αρτέμιδος 6 & Επίδαυρου
Μαρούσι 15225
τηλ.: 210-6875356

Επίσης, έχετε δικαίωμα ανωνορίας στην Αρχή Προστασίας Δεδομένων Προσωπικού Χαρακτήρα στη διεύθυνση www.dpa.gr.

Εάν υλοποιείτε αυτό το κείμενο και σας εβόησε η ευκαιρία να εκφράσετε απορίες, ή αν σας το μέτε ορκος ο νοηματικός γλώσσα και σας εξήγησαν το κείμενο και συμφωνείτε, παρακαλώ υπογράψετε παρακάτω.

<u>Ονοματεπώνυμο Συμμετέχοντος:</u>	<u>Ονοματεπώνυμο Ερευνητή:</u>
Υπογραφή	Υπογραφή
Ημερομηνία:	Ημερομηνία:

Στην περίπτωση δημοσίευσης μέρους του εκπαιδευτικού υλικού ρήτσο με αποκλειστικό σκοπό την παροχή πληροφοριών αποτελεσμάτων σε βιώσεις, συνέδρια και επιστημονικά φόρουμ, συμφωνείτε να χρησιμοποιούνται τα δεδομένα σας ρήτσο χωρίς την αντανάγξη του ονόματος σας:

ΝΑΙ [] ΟΧΙ []

Ονοματεπώνυμο Συμμετέχοντος:

Υπογραφή

Ημερομηνία:



Figure 1: Information and consent form that will be signed by the evaluation participants.

Ηλικία (αριθμητικά)				
Φύλο	Γυναίκα	Άντρας		
Μορφωτικό επίπεδο	Απόφοιτος-η Λυκείου	Φοιτητής-ρια	Απόφοιτος-η Τριτοβάθμιας	Κάτοχος Μεταπτυχιακού
Εξοικείωση στη χρήση ΗΥ	Καμία	Μικρή	Μέτρια	Μεγάλη
Διάρκεια εκμάθησης νοηματικής	Κάτω από 1 μήνα	1-2 μήνες	2-3 μήνες	Πάνω από 3 μήνες
Φοίτηση σε ΑΕΙ (ονομαστικά)				

Table 1: Questionnaire used in the collection of relevant demographic and literacy information from the evaluation participants in the form of a questionnaire (shown in Greek).

	Πολύ	Αρκετά	Μέτρια	Λίγο	Καθόλου
Θεωρώ ότι η πλατφόρμα είναι εύχρηστη					
Ο διαθέσιμος χρόνος μου αρκούσε					
Το επίπεδο δυσκολίας της πλατφόρμας ανταποκρίνεται στις ανάγκες μου					
Είμαι ικανοποιημένος-η με την αισθητική της πλατφόρμας					
Αισθάνομαι ασφαλής να χρησιμοποιήσω την πλατφόρμα για την αξιολόγησή μου					
Θα χρησιμοποιούσα την πλατφόρμα για να βελτιώσω την επίδοσή μου					

Σχόλια: Εισάγετε παρακάτω οποιοδήποτε σχόλιό σας

Table 2: Subjective evaluation questionnaire to be employed in the SL-ReDu prototype validation.

- At the end of the evaluation session, the participants will provide feedback by means of a subjective evaluation questionnaire, depicted in Table 2 (in Greek), focusing on user trust, ease of use, and usefulness. This includes a small number of questions to be answered in the Likert rating scale with five discrete options, ranging from one (poor) to five (excellent), as well as the possibility of providing any additional feedback in free form. The collection of subjective evaluation cues will provide feedback on user attitude and opinion on the functionality, design

and layout, level of difficulty and overall satisfaction with the platform, and can be measured in terms of mean opinion score, averaging the Likert scale results across the volunteers.

Besides the subjective feedback of the volunteer evaluators, the project team will analyze the results of their submitted answers to provide objective measurements of system performance. Such measurements will concern the accuracy of the developed GSL automatic recognizer that is incorporated in the prototype, the recognition latency, the number of iterations performed by the participants including possible re-initializations, and the overall time that the volunteers have spent to conduct the available activities. In this respect, objectivity, validity, usability, and functionality of the platform will be validated, as well as other possible factors such as design templates or the time assigned for each activity.

The above evaluation protocol will be followed in the two validation cycles of the SL-ReDu project. More specifically:

- The first validation cycle, which will be documented in D5.4 marking milestone MS2 of the project, concerns small-scale testing of isolated lexical and grammatical signs, as well as numerals and fingerspelling.
- The second validation, which will be documented in D5.6 being aligned with milestone MS3 of SL-ReDu, concerns more advanced grammatical units, such as continuous strings of signs and changes of signing movement through morphological inflection, and it will involve larger-scale testing.

Both cycles include GSL learning activities for perception as well as production of GSL, with some indicative content provided in Section 4.

4 Indicative Evaluation Content

Indicative evaluation content from accompanying Deliverable D3.2 (M12) is the inspiration of the present section. From a structural point of view, evaluated language activities in the first validation cycle cover the part of the platform that tests handshape articulation, loci and movement parameters on isolated signs level (i.e. lexical and grammatical vocabulary), numerals, and fingerspelling symbols. The SL-ReDu evaluation environment will contain activities aligned with current methodologies in SL teaching as L2 [7-9] and developed in compliance with the UTH-SED curriculum. In the second validation cycle, on the levels of lexicon-semantics, syntax, and morphology, the language material covers issues of one/two-hand formations, movement variation, semantic classifier use, declination agreement, word order, movement repetition, adverbial modifier structure in 3D space, and formation of plural, declarative, negative, and interrogative constructions, as well as numerals and fingerspelling [10-14]. Evaluation content examples are provided in the following for the two use-case scenarios of self-monitoring of productive learning and objective assessment of learning performance.

4.1 Self-Monitoring of Productive Learning

Activities of L2 learning in the most part concern seven major areas: vocabulary, grammar, reading, listening, writing, pronunciation, and speaking [15, 16]. In the evaluation material of SL-ReDu, the self-monitoring units of listening and reading, as well as writing and speaking, are respectively replaced by their visual counterparts of viewing and perceiving signing. The material is organized in sections, each of which is preceded by an example or an explanation, followed by exercises of various types that the learner navigates at a leisure pace. These include repetition, permutation exercises, matching exercises with fingerspelled words against signs, pictures against signs, multi-choice and category exercises. Self-improvement exercises and evaluation for grammar utilize multi-choice, permutation, and matching. In more detail, these are:

- *Multiple-choice* exercises, which involve questions and answers phrased as video text of a phrase, video text of a word, or a picture. Each exercise defines several candidate answers, typically two to five, shown in Figure 2.
- *Permutation* exercises that require the learner to sort letters, words, or pictures in a specific order. This type is not anticipated in the evaluation, though.



Figure 2: Example of a multiple-choice exercise with a picture stimulus (prompt) on the left and four possible answers (different classifiers) on the right.



Figure 3: Example of a matching exercise in the area of grammar. The student is required to match still images of entities on the left and the correct SL classifier for each of them on the right.

- *Matching* exercises that require the learner to identify two matching items with a shared characteristic or, as a category exercise, to sort items as per a target semantic or linguistic feature in still and/or video form (see an example in Figure 3).
- *Fill-in the blank* exercises, where the learner is asked to fill in what is shown in a video or picture. Such exercises have been modified for SL use to allow learners to drag answers from a closed list and slot them into the space assigned for the answer, as indicated in Figure 4.
- *Type-the-answer* exercises, which are combined with fingerspelling and numbers only, for minimal interference between spoken and signed language, as shown in Figure 5.

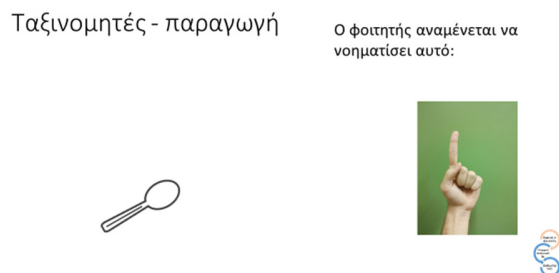


Figure 4: Example of a fill-in the blank exercise with grammatical scope (classifiers) adapted in SL, using a graphics-image stimulus (prompt), expecting a signed video from the student.



Figure 5: Example of a fingerspelling exercise where the student is presented with a fingerspelled symbol or sequence and is required to choose the typed equivalent.

4.2 Objective Assessment of Learner Performance

In a similar way with the self-monitoring activities, questions of the same types but differentiated content will be incorporated in a test suite to be used as a one-off exam-like activity, aiming to evaluate the SL-ReDu prototype module for objective assessment of the GSL learner performance. In this module, the exam-like exercises are presented sequentially to the learner, who is given a maximum number of attempts to respond correctly, as well as a time-limit to complete the assignment. An overall assessment score is provided to the learner upon completion of the activity. An example of a multiple-choice type exercise is illustrated in Figure 6.

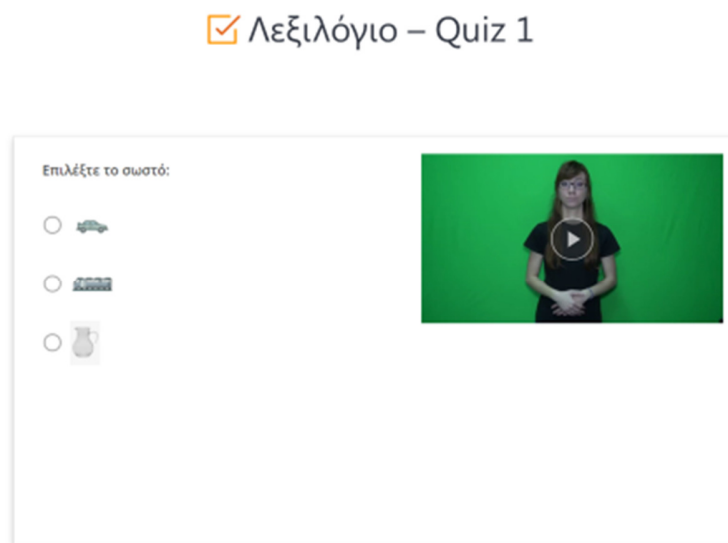


Figure 6: Example of a multiple-choice type exercise for objective assessment of learner's performance, featuring a written prompt, questions in SL, and response acceptance in graphics-images.

5 Conclusions

In this deliverable, we detailed the evaluation procedure of the SL-ReDu project. Specifically, we present the recruitment strategy of the evaluation participants, the protocol that will be followed in the evaluation including the subjective and objective data that will be collected to judge the success of the SL-ReDu approach, as well as indicative evaluation content. This deliverable is part of the Task 5.2 project evaluation activities of WP5, and it will guide follow-up deliverables D5.4 and D5.6 that will report the evaluation results of the two validation cycles in SL-ReDu. The deliverable constitutes part of the first project milestone (MS1).

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