Developing technology-enhanced literacy learning for LESLLA learners

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The problem

It is generally known that most non-literate adult second language (L2) learners have difficulty becoming independent readers. In the Netherlands for instance, the proficiency level that is required for the so-called integration exam and which indicates the start of independent reading - level A2 of the Common European Framework of Reference of Languages - is attained by few students and even then after many hundreds of hours of instruction (Kurvers & Stockmann, 2009).

One of the main reasons LESLLA learners are not as successful as children who learn to read and write in their mother tongue may be that they receive fewer hours of reading instruction; hundreds of hours is still less than the thousands of hours (middle class) children receive. Often, it is also the case that the course material is of a lower quality in the sense that it is not geared to the specific situation of the adult non-literate or low-literate L2 learner. Moreover, materials rarely enable individualization of instruction, important in the typical multi-level LESLLA class (see Kurvers & Stockmann, 2009). Adults who learn to read for the first time in their lives in an L2 with a phonological system different from that of their native language and whose social exclusion results in minimal vocabularies need considerable time and patience to build up their vocabularies, to become familiar not only with new sounds or sounds that are slightly different (similar to literate L2 learners), but also with the metalinguistic awareness of linguistic units required for reading in an alphabetic script such as words, graphemes and phonemes (see e.g. Kurvers et al., 2007). This is because they do not have native language reading skills to transfer. Moreover, such learners present different learning trajectories, and vary in the pace at which they proceed in their acquisition process (Dalderop, 2011). If the classroom is a teacher-fronted one, a learner may listen to sounds in the L2 several times during a lesson, and, even under the most favorable conditions, (s)he may pronounce those sounds only once or twice with teacher feedback. Then the learner is expected to practice the correspondence between grapheme and phoneme on his/her own, without the feedback of the teacher or another native speaker. This leads to an L2 phoneme's native-language-based pronunciation becoming entrenched and hindering the learning of grapheme-phoneme correspondences than is the case for learners who have native language literacy skills to transfer. Although there are learning tools (DVDs for instance) with words and individual sounds pronounced for L2 learners available to LESLLA learners, the project discussed below has created materials for augmenting practice through more *intensive* practice (always with feedback) and more *extensive* practice (for a longer time and more often). The Digital Literacy Instructor project is designed to increase practice time and speed of learning basic grapheme-phoneme correspondences and 300 words, in the four project languages: Dutch, English, Finnish and German.

A solution

Feedback that is systematic, consistent, intensive, clear and at the learner's current level increases the quantity but also the quality of practice time, since the learner can move at his/her own pace. Such feedback can realistically only be provided by an 'artificial instructor' who is virtually present in

and outside the classroom at any moment the learner wants to practice. In the project described below, this takes the form of a Computer Assisted Language Learning (CALL) application. CALL offers potentially enormous advantages compared to teacher-fronted classes: learners can practice as much as they want at their own pace in any environment they wish, all the while receiving individualized, adaptive feedback from the computer. This is particularly important for adult L2 learners who lack basic literacy skills to be able to work on many existing materials outside the classroom, without the support of a teacher. Learning that can and should be individualized releases the teacher so that s/he can do what only a teacher can do, for example involve learners in the interaction with other learners.

In the project described here feedback techniques are elevated: well-known ways of providing feedback are extended with automatic speech recognition (ASR) feedback which entails automatic error detection in reading aloud. Below, we describe the organization of the project, the steps that have been completed thus far, the steps the project will take on this work-in-progress and the pedagogical ideas underlying the software. Then we present various types of feedback and explain why we have chosen explicit and immediate forms of feedback for this group of learners. Finally, we show how the feedback is integrated in the system's seven exercise types, and we close with an example of how corrective feedback at word level is presented to the learner.

The Digital Literacy Instructor project (http://diglin.eu)

The European Union Grundtvig-funded Lifelong Learning Multilateral Project 'Digital Literacy Instructor' (DigLin) aims to provide concrete solutions for adult literacy students by developing L2 literacy learning materials in Finnish, Dutch, German, and English (listed here in order of transparency of their orthography). Five project partners in four countries are departments at universities and a further education institution for vocational education (Friesland College). All have contacts or collaborate with teachers and education centers where adult L2 literacy students take courses. The five partners are the Netherlands: Radboud University, Nijmegen (lead and automatic speech recognition), Friesland College (software creation); Germany: Herder Institute, University of Vienna; United Kingdom: Newcastle University; Finland: University of Jyväskylä.

The DigLin project combines the system of existing reading instruction materials for non-literate and low-literate L2 learners developed at Friesland College (FC-Sprint[2]) with ASR. The former provides the software for the exercises; the latter is used to recognize what the learners say as they read aloud, to diagnose errors to extend practice and feedback.

Steps involved in creating the DigLin software

Creating literacy software for four languages with different orthographies and pedagogical approaches to literacy instruction in no more than four face-to-face meetings and fortnightly Skype meetings is a complicated and challenging task. Elaborate discussions preceded the final selection of the content, i.e. which words, which sounds, photos to accompany words, level of support for learners, etc. Here we outline the steps we have taken and will take to create 15 exercise sets. In chronological order, they are:

1. Gather facts about each language's phonology, orthography, approaches to teaching (children and) LESLLA learners to read.
   The irregularity of English orthography has been and still is the cause of much debate on how children and adults should be taught to read. Teachers in the UK are currently directed to use a synthetic phonics approach alongside sight word reading. In the other three countries (whose orthographies are more transparent) reading instruction for children and LESLLA learners initially focuses solely on cracking the alphabetic code only by analysis of the word in phonemes and graphemes and by blending them into a word. It turned out to be difficult to make much more opaque English orthography fit to the model being used for the exercises.

2. Agree on selection criteria for words for the software.
   In a pure phonics approach, the choice of basic words is primarily determined by their usefulness for literacy instruction. Relevance of words for adult immigrants and frequency of words selected are of secondary importance. For the project, words were selected according to their degree of simplicity. For the most basic words this was twofold:
   - monosyllabic CV or CVC words;
   - words with phonemes that are affected as little as possible by surrounding sounds and which therefore contribute to the categorization of a specific phoneme in the L2.

   As we are dealing with L2 learners unfamiliar with the phonemic inventory and allophonic rules of the L2 and for whom all the graphemes are new and (almost) equally difficult, it seemed better to start with phonological simplicity, that is:
   - typologically frequent (i.e. unmarked) phonemes;
   - graphemes representing less allophonic variation;
   - regular orthography.

   There were also technical requirements for the selection of words depending on the possibilities of the software. Therefore we had to
   - select words that could be supported by photos (not drawings because these are less well understood by non-literates).
   - restrict the number of new elements (graphemes or allophones) within one set of 20 words to be used for a series of seven exercises in each exercise set.

3. Create a 'sound bar' for each language for use with exercises in each set.
   The sound bar is a tool for the learner to use as support in most of the seven exercises. In the sound bar, the user can see and listen to all single graphemes, digraphs and trigraphs that are used in the software. For Finnish, Dutch and German these are almost all the letters of the alphabet; this is not the case for English as we can see when we compare the sound bar for Finnish and (British/Received Pronunciation) English in Figure 1.

Figure 1: *The sound bar for Finnish (above) and English (below). The pale graphemes (c, q, w, x, z) for Finnish are not used in the exercises. The grey buttons in the English sound bar indicate that we are dealing with more than one correspondence for that grapheme. When the learner clicks on the square, the basic (most common/regular) phoneme can be heard, when clicking on the grey button the less common/regular allograph can be heard.*

4. Use the Learning Company of Friesland College's (*FC-Sprint² Leerbedrijf*) technology to create 15 exercise sets for each language.
   Five different types of exercises, adapted from *FC-Sprint²*, are implemented in the course material for each of the four languages. In each of these, sub-skills of the reading process are practiced, as shown in Table 1. The series is supplemented by exercises 6 and 7 in which reading aloud can be practiced. (This requires integration of ASR technology which the project is only now developing).

Table 1: *Overview of the exercises and their focus in DigLin*

Number and name of the exercise	Focus
1. Presentation	The meaning and form of a word
2. From letters to words	Making grapheme-phoneme correspondences (analysis)
3. Dragging words 1	Recognizing whole words
4. Dragging words 2	Recognizing strings of phonemes (synthesis/blending)
5. Dictation	Automatizing grapheme-phoneme correspondences
6. Reading with help	Reading with sound bar
7. Reading: Test yourself	Reading without help

5. Collect data from nonnative speakers of these four languages for training and testing the ASR engine and the error detection algorithms.
   Developing the ASR technology required for the oral production exercises is not an easy task, because of the relatively low proficiency and variation in native language background of the target group and the difficulties these imply for ASR and error detection (Van Doremalen et al. 2010). For this reason, the project team has collected speech data and corresponding orthographic annotations at the various locations. These data are being used to train and test the ASR engine and the error detection algorithms. Speakers are from the native languages of the major groups of literacy learners in the four countries, i.e. Arabic (Moroccan and other dialects), Berber Tarifiyt, Somali, Kurdish and Bengali (Sylheti dialect).

6. Test the software with LESLLA learners in classrooms for 50 hours as they work with the software.
   All technical components will be tested in isolation and improved. As soon as the new CALL/ASR course material is ready, the teachers of the experimental literacy classes will familiarize themselves with relevant digital pedagogy and the newly developed software. At one-day workshops at each project site, they will be instructed on how to use the DigLin course materials. Then their students will start working with the materials.

7. Evaluate results and reactions of the students to the software after 10, 25 and 50 hours working with the software. Teachers will be interviewed at the end of the testing period.
   The evaluation is twofold: pedagogical and technical. Both perspectives are integrated into interview questions, with regard to the students:
   - How do learners use the DigLin materials?

- How does it contribute to achieving learner goals and increasing motivation?

and with regard to the teachers:

- Which components of the material do L2 literacy teachers rate as more or less conducive to learning how to read?
- Which suggestions do they have for improving the materials?

For this purpose digital questionnaires and an interview manual are being developed. For evaluating technical aspects, the interactions between system and learners' responses will be logged. The accuracy of the system in recognizing learners' responses and identifying the errors made in reading will be measured.

8. Disseminate results and expand DigLin.
   Dissemination is not the final step, but has already started, with a website with gradually increasing information about the project and presentations at national and international conferences and academic publications in conference proceedings and journals.

At the moment of writing we are working on steps 4 and 5 and 1.5 years of the three-year project has passed. The field testing is planned for half-way through the second year.

The FC-Sprint² concept

As the DigLin system makes use of the learner-system of FC-Sprint² materials, we introduce the basic pedagogical ideas underlying FC-Sprint². The name comes from Friesland College, a school for advanced vocational education in the Netherlands, where this pedagogical concept has been implemented. This name suggests the speed and motivation that the idea promotes.

The concept of FC-Sprint² is based on two pillars of thought.

1. *An approach to learners by teachers under which control moves from the teacher to the learners.*
   FC-Sprint² starts with high expectations; learners are not told what they should do. Instead they are asked what they can show the teacher, and (s)he conveys to them the idea that they will impress the teacher. Then the learners are asked to present to their classmates what they have learned. This requires learners to work with the resources the teacher has made available, which range from books and audio-recordings; classmates can also be resources. The teacher him/herself is the last resort. That is, if the required knowledge is really not available from any of these resources, the teacher acts as a resource. This is a radical departure from many LESLLA classes, in which the learners are heavily dependent on the teacher.

2. *Providing learners with resources so that they can become more autonomous learners.*
   Students require the right resources, and a large part of these resources are built by advanced students of Friesland College and teachers from the *Application Development* and *Media Design* tracks at the College. Together they build small programs so that other students - in this case adult L2 literacy learners from the educational department where literacy for first time readers in L2 Dutch is being taught – can autonomously find the information needed for discovering how reading works instead of being instructed by the teacher.

Under the FC-Sprint² approach, learners are not directed to specific materials (resources) that they should use at a particular moment in the learning process. Rather, all the material is provided at once. Learners are then guided (by the teacher, but also by the program itself) to first discover which

resources they can use to reach a target set by the teacher. Learners are expected to negotiate the targets set by the teacher, and come up with what they themselves want to learn. The teacher is thus the guardian of the learner's education. If a learner comes up with a target him/herself, the teacher has to decide whether this is an appropriate target. If so, the teacher defines the target based on the learner's input. This involves high expectations. Learning materials are built in such a way that there is a top layer (e.g. the exercise shown on the computer screen) with information underneath which a learner can access if (s)he needs it. The idea behind using the former is that the learner is in charge and is not led by the computer. However, there is immediate feedback so that a learner does not repeat errors only to find out at the end (with a 'check the answers' button) that (s)he has been making errors. Such 'check the answers' buttons at the end of an exercise constitute a test (e.g. Exercise type 7) and are not an effective learning exercise.

At first sight, this seems contradictory to the need for systematic and sequential instruction, a main characteristic of the phonics approach. The digital material has been organized very systematically, but it allows the learner to follow more than one system. There is a carefully built up structure of increasing difficulty in the selection of phonemes and graphemes (see step 2) and in the exercises within a set of words (see Table 1). The learner her/himself has to discover that order and if using it makes sense for him/her. When it comes to digital resources, these are structured such that a learner can dig deeper to find more information. For example, when a learner needs to know how a word sounds (s)he can hit a button to hear it.

Feedback

Research indicates overall effectiveness of corrective feedback (CF) as discussed in Lyster et al. (2013). Relevant to users of the DigLin materials, a comparison of feedback to learners in language laboratory settings to those in the classroom indicates that 'in the classroom context, there is more distraction, and feedback is often not directed toward individual learners' (Li 2010:345). Moreover, L2 learners express a preference for receiving CF over having their errors ignored (Plonsky & Mills 2006). Studies also show that explicit CF on pronunciation is important for improvement (Saito & Lyster 2012). Because acquisition of phonology is closely linked to LESLLA learners' ability to make accurate grapheme-phoneme correspondences, as noted above, CF can play an important role. Here we argue that explicit CF will be more effective than implicit CF techniques; this is because learning to read in an alphabetic script involves conscious awareness of phonemes as linguistic objects.

More so than literate learners, those adults learning to read and write for the first time in their lives are often entirely dependent on the feedback of their teachers in the classroom. Their lack of transferable native language literacy skills greatly restricts options for independent work as these are invariably tied to literacy. In a classroom, however, continuous explicit feedback for one and the same learner – although useful – is neither practical nor effective. When the learner experiences negative attention in front of classmates CF typically results in anxious learners who may decline to participate. Explicit, negative CF does not create the safe environment that is fundamental in learning for LESLLA learners (see e.g., Santos & Shandor, 2012). Practitioners and researchers have experimented with materials in which a safe environment can be guaranteed while providing opportunities for systematic, consistent, intensive and clear feedback at the moment learners need it. Paralinguistic signals, which are both explicit and immediate, contribute to this safe environment.

They attempt to non-verbally elicit the correct answer from the learner. This is executed in many ways in the *FC-Sprint*^{2} and the *DigLin* materials.

Types of feedback techniques

In order to operate autonomously, the *DigLin* learner needs ample opportunities for getting feedback. All feedback techniques provided in *DigLin* are forms of immediate feedback (except exercise 7, 'test yourself'). In Ranta & Lyster's (2007) CF taxonomy, this falls under explicit feedback with a paralinguistic signal. In the *DigLin* exercises, this is a disappointed sound, or an item that refuses to stay in the blank to which it has been dragged. The learner can make repeated attempts and the system responds each time rather than at the end. This prevents the possibility of the learner automatizing his/her errors.

CF (when the answer is incorrect) takes a friendly form, as shown in the screen shots in Figures 2-6. Positive feedback is signaled by the learner's successful dragging action, by a green **√**, a green button, or an encouraging sound.

The feedback techniques in *FC Sprint*^{2} can be divided into two main types:

- *Feedback created by the system*
  When there is a certain action, for instance when the learner drags, reads, types a word or grapheme, the system reacts with immediate feedback (correct or incorrect).
- *Feedback created by the learner him/herself*
  By clicking on buttons, hovering over buttons, comparing sounds, listening to sounds and words, and looking at photos (necessary to understand why an answer is incorrect). This type of feedback can be compared to the use of a dictionary by literate learners.

Exercises

The exercises are constructed in such way that non-literates are challenged to do something: to touch (with a mouse) colored buttons, to listen and look and to do so again and again. The *DigLin* course materials consist of 15 sets of 20 words for each language. In these exercises, clicking a mouse on the leftmost green button activates the audio for that word and the next, smaller button activates a photo of the word. For Finnish, German and Dutch, the basic orthography for each language is involved in this selection; for English more sets of 20 words would be needed for coverage of all grapheme-phoneme correspondences. Although learners can start with any set of words they choose, the exercises within a set are presented in a specific order (see Table 1) which reflects the pedagogical steps in a phonics-based method aiming at associating specific sounds (phonemes) with specific letters (graphemes). This is done on the basis of a whole word which is visually and auditorily divided into smaller units (analysis). Traditionally, this is done with a sheet of paper and the voice of the teacher that clearly shows the sub-lexical structure of a word (the analysis) and supports the blending of the sounds into words (synthesis).

In computer-aided systems like *FC-Sprint*^{2} and *DigLin* these processes are taken over by the visual and auditory form of the exercise shown in Figure 2. The visual form shows a written word as a composite unit of separate elements. The squares with graphemes can be activated and they play the specific vowel or consonant. In this way both the visual and the auditory character of the word

can be realized as often as needed for systematically developing letter-sound associations. Not only is word analysis taken over by the computer programme, but the synthesis also is to a certain extent. That is to say, a learner can understand what the result of the synthesis is (the entire word played by the green button to the left), but is not challenged to read it aloud. *DigLin* will add this possibility to the five exercise types taken from FC-Sprint[2] in the form of ASR providing assessment about the read word. Here pronunciation plays a role as well.

The presentation exercise (Fig. 2) is meant as an orientation for the learner. (S)he can try out what (s)he wants. In the German exercise called "From letters to words" in Figure 3 the learner is challenged to fill in the blanks with the correct graphemes.

Figure 2. *Presentation of 20 Dutch words with the sound bar at the bottom. The meaning of the word 'boom' is activated by the learner and shown on the screen.*

The learner whose screen is shown in Figure 3 has followed a strategy of finding out where to place the first letter of the alphabet. (S)he has found all blanks for the <a> at this point since the block with <a> in the alphabet is no longer grey. So at the end of this exercise all grey blocks in the alphabet will have become white. Other learners may follow different strategies, for instance first filling in all the blanks of the first word.

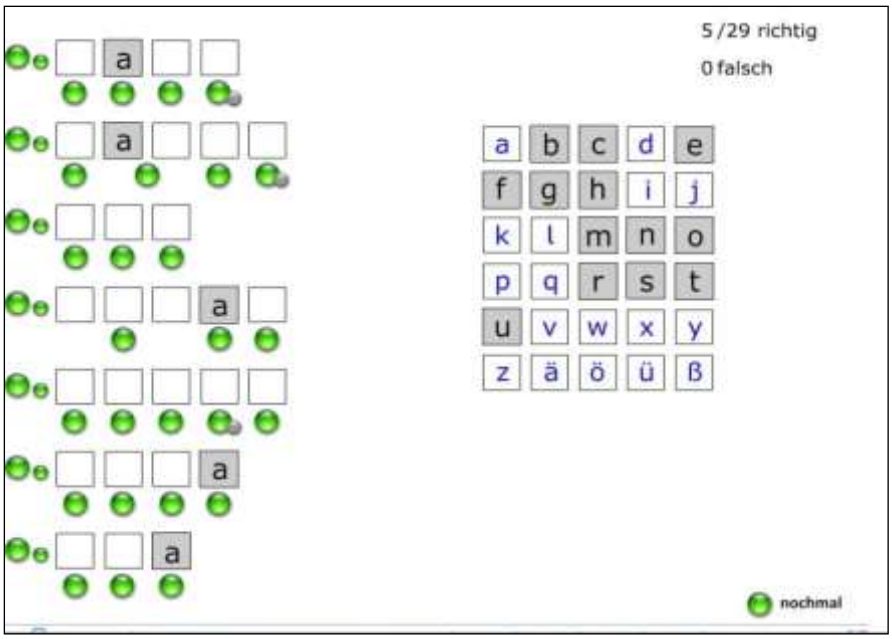

Figure 3. *From letters to words (German version)*

In Figure 4, words are dragged. There are two rows of words and two rows of blanks.

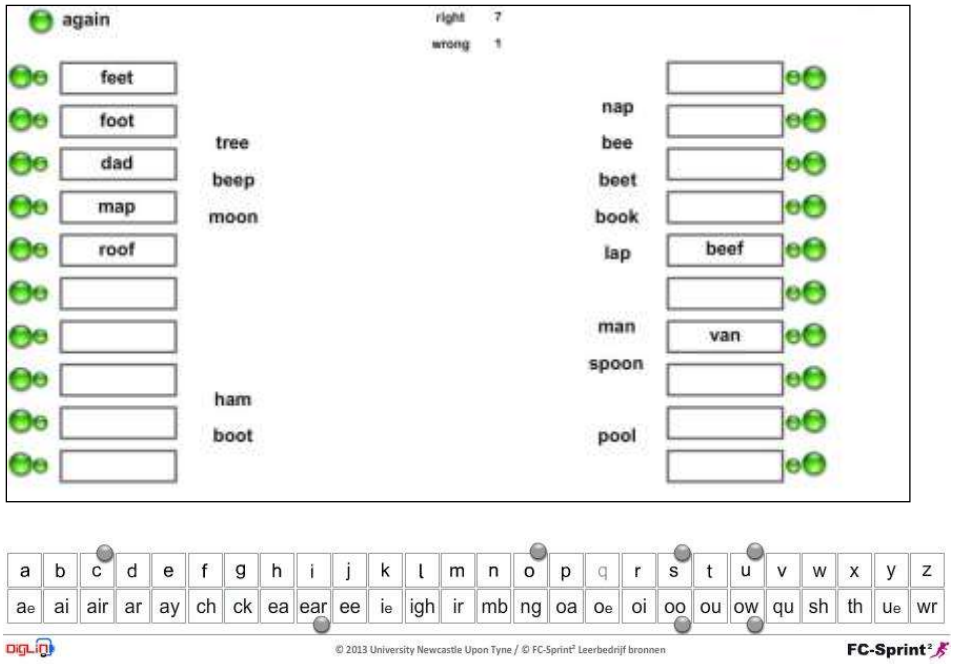

Figure 4. *Screen shot of Exercise 3: Dragging words-1 (English version)*

The learner needs to drag words listed to the blanks. The learner whose screen is shown has successfully dragged seven words to the correct blanks on the left and the right. A learner can use several strategies: (S)he can recognize the word as a unit and connect it the correct photo, or (s)he can first listen to the word, try to analyze the word (with help of the sound bar) and try to recognize the written word on the basis of the first grapheme, or use similar strategies.

Figure 5 also shows a dragging exercise, this time based on the dragging of individual graphemes in German. This exercise is particularly useful for blending of individual phonemes into a

word. This exercises requires the learner to first synthesize the phonemes 'hidden' under the four buttons to the left of each blank; then when the learner locates the word <Sofa> 'sofa', (s)he must search for it in the list of written words and drag it to the blank. This learner has successfully dragged five words to the appropriate blanks (a green button appears right of the blank, when the action is correct). The learner can also listen to every grapheme in the sound bar.

This form of feedback takes the form of being able to check the synthesis of phonemes without reading the word aloud. It is a way of disentangling reading (i.e. synthesis of graphemes to silent word reading) from pronunciation and thus provides evidence that it is possible for even beginner learners to practice (and test) their skills without reading aloud. Yet, this is not *DigLin's* ultimate target. Rather, the aim is reading aloud at a level that native speakers of the target language can understand the learner without great effort.

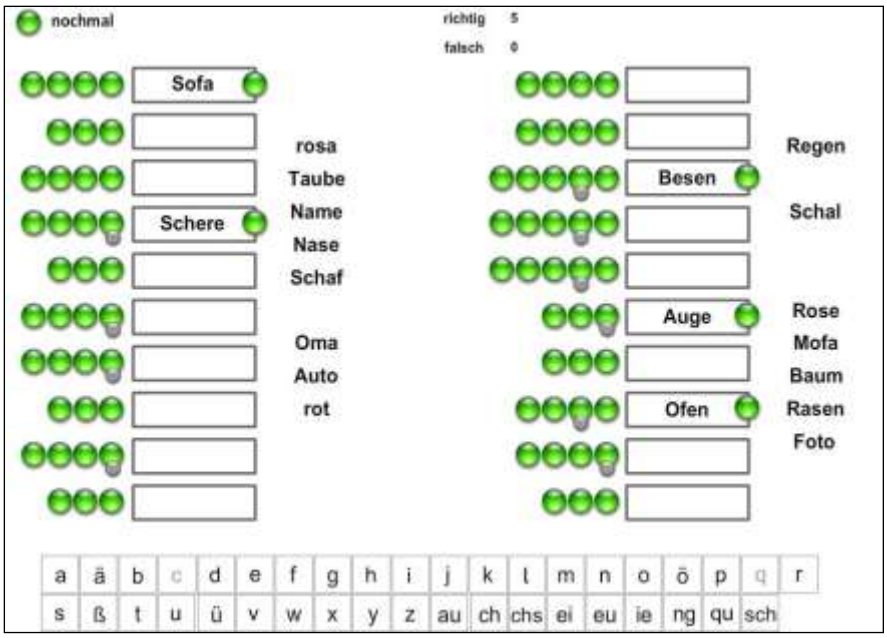

Figure 5. *Screen shot of Exercise 4: Dragging words-2 (German version)*

In Exercise 5, shown in Figure 6 for Finnish, the learner has to type the word (s)he hears in the blank. This requires analysis of the spoken word and finding and typing the corresponding graphemes. The sound bar at the bottom can help in finding the appropriate graphemes. The screen shot in Figure 6 shows that this student has correctly written 14 words; an incorrect answer simply does not get the green sign (√).

Figure 6: *Screen shot of Exercise 5: Dictation (Finnish version). The leftmost button provides the spoken word the student has to type.*

ASR-based corrective feedback on read words

Exercises 6 and 7 (not shown here) form the last phase of the beginning reading process (see Table 1) for each set of words. These exercises consist of reading 20 words of a Dutch, English, German or English set. There are no photos and no chances to listen to words. Exercise 6 includes only the 20 written words and the sound bar, and Exercise 7 is without the sound bar and words are in an arbitrary order. This exercise enables the learner to assess the quality of their pronunciation by providing explicit feedback on words read aloud.

Figure 7: *Screen shot of feedback by ASR* (Dutch version)

Because this form of feedback is not included in *FC-Sprint*[2], the *DigLin* project has been developing additional exercises using dedicated ASR technology and error detection algorithms. The application of ASR technology and automatic error detection in the non-literate classroom is innovative and challenging, particularly because we are dealing with the non-native speech of low-proficient

learners (van Doremalen et al., 2010). The process in this exercise will work as follows: The learner reads a word aloud and after every word (s)he receives detailed feedback. It is gradient rather than absolute; it indicates the degree of correctness. The student in Figure 7 has pronounced <kam> 'comb' but the pronunciation is not sufficiently close to the target (amber color). The phoneme /a/, which was most incorrect, appears in red. The learner's realization now appears on the screen and the learner can compare this with the target sound and try again.

Conclusion

The learning concept of FC Sprint[2] might appear to conflict with the systematic and sequential instruction essential under a phonics approach. The Digital Literacy Instructor, however, has the potential to retain these features. As seen above, DigLin shows the structure of the word for the learner's eye and ear in a systematic way, while allowing the learner more freedom. It allows individual routes based on native language influences and individual problems, interests and learning strategies. Teacher feedback is replaced by DigLin's systematic, consistent (always the same exercises and same feedback), intensive (practice is illimited), and clear (visual signals) corrective feedback. The teacher supports and encourages the learner by setting high expectations. Is this really feasible for the non-literate adult L2 learner, one might ask. In the beginning, the learner might have a hard time, but experience with non-literate students at Friesland College, elsewhere in the Netherlands and in Denmark at *Laer Dansk* have shown that this approach is successful (see Koot et al., 2011). Learners become more active, explore on their own how to solve problems they encounter, and, as a consequence, their motivation increases. Can a non-literate adult learner even work with the computer without a thorough introduction to digital skills? FC-Sprint² assumes that that can; many skills can be learned just by doing, like pre-school children who start using computers, tablets, iPads and so on, without any instruction or the help of older children or adults if we only challenge them! The next phase of the project (September 2014 – February 2015) will reveal in the four project countries precisely how learners rise to this challenge.

Acknowledgements

This project is funded with support from the European Commission's Grundtvig programme for lifelong learning under project number 527536-LLP-1-2012-NL-GRUNDTVIG-GMP. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

We thank the other members of the *DigLIn* team for their contributions, in alphabetical order: Catia Cucchiarini, Marta Dawidowicz, Vanja de Lint, Jan Deutekom, Enas Filimban, Lucy Martin, Maisa Martin, Rola Naeb, Jan-Willem Overal, Karen Schramm, Helmer Strik, Taina Tammelin-Laine, Joost van Doremalen.

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