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# Innovative Inclusive Educational Technology in Language Classrooms and Learner Perspectives: A Study of Nine Learner Narratives

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**Abstract.** Emerging from studies of innovative educational-technology designs for disabled students, Universal Design for Learning (UDL) has established principles to bridge special needs education and regular classroom teaching. Although UDL has been around for some 40 years, apparently, only one empirical UDL study of language classrooms exists before Kasch, and no studies before him in lower-secondary language classrooms. Only Kasch has worked on integrating Computer-Assisted Language Learning and UDL in a pedagogically informed cross-pollinated Computer-Assisted Language Learning (CALL) and UDL design.

The present paper examines a sui-generis innovative language learning design and learners' interaction with it, affording the digital scaffolds: 1) multimodal bilingual comprehensive, 2) contiguous (words-in-context) and non-base-form glossing, 3) text-to-speech with highlighting functionalities as well as 4) bilingual retelling functionalities for individual Ebook pages and 5) learner response functions.

The hypothesis explored is that multimodal UDL digital scaffolds can be pedagogically integrated in language instruction materials and will help to bolster language acquisition in a variability of learners. The paper presents the findings from semi-structured interviews in a stratified sample ( $n = 9$ ), appearing to offer support to the viability of the sui-generis CALL and UDL language learning design.

**Keywords:** Educational technology · Inclusive practice · Universal Design for Learning · Language teaching · Empirical study

## 1 Background

In recent understandings of educational technology for special-needs learners, researchers proffer inclusive rather than assistive uses of assistive or remedial technology in special education needs (SEN) pedagogy [9, 10] and in Universal Design for Learning (UDL) [12, 18]. In research on UDL in language classrooms, Strangman et al. [20, 23] have empirically explored the affordances of digitised texts and applicable

general-purpose software for special-needs learners (like search engines and text-to-speech software, automatic translation engines as well as virtual animated “coaches” scaffolding learning/reading strategies). However, the authors apparently disregard the now well-studied limitations of pedagogically uninformed general-purpose software as well as general learning design criteria [5, 14].

Cross-pedagogically integrated understandings of assistive/inclusive educational technology in language classrooms have so far only been addressed by [15], who in 2018 investigated a cross-pollinated learning design hybridising computer-assisted language learning (CALL) and UDL in a pilot study [15]. Apparently, prior to Kasch [15] pedagogically integrated inclusive I(C)T designs in language classrooms have not been available<sup>1</sup>.

CALL expands with technology [3] has of late moved into robot-tutoring [27] studying pre-schoolers’ (social-) human-robot-interaction, the large-scale study finding, however, no increased learning gains over tablet-based instruction. The design of the study of the present paper, however, relies on the existing Bookbuilder platform for constructing Ebooks at cast.org. The scaffolds of the design comprise compendious clickable bilingual multimodal glossing (text, speech/sound, pictures) allowing learners to have access to help on all text and everywhere in the text and with chunks of contiguous text glossed, rather than lemma-/base-form glossing of words in isolation. Individual-word glossing is exceptionally used in 4–6 word cotext allowing word-for-word translation into Danish. Additional scaffolds offered by the design and examined in this study are audio files in English and Danish recapitulating the content of each page in the Ebook (prototype) and built-in text-to-speech functionalities. In addition, the built-in response field for each Ebook page was used, providing learners with a reflection question to scaffold learners’ reading strategies. Figure 1 below shows the compendious multimodal glossary functionality from the Ebook prototype. At the bottom of the page, two clickable

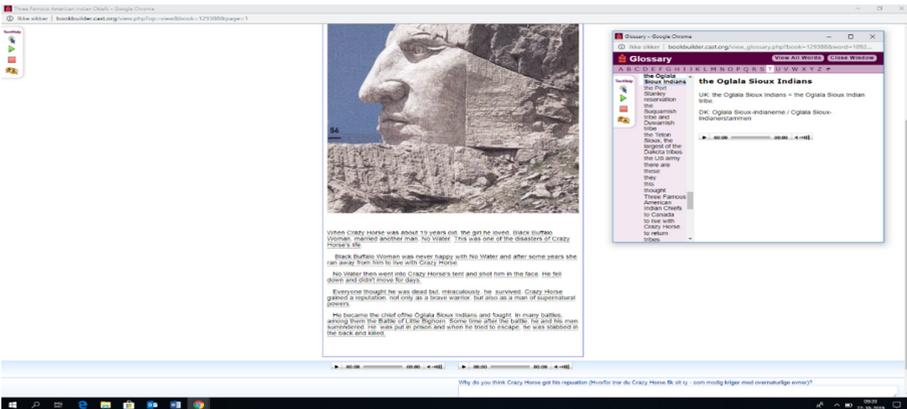


Fig. 1. Ebook functionalities (screen dump)

<sup>1</sup> Thus, a search of the entire ProQuest set of databases with the truncated search string “Universal Design for Learning (ab)” AND “empirical (ab)” for peer-reviewed publications only returned 34 hits on 29/03/2019. Of these, empirical studies - including review studies - examine only pedagogically neutral or general purpose ICT and UDL-guided applications.

audio files for having the page contents retold are accessible, as are the text-to-speech functionalities on the left-hand side of the graphic user interface.

To examine the viability of UDL-CALL design and the scaffolds, the paper sets out to examine learner experiences in classroom interventions. Using semi-structured interviews of learners drawing on Kvale and Brinkmann [4, 17] sampled from a four-point scoring range of (written) performance strata, the paper explores learner experiences of interacting with the design. The study is part of an ongoing parallel quantitative and qualitative research project with data integration [8, 11].

## 2 Qualitative Research Interviews: Research Questions and Interview Guide

The study of this paper carried out nine interviews in two days on the day of the last of three classroom interventions and on the following day. Based on Brinkmann and Kvale, [4, 16, 17] the author had designed an interview guide for a semi-structured interview, translating theory- and research-informed hypothesis-relevant research questions into quotidian parlance comprehensible for a Danish year-seven learner (13–14 years of age). The overall research question was “What does input channel augmentation and variability mean to foreign language learning processes?” The study hypothesises that assistive functionalities are helpful to learners in the whole classroom (and not just struggling learners) and that learners find other uses for functionalities than intended (remedial) ones [21]. This hypothesis was explored in questions asking interviewees to tell about usages and experiences of individual functionalities. The augmented scaffolding in the totality of functionalities were expected to produce a sense of “mastery experience” and “self-efficacy” [1, 2] in students. The interview guide also asked to the interviewee to give further relevant comments, if any. The author conducted interviews and transcribed them verbatim, annotating paralinguistic features, such as laughter.

## 3 Sampling, Interviewing and Narratives

The nine interviewees were sampled in conformity with the Danish national Code of Conduct and thus based on informed consent from parents and students alike. Accordingly, a sample reflecting multiple levels of performance at the five-point Danish nationwide Test in English-as-a-foreign-language (EFL) proficiency attained by the class was taken, representing the levels KUM (clearly below average), UM (below average), M (average) and OM (above average)<sup>2</sup>. A list of consenting students had been prepared by the collaborating teacher sample of consenting students was given to the interviewer, who was new to the classroom and did not know the students’ levels until after the interventions. The teacher had been instructed by the author to conduct a national test prior to interventions and prepare a list of consenting students, aiming at having at least one student represent all performance strata. The original list contained 10 students, out of which, one student

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<sup>2</sup> No student in the classroom had performed at KOM (clearly above average) level, but all other strata were represented.

regretted his/her consent. After this, the list of interviewees contained: one KUM student, one UM student, two M students and five OM students. The sample distribution does not quite match national performance averages of 2018 [26]: 5% KUM performers, 17% UM performers, 34% M performers, 37% OM performers, and 11% KOM performers. In other words, 3 OM (33.3% of the sample) and 3 M interviewees (33.3% of the sample) and 1 KOM (11.1% of the sample) might have provided the author with a more fine-tuned representative breadth. The additional M and OM informants gave the author, however, the opportunity to look into intra-level variability, if any, i.e. to see if students inside the same proficiency range would have different learning experiences and different narratives to tell.

No student, it turned out, had the exact same learning experiences or learning strategies: Hence, nine thematically different narratives. In conducting the interviews, the author strove to abide by the interview guide but also to make room for spontaneity and humour to reduce tension, if any, between him and the interviewee. The distillations performed aspired to represent the narratives of all interviewees and avoid biased representations. As transcriptions document, great care was taken to have the student's opinion and clarify their viewpoints by the use of follow-up questions.

Like Mark Turner's cognitive semantics [25], contemporary narrative inquiry [6] argues that human beings structure experiences as stories. In this light, Brinkman and Kvale's hermeneutico-phenomenological qualitative approach to research interviews translates into a co-constructed "story" or narrative structuring interviewee experiences [17], i.e. a collaborative effort on part of interviewer and interviewee to represent the interviewee's experiences. Transcribing the narratives (in itself an interpretation cf. [3]) then enabled a thematic meaning condensation by the author. In the narratives, gender-neutral reference is used ("they" for "s/he", "themselves" for "himself or herself", etc.) for anonymity.

### 3.1 Nine Narratives of Learning Experiences

The (transcribed) interview with KUM (clearly below average) is a narrative conveying the theme of pleasure, i.e. "intrinsic motivation" and "self-determination" [22] of having access to help: all functionalities helped KUM in learning as regards their recognition networks [12]. Functionalities helped KUM to "understand" the text and enabled them, KUM felt, to know how to explain the text in their native language. Thus, bilingual text glossing and pictorial glossing as well as bilingual sound glossing, retelling functionalities in Danish and English and text-to-speech with text highlighting functionality were used. The informant expressed "intrinsic motivation", saying it was very good to have them, and it was "actually rather fun"<sup>3</sup> to have such functionalities, as it was "something entirely new". KUM expressed that they would like to have such functionalities in their regular text-based instructional materials. KUM also explained how they felt that if you could not understand one meaning representation, you could just go on to the next and when asked of what individual functionalities offered, KUM told me that you got more "information". In summary, the student's narrative appears to depict an experience of

<sup>3</sup> All quotations were translated from Danish.

having the help to “self-regulate” their learning [19] – an experience alignable with Bandura’s “mastery experience”, which is a source of “self-efficacy” [2].

The narrative distilled from UM’s interview pinpointed specific experiences with functionalities. The narrative saw no use in pictorial representation but great use in both bilingual glossing modalities (text and sound) as well the retelling functionality. The experiences, however, also pointed out that sometimes near-inaudibility of spoken glossing needed an increase in volume and that the text-to-speech function was not fast enough compared with that of a commercial assistive software package offered to dyslexics in Danish primaries and lower-secondaries, which UM used. The experience was, apart from easy access and a help for UM to understand “the meaning” of the word – to help the words to “sink in”. The narrative also touched the themes of non-lemma-based and contiguous glossing, which were a pleasant alternative to confusing base-form dictionary entries (for non-base form look-ups) and multiple entries to keep track of with e.g. collocations or constructions abounding in low-frequency words. Information-retrieval from the standard lemma-based glossing in standard language teaching glossaries and online dictionaries made comprehension much more error-prone. The retelling function (in sound) was also experienced as useful and as something the interviewee used very much to make sure that they were “absolutely certain” “what the text was about”, preventing them from relying on misunderstood guesses - but also something that helped them to communicate on the text, i.e. scaffolding both “self-regulated learning” and communication skills [19]. In addition, sound sources were also “nice” for having access to speech by a real human being to listen to as an alternative to built-in robotic software-based diction. The narrative may suggest that access to English spoken by (competent) humans is experienced as sparse in the classroom and that retelling augmentations can help to meet such needs in learners. On having the totality of functionalities at their disposal, the narrative expressed the interviewee’s great satisfaction, saying it was “mega nice” without further ado, also expressing “intrinsic motivation”. In summary, UM’s narrative depicts a learner experience different from KUM’s. Compendious glossary functionalities were felt to facilitate both vocabulary acquisition and communicating on the text and not just textual comprehension. The general theme of self-efficacy achieved via self-mastery is also represented here. Like KUM’s narrative the functionalities involved “intrinsic motivation” [22], as suggested by the above “mega nice”.

In M1’s narrative, the experiences of using the glossary function were not as plentiful: only a few words had been looked up and sound glossing was not used at all, as M1 explained, because they had completely forgotten about the feature. However, both text glossing in English and Danish was used as it helped M1 to understand “what the text was about”. M1 would read the glossing in English first and the Danish glossary entry. When explaining what the user experience was like, M1 stated that, “it felt easier to read (the text)”. The informant’s experience of using the highlighting text-to-speech function was one of listening while reading as, in M1’s opinion, “it is easier reading the text and understanding it” when listening to the text-to-speech function, suggesting “super-additive” comprehension “effects” from bimodal learning integration [7]. M1 also used the retelling functions both in Danish and in English, which also M1 experienced as helpful for text comprehension and - especially helpful for a jigsaw task in intervention asking students to present part of the text. M1’s narrative expressed concern

about misaffordances. When asked about whether having all the functionalities at your disposal in other instructional materials would be of help, M1 expressed that it would only be the case if the functionalities were not too much help, as then, “we don’t kind of learn things ourselves”. On second thought, however, M1 expressed that it would not be too much help when having to communicate about the text in English. Like UM’s and KUM’s narratives, M1’s pointed out that having the assistive functions meant that it “was much easier to learn English”. Although M1’s narrative also shares the theme of facilitated self-efficacy, it presents a special experience: listening to retelling functionalities in both EFL and Danish combined with listening to text-to-speech functionalities while reading apparently almost obviates the need for bilingual sound glossing and possibly significantly reduces glossary look-ups, owing in part to bimodal integration [7]. This is a creative tack on functionality use: Bilingual retelling seems a near-substitute for compendious sound glossing. Astoundingly perhaps, the bilingual retelling function originally meant to prepare dyslectic or struggling learners for reading the text, presents another learning opportunity, viz. use it for comprehension checks, scaffolding self-regulated learning [19] or cognitive executive functions [12].

M2’s narrative depicts another learning experience of glossary function usage. M2 sometimes used pictorial glossing to see “what things looked like”. As for textual glossing, M2 only used the entry in Danish, not using the sound glosses at all. M2 did not need the sound glosses as they felt it was easier to just read the entry in Danish and since they felt they did not have literacy problems. M2 felt that textual glossary entries helped them learn the meaning of the individual glosses. When asked about the text-to-speech function, it turns out that M2 had mistaken this function for the retelling functions, of which they used both functions, listening to the Danish one before the English one. M2 explained that these functions helped them feel more certain about meaning comprehension. In their narrative, M2 argued that the assistive functions would be of great help, if one were a “dyslectic or the like”, but answered affirmatively when being asked if the functions could be of help to themselves. When asked about navigation in the graphical user interface, M2 expressed that they found it very easy. In summary, M2’s narrative also speaks of self-efficacy with retelling functions in both Danish and English, as a help to self-efficacy and self-regulated learning [19], becoming certain about one’s understanding in addition to checking textual glossing in Danish. Moreover, despite their arguments that functions are most meaningful for “dyslectics and the like”, retelling functions were found to be very useful to remove uncertainty. M2’s narrative is interesting from the vantage point of language acquisition and cognition. According to e.g. usage-based theories of language acquisition [24] or general theories of cognition, it stands to reason that other learning is involved in M2’s comprehension check in listening to a paraphrase of the meaning content in two languages and comparing this with their own understanding(s). It seems to be rather a complex cognitive process calling for involving an integration of dense cognitive structures of possibly both monolingual and bilingual semantic networks. Unlike individual glosses, the comparison involves an entire Ebook page, i.e. M2 might very well have learned more than they themselves realize.

OM1’s narrative shows us another combination of learner experiences. OM1 did not use pictorial glossing, as they did not find it helpful. OM1 used textual glossing in

English, though, and then textual glossing in Danish, if they did not comprehend the former. Glossing helped OM1, as they explained, to understand individual glosses and but also to understand the whole sentence and “constructing wholes”. OM1’s experiences portrayed a new version of the self-efficacy theme: the text-to-speech function, they said, helped them in acquiring pronunciation skills. OM1’s narrative spoke of a preference for the auditory retelling scaffold in Danish, which was used for comprehension checks, but occasionally the retelling function in English was used first after reading to see if listening to the function made more sense than reading the text. Like the other narratives, the navigation was seen as easy, in fact “very easy” and seen as a good alternative to Google searches and Danish bilingual online dictionaries.

OM2’s narrative is different. Saying that they are a relatively proficient EFL learner, OM2 argues that pictorial glossing was of little use to them and not used at all. Instead, OM2 used bilingual textual glossing, starting with the English entry and then consulting the entry in Danish. Sound glossing was not used by OM2 at all. Instead, apparently, OM2 used the text-to-speech function to find out about and hear the pronunciation of word highlighted. OM2 found it nice, however, that you could listen to somebody else read the text aloud if you were not sure that you understood. OM2 felt that glosses helped to acquire words, viz. glossary entries in English that OM2 felt that they might learn additional words from. In addition, OM2 used the response function, but unlike e.g. M1 who did not think it conducive to learning English, OM2 thought that it helped them to think about how to formulate answers, i.e. facilitated working on written proficiency and, therefore apparently, OM2 used the response function consistently. Again, we see a different variation on the theme of self-efficacy, namely a story of using the text-to-speech function for pronunciation practice rather than for auditory access to meaning construction. Similarly creative is the use of English glossing for extended vocabulary acquisition and using the response function to work on written proficiency, rather than the intended use of helping the learner with their “strategic networks” [13] regarding on-task behaviour.

OM3’s narrative presented yet another learner experience. OM3 felt they did not need pictorial glossing and thought it a good idea to avoid the Danish retelling function, as it would make “things too easy”. In fact, OM3 did not use retelling functions in general, as they felt they had no problems understanding the text, their only need being access to textual glossing occasionally. The glosses, they felt, helped them comprehend the individual entry as well as the whole text. However, OM3 mostly used the glossing in Danish, it being the most “convenient” access to meaning. However, like e.g. KUM, OM3 expressed “intrinsic motivation”, saying that having all the functions was a “delightful experience”, especially as, like UM, that the non-lemma-based glossing design gave them easy access to good explanations to help them understand the very “hard words”. Unlike OM2, OM3 did not feel that the response field function helped them to acquire English. Here the themes of self-efficacy and “self-regulated learning” were expressed as having access to understanding the “very hard words”, which sufficed for OM3 to move on, apparently, and to this end, the design was, as OM3 expressed, rather suitable.

OM4’s narrative told of pictorial glossing as a help to envisage the meaning content but not as something helping them to acquire English. OM4 saw themselves as somebody who was good at English and found that they could learn more consulting textual glosses

in English, which they found easy to understand, and not just Danish textual glosses. They felt that it was “cool” to use the textual glossing in English, and if they did not understand, they could just go to the entry in Danish. Like other OM informants, OM4 did not use sound glossing. However, they used the built-in text-to-speech function for working on pronunciation. OM4 liked having the retelling functions at their disposal although they did not use them: it helped them feel secure that if they needed help understanding the whole text, help could be offered. Moreover, OM4 found that the response field helped them to learn English in that it helped them “to dig deeper” - to think about if they had understood the text correctly and let the meaning content sink in, i.e., used the function to help them to keep track of the details of the meaning content. OM4 thought it “mega delightful” having access to all the assistive functions and using functions at their own discretion, and that navigation was easy and was, as in other narratives, a pleasant alternative to search engines and online dictionaries. OM4’s narrative also expressed pleasure of participating in the “experiment”. Also in OM4’s narrative, we see a new variation on the themes of “self-efficacy” and “self-regulated learning” and “intrinsic motivation” [19, 22]. OM4 seems to use the English textual glosses for boosting their confidence to be motivated by a “mastery experience” - cf. [2]. It stands to reason that consulting the English glosses also helps the student to solidify their vocabulary and English proficiency in general in its capacity as interpretation practice and “usage-based” appropriation of the foreign language [24]. OM4’s narrative of the learning experience expressed that consulting glossing in English may be a “cool” experience boosting confidence. OM4 liked to have the safety net provided by the mere access to retelling functions – though not used – to alleviate fears of misapprehension. Like OM2, OM4 presented a creative use of the text-to-speech function, viz. for practicing pronunciation skills.

Unlike the above OM narrative, OM5’s narrative presented experiences with sound glossing. Like OM4, OM5 also used pictorial glossing to have an idea of what things were and like OM4, they used the textual glossing in English, and if not helped enough, the entry in Danish. OM5 expressed that they really liked the way glossing was “well-written”. Unlike OM4, OM5 was not sure the response field was of any help to them regarding language acquisition, although they had used it almost consistently. Also here “self-regulation” was scaffolded: OM5 was very pleased with direct access to direct glossing and authoritative “well written” explanations and not having to rely on Google searches that they felt might not help them find the right answer. OM5 used sound glossing a few times because they found it pleasant to listen to as it they found it to be “good recordings” in English and Danish. They just wanted to listen to it (out of curiosity, apparently), as they felt they could easily under textual resources. OM5’s narrative evaluated the assistive functionalities trying to take the point of view struggling learners and expressed that, in general, they felt that run-of-the mill instructional materials left struggling learners behind. When asked to clarify, OM5 told of a struggling learner they had as a friend, who they imagined could do well with such assistance, and that the assistive software their friend had was no good compared to the functions in the Ebook. Hypothetically, OM5 felt that they might use the retelling function in English but primarily understood it to be a very good helping hand to “struggling readers”. Unlike OM4, as for whom retelling functionalities could inspire security and confidence,

OM5's narrative presented no such need, and their concern and empathy for struggling learners seem to convey a confident learner personality, for whom access to bilingual textual glossing apparently sufficed. OM5 preferred the Ebook prototype to course books because you had access to "all these explanatory resources", meaning that you could avoid situations when "you have to raise a hand to ask the teacher, 'What does it mean?'. Thus, thematically, OM5's narrative expresses a sense of assisted "self-efficacy" and "self-regulation". OM5's narrative concludes in the pleasurable experience - when asked for supplementary relevant remarks - it was very good to work with the Ebook and they felt that the Ebook was "hard to surpass" as an instructional material.

## 4 Findings and Conclusions

The sum of narratives conveys a variability of learner experiences and learning strategies/behaviours, presenting its answers to the research questions. A shared feature is one of facilitated learning processes by having access to the functionalities and ease of navigation, i.e., the hypothesis expecting a sense of increased self-efficacy was corroborated. Interestingly, the road to self-efficacy and self-regulation and the usage of assistive functionalities were both diverse and unpredictable. Learners found alternative uses aiding them in their language-learning process, using e.g. text-to-speech functionalities for pronunciation acquisition and retelling functions for comprehension checks. This lent support to the subhypothesis that different learners would experience and apply affordances differently. Apparently, only one learner applied the retelling functions for their originally intended use (KUM). The hypothesis that all functionalities would be of use to all learners in different ways was, however, only in part corroborated. Though they liked having access to all functionalities, most learners did not find all functionalities useful, but a variety of learner experience and usage concerning functionalities varied across performance strata and within strata of performance. For instance the narratives made clear that that some OM, M and UM learners might use the text-to-speech functionality to facilitate comprehension, while other M and OM learners might use text-to-speech functionalities for working on their pronunciation, but not the KUM and UM learners. It thus makes sense to provide all learners with all functionalities as diverse usages align the same assistive functionality with multiple learner strategies. Moreover, although there is trend in narratives for less usage to correlate with higher test performance, proficiency is in the narratives no good predictor for functionality use. Narratives rather show that assistive/remedial functionalities are of meaningful use to all strata of learners. Moreover, pedagogically informed assistive functionalities produced both a useful and delightful experiences. Since, however, only nine interviews have been conducted and individual variety abounds, further interviews are being conducted in current classroom interventions to reach a saturation point (cf. e.g. [17]) of the representative breadth. Moreover, there only being three Ebooks, which the author had to construct himself, aspiring to UDL principles compliance available precludes longitudinal studies, which could unravel further details on design viability. Even so, the narratives appear to corroborate the viability of all innovations of the instructional material design. In other words, pedagogically informed inclusive practices can be facilitated by a UDL-CALL learning design [15], i.e. time may be ripe for introducing pedagogically informed universal design to language classrooms.

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