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Competence visualisation: Making sense of data from 21st-century technologies in language learning

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Abstract

This paper introduces an open learner model approach to learning analytics to combine the variety of data available from the range of applications and technologies in language learning, for visualisation of language learning competences to learners and teachers in the European language context. Specific examples are provided as illustrations (Facebook, Second Life and mobile assisted language learning (MALL)), though the approach is a general one. We describe the Next-TELL open learner model as an exemplar that can encompass a range of data from a variety of technologies and activities, and as a competence-focussed visual analytics tool that can be readily used inside and outside the classroom.

The Next-TELL open learner model offers several visualisations for learners and teachers to explore the learner's current competences, which can be selected according to user preferences or the purpose of viewing the learning data. The selection of visualisations means that the open learner model is appropriate for school, university and other learning contexts. Viewing this data can help students to reflect on and monitor their learning, and can support teachers' decision-making during classroom activities or later, in their planning of subsequent sessions. As an example, we outline the use of the Next-TELL open learner model in a school in Norway.

Keywords: Open learner model, 21st-century technologies, language learning competences, visual learning analytics

1 Introduction

Twenty-first-century technologies are now part of everyday life, and this is also increasingly the case in language learning. A variety of activities, tools and platforms are available, each providing data about learning. However, discussing Web 2.0 technologies in language learning, Wang and Vasquez (2012) found that wikis and blogs have thus far received

greater attention than new approaches in virtual worlds and with social networking tools. Although there have been only limited studies indicating reliable measures of learning gain in mobile contexts (Burston, 2015), there is increasing focus on understanding how to *appropriately* use mobile technologies in language learning (Kukulska-Hulme, 2013).

In this paper our aim is to unite the various activities and technologies used within a language competence framework (e.g. Common European Framework of Reference for Languages (CEFR) (Council of Europe, n.d.)), thereby accommodating the possibly large amounts of data available from today's technologies into a pedagogically useful formative assessment and feedback tool. To illustrate we use the Facebook social network, the Second Life virtual world and mobile assisted language learning (MALL) as our examples since, as stated above, these have received less attention in language learning contexts, or interest is growing in defining appropriate use of the technologies. We show how data from such sources can be combined in meaningful ways in visualisations of learning for students and teachers.

1.1 Social networking: Facebook

Lantz-Anderson, Vigmo and Bowen (2013) highlight the potential for Facebook[1] and social networking to become extended spaces for language learning. Facebook brings opportunities to practise a variety of aspects of language, such as reading by following events, cities, sports teams in the target language; or allowing discussion or collaboration around pictures, events, etc. – all in an already familiar environment (Terantino & Graf, 2011). Facebook can also help with writing, for example in the brainstorming phase and from comments, before writing commences (Yunus & Salehi, 2012). It can also be used as a place to raise and discuss grammar and sentence structure (Suthiwartnarueput & Wasanasomsithi, 2012). Facebook can allow meaningful language use amongst users with different native languages, because discussion occurs with a real audience (e.g. Blattner & Lomicka (2012), with English and French). It can promote intercultural communication and help raise awareness of different language varieties (Blattner & Fiori, 2009), and support social and personal language learning strategies (Ibrahim, Prain & Collet, 2014). It can also support incidental learning even where the primary goal of students in joining Facebook was to socialise (Kabilan, Ahmad & Abidin, 2010), or it can be used as a route to connect with native speakers (Lee & Ranta, 2014). Finally, Facebook also shares some of the advantages of more traditional discussion environments in that it can support those who are more reticent in discussion, permitting delayed response in what remains authentic communication (Omar, Embi & Yunus, 2012), and can foster a sense of community (Blattner & Fiori, 2009). It may also make homework assignments more enjoyable, leading to a change in attitude towards language classes (Buga, Capeneata, Chirasnel & Popa, 2014).

1.2 Virtual worlds: Second Life

Second Life®[2] is a multi-user persistent (i.e. always-existing) 3D virtual world, where each user has their own customisable avatar, and can communicate through text and spoken interaction as they move through, and interact with, the environment. Second Life can be a way of

[1] https://www.facebook.com/

[2] http://secondlife.com/

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enabling interaction with native speakers (e.g. Thomasy Blasing (2010) for learners of Russian; Castillo (2011) for learners of Spanish), and interactions may positively influence motivation (Wehner, Gump & Downey, 2011). The environment, if appropriately constructed, can offer the kinds of interaction for practice that are difficult to achieve within the classroom, such as shopping or going to the bank (Milton, 2013). Chatbot agents in Second Life can offer further opportunities for interaction (Pietroszek, 2007). Peterson (2012) studied Second Life text chat of volunteer EFL science undergraduates, finding supportive interactions and peer-scaffolding which, in turn, led to social cohesion and task-focussed language, and enhanced learner autonomy. The existence of avatars in the computer-based environment was one of the main factors in increasing participation and engagement, as well as discourse management. Participation and engagement were also facilitated by meaning-focussed task design in a collaborative setting in oral use of Second Life, for doctoral students practising oral communication in English (Deutschmann, Panichi & Danielsen, 2009). Emphasis on communication (i.e. both oral and aural) skills was considered important, as was an authentic task rather than role-play. Furthermore, self-efficacy ratings were found to increase across a lesson when undergraduate learners of Chinese were immersed in a task in a Chinese setting in Second Life (Henderson, Huang, Grant & Henderson, 2009); and higher self-efficacy is likely to result in higher achievement and greater involvement in the Second Life language activities (Chiang, Yang, Huang & Liou, 2014).

1.3 Mobile assisted language learning

Mobile assisted language learning (MALL) refers to the application of mobile technologies for language learning where there are particular advantages offered by the mobile context (Kukulska-Hulme, 2013). Although there are, as yet, relatively few statistically reliable measures of learning gains from using MALL (Burston, 2015), the fact that mobile technologies are already used by learners offers opportunities not previously available. These opportunities for MALL are broad, ranging from more traditional vocabulary flashcards approaches (Basoglu & Akedemir, 2010) to mobile phones for listening skills (Nah, White & Sussex, 2008), mobile gameplay for language learning (Holden & Sykes 2011), and context-based approaches where a system can prompt with expressions at the appropriate level of formality for the location and participants, – such as a meeting room or office (Ogata & Yano, 2004), or offer activities according to available time and likelihood of interruption in the current location (Cui & Bull, 2005). Personalised recommendations of materials according to learner level or readiness have also been proposed (e.g. Hsu, Hwang & Chang, 2013, for reading materials), and lunchtime MALL opportunities can extend from the school to the home environment (Hwang & Chen, 2013). Metacognitive processes can be supported, such as facilitating on-the-spot noticing and recording using handheld devices wherever the learner happens to be (Kukulska-Hulme & Bull, 2009); and facilitating noticing and the processing of non-salient second language forms in the classroom – in this case, using iPods (de la Fuente, 2014). While different technologies may be used for MALL, these may easily fit into users' daily routines.

1.4 Combining technologies, applications and open learner models

Given the advances in technologies enabling the approaches described above, together with more traditional applications for language learning that may be used alongside these, we

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must remain flexible in our aim to support teachers using technology in the language classroom. For example, instructors using Facebook with a course may do so for different purposes, such as discussion of language form or meaning; brainstorming ideas; interacting with speakers of other languages; reading related to specific events or places. Instructors incorporating Second Life or other virtual worlds may wish students to practise specific roles or activities; interact with native speakers of the target language; and interact using text or speech. MALL may be used to extend Facebook use to the mobile context; benefit from location-based activities; or to extend the classroom to the home. In all these cases, data relating to competence levels[3] of learners may be generated during interactions. We introduce an approach to visualisation of this learning data, to help make it more understandable and usable for teachers and learners, to prompt learner reflection, and to aid learner and teacher planning and decision-making.

2 Open learner models for learners and teachers

There is now much interest in visualisation of learning data (Klerkx, Verbert & Duval, 2014), and learning analytics dashboards are being developed to help make sense of large amounts of data (see Verbert, Duval, Klerkx, Govaerts & Santos, 2013). These are often performance, activity, interaction, navigation, or behaviour-focussed. In contrast to this, in this section we introduce an approach that visualises current competence levels, based on learner modelling comprising data from a range of activities and platforms. We describe the typical role of a learner model; the extended approach of opening and visualising the learner model to the learner; and a further extension where the system does not perform any teaching, but leaves control and responsibility for learning with the user.

2.1 Learner models

A *learner model* holds representations of attributes relevant to an individual's learning. Most commonly modelled are skills, competences or knowledge, though other attributes such as misconceptions, learning style or motivation can also be modelled. The contents of the learner model are usually automatically inferred during the individual's interaction with the teaching system, based on their attempts at problem-solving, help requested or used, time on task, responses to specific questions, etc. The learner model is then used by the teaching system to select or generate appropriate feedback, tutoring, exercises, materials, etc. to meet the specific learning needs of the individual user, at the particular time. Thus, the learner model is dynamically updated: as the user learns, their learner model updates to reflect this.

Many CALL approaches use natural language processing and parsing to interpret and infer learner language, in order to tailor feedback. For example, E-Tutor performs a parser-based linguistic analysis of learner input, to provide personalised error-specific feedback (Heift, 2008); and TAGARELA uses triggers such as pictures, word lists, written cues, etc. to constrain input in order to analyse learner data (Amaral and Meurers, 2011).

[3] We use the term "competence level" to describe students' level of achievement in a range of language skills or abilities. This is further discussed in Section 3.

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Such constraints allow the system to tailor feedback with sufficient precision for the learner. In contrast, while all student input is parsed, the Intelligent Sentence Writing Tutor offers learners a choice of level of correction: hint, complete correction, or the opportunity to retry without any correction (Dodigovic, 2013).

Other approaches include using a Facebook profile to initiate a learner model with information about age, residency, languages spoken, etc., together with a test to assess level of English, which allows the learner to be assigned to one of four stereotypes (novice, intermediate, advanced, expert). This broader model can subsequently be refined during interaction using inductive techniques such as Bayesian networks (Virvou, Troussas, Caro & Junshean Espinosa, 2012). The Tactical Language and Culture Training System takes a serious games approach, using dialogue models and speech recognition to detect the user's ability to use language appropriately, in a simulated face-to-face setting (Johnson, 2010). In this system, learners are offered advice on appropriate games or activities according to the state of their learner model, but the learner retains control over these choices.

2.2 Open learner models and independent open learner models

As described above, learner models are typically used by a teaching system to identify the most appropriate next system action or intervention for the learner. *Open learner models* (OLM) are learner models that are 'open' to the user. This means that, instead of the learner model being used solely by the system to personalise the interaction to the learner's needs, it can in addition be accessed directly by the learner or other users (Bull & Kay, 2007). Access to their learner model must be in a form that the user can interpret, and will not necessarily match the format of the underlying model. For example, the learner model may be presented as a concept map (Mabbott & Bull, 2004; Perez-Marin, Alfonseca, Rodriguez & Pascal Neito, 2007), or simpler skill meters (Bull, Jackson & Lancaster, 2010; Mitrovic & Martin, 2007; Weber & Brusilovsky, 2001) or, more recently, treemaps (Hsiao, Bakalov, Brusilovsky & Koenig-Ries, 2011; Kump, Seifert, Beham, Lindstaedt & Ley, 2012). Further detail is given in Section 2.3. OLM visualisations differ from many of the currently popular learning analytics dashboards (see Verbert *et al.*, 2013), in that they are based on an underlying *inferred model* of the learner's *current competences* or *understanding*, rather than behaviour or performance data logged.

Figures 1–5 show some of the visualisations of the Next-OLM (Johnson, Cierniak, Hansen, Bull, Wasson, Biel & Debus, 2013), to illustrate different visualisations and complexity or structure of information that can be shown in an OLM. The example relates to learning English which, in this instance, can be practised in the language class (competences shown at the foot of Figure 1) or in a setting of (face-to-face or online) meeting facilitation and participation – a 21st-century skill where English is also used (top of Figure 1).

Figure 1 shows skill meters for each competence and sub-competence: the "fuller" a skill meter, the higher the corresponding competence. Skill meters are quite common, as they are easy to interpret. Figure 2 shows the network visualisation. The larger and brighter the node, the stronger the competence indicated by that node. The network enables the structure of the competence set to be displayed in a smaller area, while the skill meters accumulate in a longer list. However, the underlying structure of the visualisation matches that for the skill meters. The radar plot in Figure 3 enables easy comparison of strengths and weaknesses

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Fig. 1. Skill meters

across the range of competences, though another visualisation will typically be more useful to follow up on specific areas if there is a large number of competences displayed. The same is true of the network view. The word clouds in Figure 4 show stronger competences in larger (blue) text on the left, and weaker competences in larger (black) text on the right. This is especially useful for a quick overview of strengths and difficulties, but less useful for a detailed examination since competences at the borderlines of strong/weak are harder to see. In the latter case, users can follow up their exploration using a different visualisation. Figure 5 shows a treemap, which, through a layered approach where clicking on an area reveals the corresponding sub-competences, allows complex competence structures to be examined within a restricted screen space – especially applicable for MALL. It is, however, more difficult to compare different areas of the curriculum or competency set.

2.3 Benefits of open learner models

There are many reasons for open learner models (OLM) (see Bull & Kay, 2007), and significant effects on learning and self-assessment have been found (Kerly & Bull, 2008;

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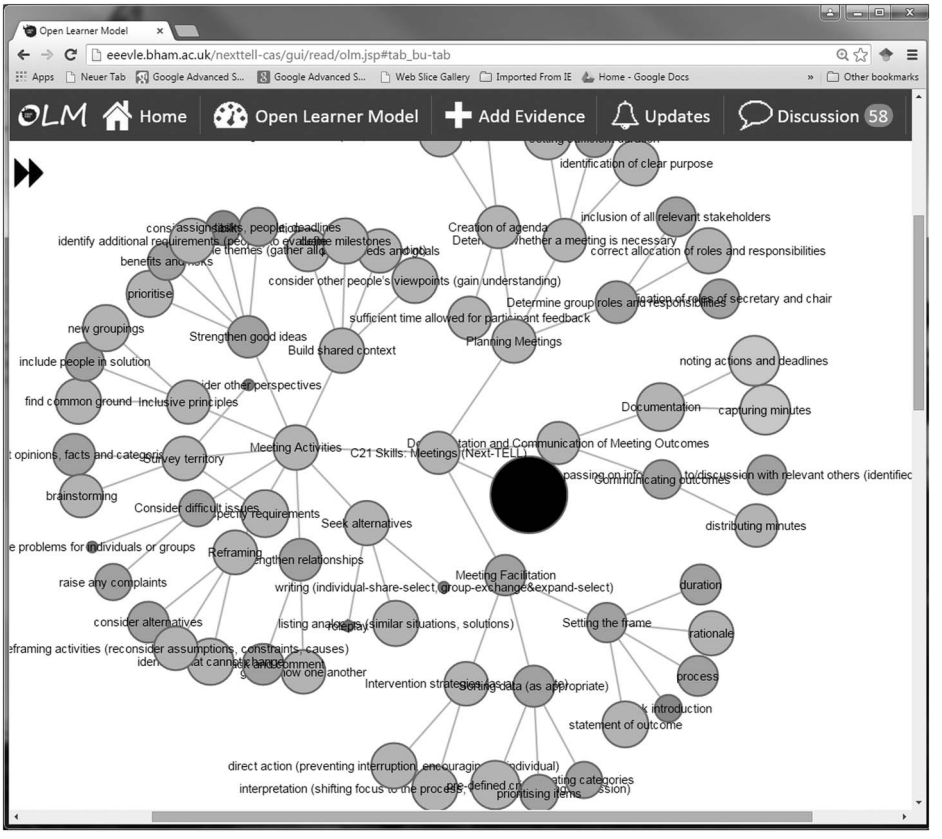

Fig. 2. Network

Long & Aleven, 2013; Mitrovic & Martin, 2007; Shahrour & Bull, 2009). Central to our discussion is that the OLM is a means of providing *formative assessment opportunities for learners*, and data about individuals and the class to *support teachers' planning and decision-making*. Because learner models are usually dynamically updated, the learner model maintains a current representation of the learner's knowledge, skills or competences. This means that this data can be used as a type of immediate feedback on the user's actual competences or understanding at a given time. A system is not only able to tailor its feedback (because it has a learner model), but by opening the learner model this data about the learner also becomes a *learning resource for the learner*. On viewing their learner model, as shown in Figures 1–5, the learner may subsequently reflect on their learning. Reflection and self-assessment are key components of formative feedback, and are a metacognitive activity that useful feedback aims to prompt (Nicol & Macfarlane-Dick, 2006).

Independent open learner models are not embedded in an adaptive teaching system: the system does not necessarily aim to further individualise the learner-computer interactions beyond presenting learners with their learner model (Bull, Mabbott, Gardner, Jackson, Lancaster, Quigley & Childs, 2008). Therefore, the task of taking decisions in their learning lies with the learner, encouraging greater learner control and responsibility over their

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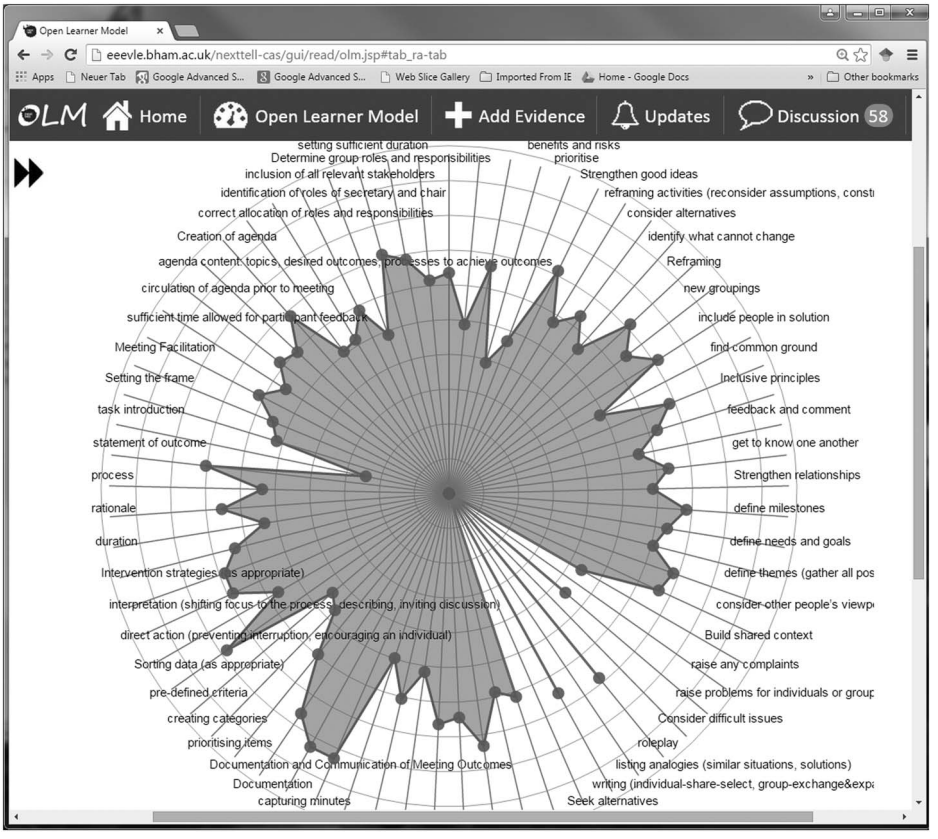

Fig. 3. Radar plot

learning (Bull & Kay, 2007). The learner, therefore, decides how to act on the information in their OLM as an independent learner. This may be, for example, by browsing online for explanations, attempting exercises or asking the teacher for advice. While OLMs generally have greater learner responsibility for their learning amongst their aims, independent OLMs *rely* on it: it is the role of the independent OLM to provide the learner with the type of individualised information on their understanding or competences, as described above, and to expect *the learner* to then make use of this information.

2.4 The Next-TELL open learner odel

The Next-TELL OLM visualisation examples in Figures 1–5 are from an independent OLM. Unlike most (independent) OLMs, the Next-TELL OLM can take data from a variety of online activities and tools, for example, as described in Sections 1.1–1.3. It has an API through which such learning data can be transferred, or self-, peer and teacher assessments can be given in cases in which data is not automatically contributed. The data from the various sources is combined using a weighted algorithm with more recent entries having greater influence as these are likely to more accurately represent current competence levels

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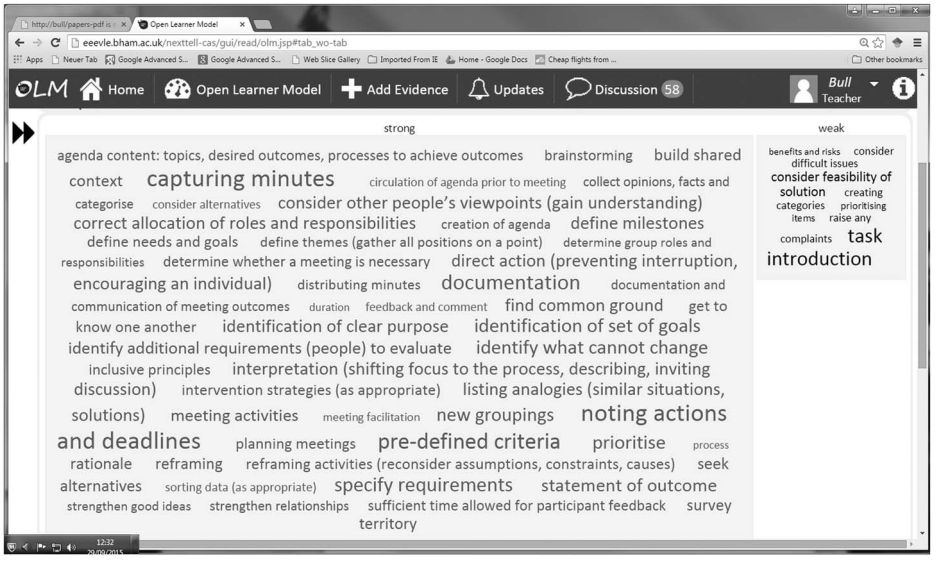

Fig. 4. Word cloud

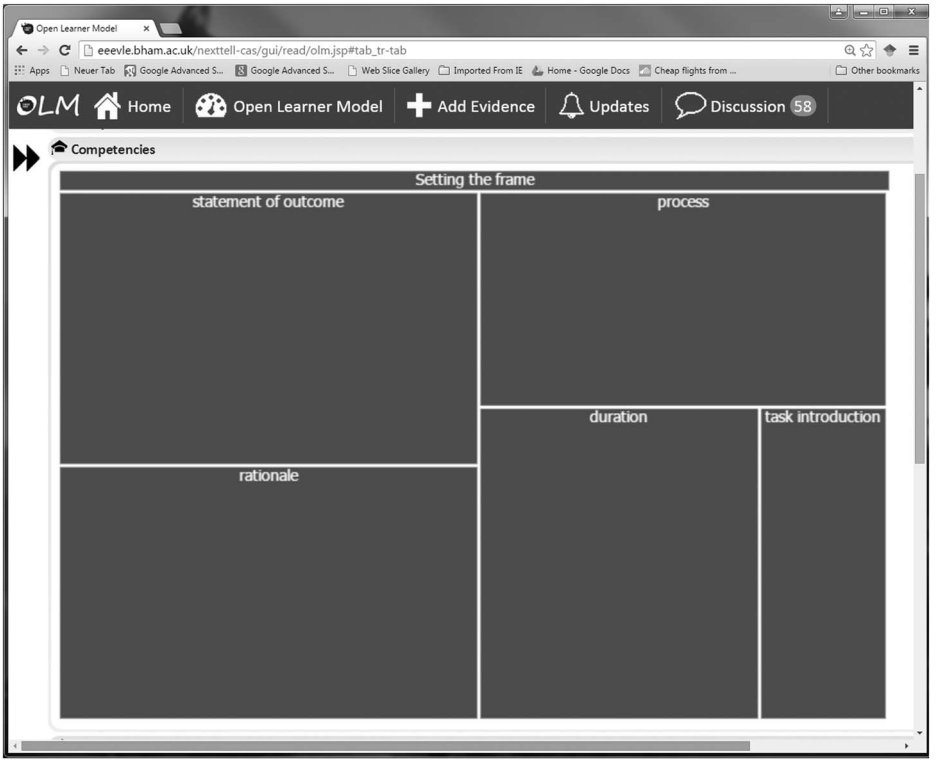

Fig. 5. Treemap

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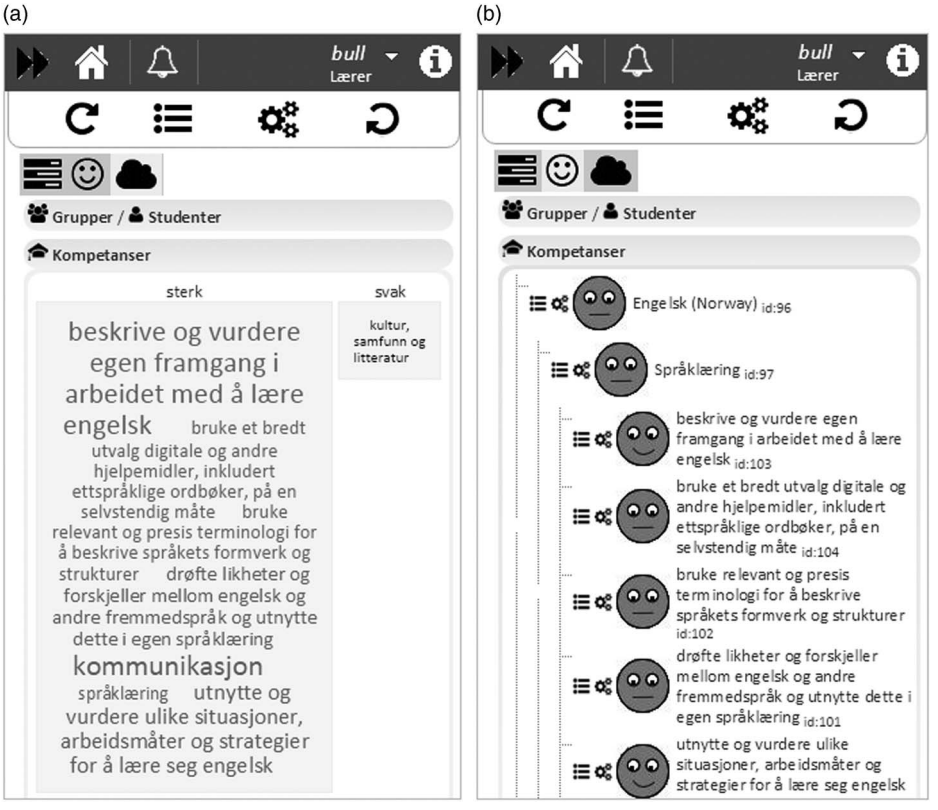

Fig. 6. Smartphone interface

(see Johnson *et al.*, 2013). The weightings may, however, be edited by the teacher. This is because the quality of the data from any source depends on the quality of the various activities and assessment methods that generated the data, and this can be best determined by the teacher. Students and teachers can use the visualisations according to their own preferences for how to view the information, in line with previous findings with several OLMs (Bull, Gakhal, Grundy, Johnson, Mabbott & Xu, 2010). Figures 1–5 give the teacher's overview of the competences of all students ("test students", in this example), but this can also be displayed for individual learners; and learners can also view their own learner model in the same way, as shown in Figures 1–5. A restricted interface is available for smartphones, as shown in Figures 6a and 6b (using the word cloud and smiley visualisations in the Norwegian interface – see Section 4).

OLMs and independent OLMs have been developed for a variety of language contexts. Examples include: overviews of the extent of understanding English grammar items (Zapata-Rivera, Hansen, Shute, Underwood & Bauer, 2007); pronunciation (Demmans Epp & McCalla, 2011); learning technical terminology (Dimitrova, 2003); historical text comprehension (Grigoriadou, Tsaganou & Cavoura, 2003); prompting noticing (Shahrour & Bull, 2009) and awareness (Xu & Bull, 2010) in language learning; and as a means to bring together information on student competences drawn from a variety of classroom

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Fig. 7. Competences for Norwegians learning English, and activities contributing to the competences

activities (Bull, Wasson, Kickmeier-Rust, Johnson, Moe, Hansen, Meissl-Egghart & Hammermueller, 2012). Similar approaches in the foreign or second language domain are reflected in performance reports, for example, as described by Heift (2005). However, we here take a broader view and argue for the potential for OLMs and independent OLMs as a central focus for supporting users who are using a range of 21st-century technologies in the language curriculum. Such OLMs can, for example, combine competence data from Facebook posts, Second Life interactions and MALL, as well as data from other sources. We illustrate this in the next section.

3 Learning languages in the European context

The CEFR gives competence-based common reference levels for language learning, according to language use and abilities (what learners *can do* with language, rather than a knowledge-based perspective). The CEFR describes scales with reference to reception, production, interaction and mediation. Self-assessment is also important, and learners can identify their skills based on "can do" statements according to three areas: speaking (spoken interaction and spoken production); understanding (listening and reading); and writing. Thus, skills are identified as integrated, rather than separate. While the CEFR is not

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sufficiently detailed to define task difficulty or to design diagnostic testing items, it serves as a useful starting point (Huhta & Figueras, 2004).

While our approach to integrating learning data from a range of sources is a general one, as an illustration we use the context of learning English in Norway. Using an adaptation of the CEFR, Norway has a set of national learning goals and competences which must be incorporated into the teaching and learning of English in schools (Utdanningsdirektoratet, n.d.), the details of how this should be achieved being determined at local level. The approach of the Next-TELL OLM can easily be adopted in situations like these; in more rigid teaching frameworks where the curriculum is tightly defined; and also adapted for more flexible contexts.

For our example of learning English in Norway, there are three main general areas: communication (Kommunikasjon); culture, society and literature (Kultur, samfunn og litteratur); and language learning (Språklæring). These are shown in the Norwegian interface to an individual's OLM in Figure 7, under the list of competences (Kompetanser). These areas are allocated target competences for specific timespans in school education, after two, four, seven and ten years (Utdanningsdirektoratet, n.d.). For example, after two years of English "language learning" students should be able to give examples of: situations where it may be useful to know some English; common words and phrases of native English speakers; English words and phrases related to the student's own interests. By the tenth year the focus has shifted to: using a range of situations and strategies for language learning; identification of similarities and differences between the native and target language, and transfer of use to the target language; use of appropriate basic grammatical and structural terminology; independent and critical use of a variety of aids; and an ability to describe and assess one's own attempts at learning English. The "communication" target sub-competences become similarly more complex: after year two, one should be able to understand and use common language with reference to the immediate environment, understand simple instructions, and ask and answer simple questions; after year ten one should be able to use a broader range of vocabulary, understand spoken language and written texts in a range of subjects, adapt language to suit the genre and situation, write appropriately structured and argued texts, and so on. Likewise, the "culture, society and literature" competence targets become more focussed over the learning period, progressing from discussion of aspects of children's daily lives and participation in culture and literature through words, pictures, music and movement to richer discussions of lifestyles, beliefs and cultures, explanations of aspects of history and geography in the UK and USA, discussion of literature from various genres, and creation of their own oral or written language drawing on inspiration from literature and art.

Given the type of targets outlined above, and using the intermediate (four- and seven-year) target competences plus some additional ones, schools and teachers plan activities to facilitate the development of these competences. They also have to assess the extent to which the competences have been acquired. Each teacher may do this in their own way, and there may be similarities or differences across the approaches of any group of teachers. Thus, a flexible way of supporting this activity creation and assessment task, and extending the utility of the information gathered, is required. Our Next-TELL OLM offers such benefits by flexibly bringing together assessment data from different assessment/data sources, and by different teachers with potentially different approaches to assessment, and presenting this to learners and teachers.

The top half of Figure 7 shows the combined data for a sub-set of the competences. "Language learning" (språklæring) is here broken down into sub-competences (to illustrate, the first three are "describe and assess one's progress in learning English"; "use a wide range of digital and other aids, including monolingual dictionaries, in an independent manner"; "use relevant and precise terminology to describe language form and structure". The bottom half of Figure 7 breaks the competence levels down by activity, or data source. Thus, for example, the CLIL test has yielded lower levels of evidence for competences than the other activities, especially mobile activities.

In this illustration we see online tests following the Content and Language Integrated Learning (CLIL) approach (Bentley, 2010); brief e-postcards sent to learners of English in another country; more formal writing (marked by the teacher); face-to-face discussions; MALL activities; online grammar practice using OLMlets (Bull *et al.*, 2010); online discussion; activity in Chatterdale (3DLES, 2011), a virtual world based on Second Life. As stated previously, each of these activities can provide information relevant to the competence levels, either automatically (through the API), or manually (through self-, peer or teacher assessments). While many of the activities may contribute data to many of the competences, this is not usually a straightforward mapping. For example, "use relevant and precise terminology to describe language form and structure" may more likely be observed in online interaction about language form (e.g. discussion forum, online discussion in Facebook), than in an e-postcard. It may not normally apply in a virtual world, but if such a task formed part of a specific in-world activity, this then would be expected.

To specify which competences are linked to which activities/data sources, teachers can create or select the relevant competences when they add a new activity in the OLM (see Johnson *et al.*, 2013). This allows any competence (be it from CEFR; the Norwegian competence set that was adapted from CEFR; or similar; or a competence set defined by the teacher) to be linked with any activity that the teacher chooses to use. So, for example, a virtual world activity, say the context of a party, may involve competences related to language about introducing oneself and describing one's professions and hobbies (for adult learners at early stages of learning), or may involve general communication, including understanding the language of others; a Facebook post may use informal language to describe an ongoing event; a MALL activity may use competences of using language appropriate to the current location. The latter could, of course, also be included in the virtual world and Facebook activities. Alternatively, as indicated by the arrows in Figure 7, a language-focussed online discussion in Facebook may tell us about students' competence in describing and assessing their progress in learning English (beskrive og vurdere egen framgang i arbeidet med å laere engelsk), as well as their use and assessment of various situations, methods and strategies for learning English (utnytte og vurdere ulike situasjoner, arbeidsmåter og strategier for å laere seg engelsk). The virtual world activity may also contribute to students' assessment of situations and strategies for learning English, as they might identify different activities or avatars with which to interact. Mobile activities enable learning to take place beyond scheduled activities, or they may be used alongside them – for example, students might look up vocabulary during a virtual world interaction (bruke et bredt utvalg digitale og andre hjelpmidler, inkludert ettspråklige ordbøker, på en selvstendig måte – use a wide variety of digital and other aids, including monolingual dictionaries independently). Thus, multiple activities and data sources can contribute to single competences, and individual activities can contribute data to multiple competences.

As stated above, the Next-TELL OLM has an API through which external environments can pass it data, for integration into the competence visualisations for learners and teachers. This may occur directly, or data (e.g. chat, discussion or other log data) may be pre-processed, for example by the ProNIFA tool (Kickmeier-Rust & Albert, 2013), which can analyse text based on teacher-constructed rules. Our Norwegian students used the OLMlets tool (Bull *et al.*, 2010) to answer teacher-defined grammar questions (shown in the activities in Figure 7), which automatically sent learning data to the Next-TELL OLM. They also took part in a quest in a virtual world (Chatterdale – 3DLES (2011)) using text chat – also included in the activities in Figure 7. In this instance, the chat was analysed by ProNIFA, and the competences then automatically updated in the OLM. However, where such software was not available, teachers could review the chat logs to identify competence levels of the participating students, and then enter a teacher assessment using radio buttons (see Johnson *et al.*, 2013), on a numbered scale or on a scale of strong–weak. The same two approaches could be applied to Facebook posts where, for example, students may have been following an event, which they discussed in a Facebook group created by the teacher. MALL may help students to continue their learning after classes, for example, using Facebook or exercises designed specifically for the MALL context. MALL activities that produce text could also be automatically analysed in the same way. While our Norwegian teachers did not provide manual assessments, their students performed self-assessments, providing an additional source of data for the learner model.

4 Summary and conclusions

Recent advances in learning analytics such as learning dashboards (e.g. Verbert *et al.*, 2013) have highlighted the potential for using visualisations of learning data in today's technology-rich learning contexts. However, much of this data is interaction-, activity- or performance-related, and directed to the teacher. Using the Next-TELL OLM, we have shown how instructors may combine information about student *competences* demonstrated in *various activities*, which can be used to inform their decision-making from a competence-focussed perspective, and how this information may also be available for students as a means to focus their attention onto language learning *competences* rather than separate activities and performance. This provides many formative assessment and reflection opportunities, as well as recording data for quality and reporting purposes.

The activities and technologies can be varied, and from different platforms. Our general examples were:

- *Facebook,* where in addition to any teacher-defined group discussions, language learners can follow events or take part in discussions in a real-life environment. Facebook has the advantage of being a familiar environment for many (Terantino & Graf, 2011) and so can become an extended space for language learning (Lantz-Anderson *et al.*, 2013) and also offer interaction with native speakers (Lee & Ranta, 2014).
- *Second Life,* which as well as supporting teacher-defined class activities, can provide opportunities for interactions with native speakers (Castillo, 2011; Thomasy Blasing, 2010). It also affords the opportunity to practise in situations that are not possible outside the virtual world setting (Milton, 2013).

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- *Mobile assisted language learning,* which allows interactions to happen easily and seamlessly at times and places of the learner's choosing, for example, extending learning activities to the home (Hwang & Chen, 2013).

These general examples were selected because of their likely increasing importance as 21st-century technologies for language learning. In practice, such activities are likely to be used alongside other technology and non-technology-based activities, as illustrated in our example from Norway, in Figure 7.

Using the Next-TELL OLM API, external learning activities can contribute data directly to the learner model. More complex log data processing can be undertaken with other external tools, which can identify and pass the competence data to the Next-TELL learner model for visualisation. The OLMlets quizzes (Bull *et al.*, 2010) provided data directly to the Next-TELL OLM in our example case, and ProNIFA (Kickmeier-Rust & Albert, 2013) was used to analyse text chat from a virtual world activity, and could similarly be used with other chat/forum data or Facebook posts.

In addition to automated data entering the learner model, teachers, students and their peers can provide numerical assessments through radio buttons to include in the modelling process, as well as additional feedback and comments. This can be done for all types of activity, and therefore provides a way to get data into the OLM that is not easily achievable automatically – either because of the nature of the activity, or the practical or technological limitations of the particular learning context; and it also provides further reflective opportunities for students through its offering of self-assessment possibilities. The above make the Next-TELL OLM approach not only a powerful one for combining and visualising (potentially big) data, but also one that is focussed on the needs of visualisation to support *learning*, *reflection* and the development of *competences*, and that can be applied in technology-rich contexts – but also with the provision for use in cases with lighter technology use, through manual entry of data based on activities undertaken.

With widespread use of mobile technologies, in addition to language tasks or social networking on mobile devices, iPADs and tablet computers can display the Next-TELL OLM and related feedback and comments. There is also a more restricted interface and visualisation for smartphones. This means that, as new data comes into their learner model (e.g. from a peer assessment of their attempts to give directions to classmates during an earlier virtual world activity), students can access this on-the-spot, if they wish. They may also provide feedback (e.g. directly to a peer, based on a recent Facebook post) easily switching between the social network and the Next-TELL OLM. The new competence data can then be viewed in the context of existing data (e.g. from the virtual world activity, or other tools and assessments). Students are free to do this as they wish: at the time and on the move; or in a dedicated session, which may or may not be using mobile technologies. The primary aim is for them to develop an understanding of their competence development, and to reflect on their learning and identify their next learning steps as independent learners.

The Next-TELL OLM also aims to help teachers better understand their students at a level of detail that is not easily achievable without additional support. A teacher can reuse a competence set or create their own. We recommend the Next-TELL, or a similarly flexible approach, to offer language learning visualisations to learners and teachers as an understandable way to make sense of the increasing amount of useful and usable learning and competence data. Using the Next-TELL OLM, instructors are in control of the data

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sources and weighting of data contributing to each competence and, hence, the quality of data in the learner models. To facilitate this flexibility, users can use the visualisation(s) that best show the competence information according to their current purpose of viewing the learner model; the task(s) or system(s) contributing data; and their individual preferences for visualisation. Furthermore, as instructors extend or change tools and activities in their teaching (for example, to embrace newer technologies and state-of-the-art approaches in language learning), these can be straightforwardly incorporated as new activities, and linked to the relevant competences.

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