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A pedagogy-driven approach to the design of a medical abbreviations videogame: *Brevissima*

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Regular Paper

This paper explores the development of a computer-assisted language learning game which teaches medical abbreviations. We use a pedagogy-driven approach which starts from a detailed specification of the language needs as they exist in a particular context, followed by the appropriate method and related technological solutions. Preliminary feedback is provided from an anonymous survey of student opinions about the game.

Introduction

Technology-mediated language learning has a number of clear pedagogical advantages (Reinders & White, 2010, pp. 63–68). Among these advantages are improved authenticity of learning materials, potential for two-way interactions, coordination of multimedia files, immediate feedback which is delivered in multiple forms, and greater learner control and empowerment. However, in order for this potential to be achieved, technology-based educational materials must be designed carefully. We use a pedagogy-driven approach (Colpaert, 2006, p. 479) which starts from a detailed specification of the language needs as they exist in a particular context, followed by the appropriate method and related technological solutions.

This paper explores the development of a computer-assisted language learning videogame which teaches medical abbreviations. This paper has several aims: to establish educational need (both in terms of linguistic focus and curriculum gap), to explain the design of the resultant videogame and its theoretical underpinnings, and to provide some indication of what the intended

users think about the videogame. The first point, to demonstrate the need for an educational focus on medical abbreviations, is achieved through a literature review and anecdotal evidence from the classroom. An understanding is established about the forms of written and spoken abbreviations, their frequency of use in different contexts, and the current access to a variety of resources which will further this argument for medical abbreviation education. From this information, a case will be presented for a videogame. The next aim of the paper is to outline the features of the game and the cognition-based rationale underpinning its design. Issues such as exposure, feedback, and multimodality will be discussed. The final aim of the paper is to provide some indication of what the target population think of the game, in lieu of a larger study to follow. These opinions were gained from an anonymous survey-based study involving volunteer participants who played the game for two weeks and answered questions about their experience.

Linguistic needs analysis

In order to have a pedagogy-driven approach in the creation of a computer-assisted language learning tool, it is important to have a clear idea of who will use the tool and what their specific language needs are. The target population for whom this videogame is primarily designed is international students from non-native English speaking backgrounds. These students are mostly upper-intermediate to advanced English users, i.e. **IELTS** 6.5, **CEFR** B2-C1. Thus, the minimum English requirement for university entry and general English ability has been met, but often researchers recognise that there are severe deficits in the students' nursing English and communication skills as they relate to clinical practice (Chiang & Crickmore, 2009, p. 332–5; Müller, 2011, p. A15). Shakya and Horsfall (2000) observe of international nursing students that "while their level of English was adequate for conversation and non-discipline-specific reading, higher levels of proficiency are required to successfully grapple with verbal and written academic demands" (p. 165). A preliminary needs analysis has already been conducted on the target population by Müller (2011), pointing to the need to focus on vocabulary learning to support this population.

In the nursing education literature, it is recognised that nursing "is highly dependent on accurate verbal communication, since much of the information and many orders are passed on verbally" (Guhde, 2003, p. 113). In particular, Blackman and Hall (2009) point out that spoken shift handovers are among the more difficult tasks a student has to face. A spoken shift handover, as Bosher (2010, p. 358) describes it, is a process where "nurses take notes on their patients as they listen to the change-of-shift report, translating information from aural to written form … at the end of their shift". The task is made more difficult because of the speed of spoken delivery, and this is a serious problem for students (Blackman and Hall, 2009; Shakya and Horsfall, 2000, p.166). As a result, many educators emphasise the need for competent listening skills (Button, Kelton, Wotton, & Gigger, 2008, p. 77; Chiang & Crickmore, pp. 331–2; Müller, 2011, p. A17; Murray, 2012, p. A53; Starr, 2009, p. 484).

However, what also contributes to the problem of listening skills is the number of medical abbreviations included in handovers. Indeed, both nursing educators and international students identify medical abbreviations as a key area of need. In nursing education research, Guhde (2003, p. 114), Shakya and Horsfall (2000, p. 165), and Donnelly, McKiel, and Hwang (2009, pp. 204–6) point out the particular difficulties that non-native English speakers have with medical terminology. Caputi, Engelmann, and Stasinopoulos (2006, p. 111) specifically emphasise the need for knowledge of abbreviations. In one preparatory

programme, Murray (2012, p. A53) deals with medical abbreviations as one of the first points of knowledge to be acquired at the start of the student's programme. In another clinical preparatory programme, Bosher uses a specific exercise which focuses on common medical abbreviations embedded within a handover delivery (2010, p. 358). Button, et al. (2008, p. 75) similarly focus on medical abbreviation fluency as a key element in their online clinical communication educational resource.

As we developed our own face-to-face nursing English classes in our school, international students requested extra classes dealing with medical abbreviations. Furthermore, in these classes, feedback from international students indicated that they not only wanted more materials that dealt with medical abbreviations, but also how these abbreviations were used in a clinical context. Considering the above information about the gap between abbreviation use in the educational and clinical contexts, this is not surprising.

The following three sections are interlinked as they all deal with the topic of medical abbreviations and how they are formed, differing levels of usage according to context, and students' access to educational materials in the area. The first section deals with the formation of medical abbreviations and how they may vary in presentation according to their use in speech and writing. The second section explores the frequency of medical abbreviations in clinical contexts and compares this to the frequency of use in educational contexts. The third section outlines the educational resources dealing with medical abbreviation that students can access. We will begin with word form.

Word form and variation of medical abbreviations in speech and writing

Teaching medical abbreviations is not as straightforward as teaching other forms of vocabulary because they appear in a multitude of forms and can change according to their use in speech and writing. In English, there are six identified conventions for writing abbreviations (based on a mixture of capitals, lower case letters, and punctuation marks) and four major ways of shortening the original word (initialism, clipping, acronym, and blend) which may be combined to produce the final abbreviation (McArthur, 1998, pp. 1–4). Furthermore, the spoken form of the abbreviation is not always discernible from the written form. Essentially, the process involved in abbreviating words varies, as does the orthographic and oral forms which result, and abbreviations of medical terminology are no exception to this inconsistency. Thus, one medical term can appear as two, or sometimes more, different shortened forms depending on whether it is spoken or written.

The best way to understand this problem is to explore examples of medical abbreviations and their forms. An example of a common medical abbreviation is ***BP*** for *blood pressure*. It is an initialism which uses the starting letter of each word. The abbreviation ***BP*** appears in speech as either *bee-pee* or the full form of *blood pressure*. Note that, as an initialism, ***BP*** is never pronounced *beep*, even if it is possible to do so. It is typical for initalisms to have capital letters in writing, but even this can vary, especially when it involves Latin words.

Another type of abbreviation is formed through clipping, where only the first part(s) of a word are used to represent the whole word. Examples of clipping are ***ECHO***, *physio*, and *stat*. The fully capitalised clipped form, ***ECHO***, stands for *echocardiogram*, and is commonly pronounced in speech as *echo*. The lower case clipped form, *physio,* stands for *physiotherapist*, and mostly appears in speech in its shortened form, both among health professionals and lay persons alike. The overall point being made is that it is difficult to predict which type of shortened form of medical abbreviation will be used in speech or writing and which

pronunciation or capitalisation/punctuation method will be adopted. These variations in spoken and written form are important because they add to the learning burden as a result of their irregular usage.

The other type of abbreviation, acronyms, are formed using starting letters, as in an initialism, but the difference is they can be pronounced as a whole word in speech. An example of an acronym is *angiotensin-converting enzyme* which is written as ***ACE*** and pronounced the same as the word *ace,* and for this particular example, the full term is rarely found in either speech or writing, unless convention demands it (such as in the initial usage of the term in a journal, or when explaining a condition to a patient). Indeed, when professionals discuss the class of medications which inhibit this particular enzyme, the abbreviation is blended with a second full word, pronounced as *ace-inhibitors* and written as ***ACEI***, thus becoming part-acronym and part-initialism. Further examples of acronyms are ***CABG***, ***DOB***, and ***ADL***, which stand for *coronary artery bypass graft*, *date of birth*, and *activities of daily living* respectively; the spoken pronunciation for ***CABG*** is *cabbage*, yet ***DOB*** is never pronounced *dob*, and ***ADL*** similarly does not get shortened to *addle*, even though there is potential for this to occur.

Finally, there are some abbreviations which are particularly difficult and may use specialist notations. Some may be atypical in their abbreviated form, such as *Tx* and *h/o*, which mean *treatment* and *history of* respectively, refer to a non-English word, and are mostly found in speech as full words. Latin terminology also figures sporadically among medical abbreviations, such as the use of ***KCL*** for *kalium chloride* and *Na* for *natrium*, yet mostly their English equivalents of *potassium chloride* and *sodium* are used when speaking. Like other abbreviated Latin terms which have made their way into everyday usage, the original word may not even be known by its current users; further instances of this in general English are *a.m.*, ***RIP***, ***AD***, and *e.g.* which are abbreviations of *ante meridiem, Requiesce In Pace*, *Anno Domini*, and *exempli gratia* respectively. In other cases, the Latin is used for both the spoken and written abbreviated form, which is the case for the clipped form of *statim* (known in English as *immediately*), where the shortened form of *stat* is mostly used in both writing and speech, with the frequncy of use mirroring that of *id est* and the unlikelihood of the full form being used instead of the abbreviation *i.e.*.

It should now be clear that medical abbreviation knowledge is a difficult vocabulary area to teach, and that it is vital that both written and spoken forms are taught in tandem with each other. Another point to consider, which will be examined next, is how abbreviations are used in context, since this will also inform the pedagogical approach used.

Frequency of use in the educational and clinical contexts

Medical abbreviations are complicated but necessary to learn because they are a key element of communication in the nursing profession and cause difficulty in the comprehension of spoken nursing English. It should be pointed out that abbreviations are also commonly used in peer communications, medical records, and charting. To gain an understanding of the role of medical abbreviations as they are used in context, it would be useful to see a transcript of what a verbal shift handover looks like:

> He is a 72 yr old man admitted with an anterior **MI**. He has a past medical history of **CVA** ×2, unstable angina, previous **MI** 3 years ago, **LVF** and **APO**. He presented to A and E at 0200 hrs with chest pain. He was transferred to the angio suite where he had a coronary

> angioplasty and a stent inserted into his **LAD**. He returned to the ward at 0700 hrs. He is currently on hourly obs: temp 36, pulse 75, resps 18, **BP** 100/65, SaO2 98%. He is also on hourly neurovascular obs which are **NAD**. His groin is soft and dry. He has not had any chest pain since return from angio. He needs an **ECG** and repeat **CARDS** at 1100 hrs. He is rest in bed. He has an **IVT** at 80 mls/hr and is on an **FBC**.

As previously established, the actual spoken forms of the abbreviations will vary in nature and use, but the nurse listening to this handover would write notes using the abbreviations as they appear above. Another transcribed example of medical abbreviation usage in context, as might be found in a peer-to-peer spoken communication, would be as follows:

> She has been put on **ACE** inhibitors for her hypertension and we need to make sure we check her **BP** prior to administration.

The information given verbally would also appear in patient notes in abbreviated form. An example of a medical record illustrates this point (adapted from School of Nursing & Midwifery, 2012a):

Date and Time	Problem No.	Progress Notes
Day 1		60 yr old man living at home with wife and two
2/08/11		teenage children and on invalid pension.
		Diagnosis: ? SBO
		PMHx: Bowel Ca 3 yrs ago – resected no Mets
		Meds: Valium 5mg PRN
		Maxoplan 10mg PRN

The above examples show the contextual use of medical abbreviations. The next step would be to ask how these medical abbreviations are currently taught in the education system.

In contrast to the clinical setting, fewer medical abbreviations are found in the nursing curriculum. They are found in a greatly reduced density in the classroom, on educational websites, and in textbook readings. An example of the use of abbreviations in a textbook is as follows:

> A healthy person with no lung disease and no anemia normally has an oxygen saturation (SpO_2) of 97% to 98%. However, every SpO_2 result must be evaluated in the context of the person's haemoglobin level, acid-base balance, and ventilatory status (Jarvis, 2008, p. 461).

Note the standard academic practice of introducing the abbreviation with the full form before proceeding to use only the shortened form in the text. Similarly, medical websites follow this standard:

> Coronary artery bypass grafting (**CABG**) is a type of surgery that improves blood flow

to the heart. Surgeons use **CABG** to treat people who have severe *coronary heart disease* (**CHD**) (National Heart Lung Blood Institute, 2012).

These examples are typical of educational resources and clearly do not mirror the actual daily usage of medical abbreviations. Indeed, perhaps the only place where medical abbreviations may be found with regularity in the university itself is practical laboratory sessions, but even then the frequency of use of medical abbreviations remains lower than that of the clinical setting. This mismatch between contextual use and educational support begs the question of how the nursing student might be able to practice their medical terminology with enough regularity to attain fluency.

Access to medical abbreviation educational support

There are different levels of specialist language support offered among schools and universities in Australia; while some places like the Australian Catholic University have a transition course (see Chiang & Crickmore, 2009) and Flinders University have tailored nursing English programmes, it is more likely that students are expected to acquire medical abbreviation knowledge through exposure rather than a concerted effort to teach them. However, while native English speakers normally deal well with new vocabulary, international students find it much more difficult. This is due to the expectation that exposure will produce knowledge. The research shows that this is an inefficient and ineffective method of vocabulary acquisition (Schmitt, 2008, pp. 348–9). It is expected that support mechanisms such as reading glossaries will help, but these do not provide spoken pronunciations of words, and the international student is unlikely to have the kind of intuitive knowledge of a native speaker about how abbreviations are formed and used.

Ideally, a class which teaches abbreviations on a regular basis is the ideal. In the nursing school at Flinders University, one person looks after the needs of over 500 international students of mostly Asian backgrounds. In addition, there are an unknown, but significant, number of local students who have English as a second language, including the new arrivals and refugees who have spent as little as a year in an English-speaking country. One-to-one classes are ideal for the least experienced English users; however, as Donnelly, McKiel, and Hwang (2009, p. 204) point out, individualized support is not sustainable. Moreover, if all the 500 recognised international students were to ask for support, a single person could be teaching back-to-back classes the entire week just to service the need. The language learning goals are unlikely to be facilitated on a face-to-face basis, so a technological solution is needed, but which one?

There are a number of educational resources available which deal with medical abbreviations and can be easily accessed by students. For example, there a number of medical terminology textbooks which contain sections on abbreviations but without an indication of their pronunciation (e.g. Chabner's (2007) *The language of medicine* and Cohen's (2011) *Medical terminology*). There are also commercial flashcards available, usually as a part of a larger medical terminology set, such as Mosby (2006), which similarly do not provide pronunciations. The online counterpart, electronic flashcards, are freely available, e.g. nbfilter (2007) or jeffreyjjohnson (2008), but mostly they do not have sound or use an automated American-accented voice engine which has a preference for initialisms and may give wrong pronunciations of clipped words. Another option is to search abbreviation websites which are usually attached to medical terminology sites or dictionaries and give

no pronunciations, such as Better Health Channel (2011) or Stands4 LLC (2012). A common problem with all the aforementioned resources is they do not offer a great deal of contextual information around the usage of each abbreviation. Considering that there has been a persistent problem with medical abbreviations – despite these resources being widely available – it points to two possible problems: a lack of effectiveness or student motivation to engage, or both. It is possible that, if the problem of effectiveness was addressed, it might improve student motivation to access an educational resource dealing with medical abbreviations.

As evident from the discussion thus far, an ideal technological solution would be one that was able to combine multimodal materials (sound and text) in a contextualised environment. Furthermore, this solution would also need to regulate the pace of input and exposure to allow familiarity and recognition of patterns. A technology-based delivery system would need to pace the exposure to medical abbreviations and leave the student to concentrate only on the content, rather than expending energy disciplining themselves to work. This resource would need to be able to coordinate a number of files from a database simultaneously in order to deliver audio and written information seamlessly, preferably in a manner that retains the students' attention. An example of an unengaging technological tool would be a black screen which flashed a word and played the audio as it appeared, and repeated this process until sufficient exposures was achieved. In contrast, serious gaming engages the user and offers a way for the desired educational outcomes to be achieved, particularly if the gameplay relies on mental links being made between spoken and written forms. Moreover, a videogame has a wealth of other benefits.

One of the important contributions a game can make is to shift agency, ownership, and control to the student (Gee, 2009, p. 318). Games provide a learning context which is quite different from the classroom because, through the avatar, the learner is a visual central figure of action. The trajectory of action is different each time and the student controls it, unlike when they are an undifferentiated student in a classroom with a predictable time-space environment and pre-set assessment events. In a game, the learner is an autonomous individual who interacts with the materials in a virtual gaming classroom (at a time and place suitable to them) with no visible outside authority figure and no other students sharing the exact same experience. Thus, as Blake observes, "Games make the users feel that they are being competent and independent problem solvers." (2011, p. 28)

Improved motivation to interact with educational materials is often cited as an advantage of games. Felicia (2009) affirms this when he writes that "one of the foremost qualities of digital games is their capacity to motivate, to engage and to immerse players" (p. 12). He makes the point that games "can be particularly useful to perform experiments that could be dangerous in real life" (Felicia, 2009, p. 7). Games also have a realism to them that can provide immersion, partly through "a sense of authenticity and identification with the environment" (Whitton, 2010, p. 41). These are good reasons for students to be motivated to use an educational game, and if a game is well-designed, their motivation can be translated into learning (Clark & Mayer, 2011, p. 394). Furthermore, Whitton (2010) feels that games are especially suitable for language learning because "games have a place in teaching facts and knowledge, may be useful for providing a context for repetition and recall (particularly in areas where memorization is important such as language learning), and can be used effectively for training and skills development" (p. 44).

A videogame was considered a possibility as our school uses the Moodle e-learning environment which can support resource-intensive Flash software. According to Reinders and

White (2010, pp. 62–3), computer-assisted learning systems have many advantages, including independent access to materials, superior storage and retrieval of learning records, and cost-efficiency. The school was interested in funding a gaming resource because the school's international cohort alone is over 500 students and is serviced by a single assigned lecturer delivering language education who cannot meet the demand face-to-face. A foray into computer-assisted language learning was needed. The solution is the gaming resource, *Brevissima*, which will be discussed next.

The design of *Brevissima*

A specialist English lecturer worked in conjunction with an experienced clinical educator to select the most commonly used medical abbreviations from the appendices in the Australian Nurse's Dictionary (Hawley, King, & Weller, 2006, pp. 503–508) and the Australian and New Zealand version of Mosby's Medical Dictionary (Harris, Nagy, & Vardaxis, 2010, pp. 1876–1886). Reference was also made to the Spell it Out (2009) standards detailing safe practice for medical abbreviations. The clinical educator then wrote 198 handover- and peer-communication-styled sentences which contained about 3 abbreviations each. Some abbreviations are used in more than one sentence and there are 380 unique medical abbreviations in the videogame. The strategy of presenting abbreviations in sentences allows the student to hear the abbreviations used in context. Next, audio recordings were made which consisted of three male voices and two female voices. This choice was a result of the research done by Sommers and Barcroft (2011, pp. 431–2) which indicated that better listening skills are developed when there is greater acoustic variance in the materials. The resultant audio files, written sentences, and written medical abbreviations were then sorted and compiled into a database to form the educational materials for the videogame.

The gaming action of *Brevissima* involves listening to a looped sentence which contains common spoken forms of medical abbreviations which have to be matched to appropriate options shown on the screen. The player reads various medical abbreviations (as written in medicinal capsules) as they fall from the top of the screen until they disappear at the bottom of the screen. The task is to catch the correct medical abbreviation capsules that are contained in the spoken sentence, and ignore the distraction capsules which contain medical abbreviations that are not used in that sentence. The player controls the avatar (who holds a medication bottle) by using the left and right arrow keys to move across the bottom of the screen to catch falling correct answers and to avoid touching incorrect answers.

The reward system of *Brevissima* gives points for catching correct answers, during which the avatar lifts the bottle and responds happily, and if a wrong answer is selected, the player hears and sees all of their accumulated pills spilling onto the ground, they lose all their points, and the avatar cries pitifully (see Figure 1). There is a summary screen showing the sentence in writing, the abbreviations used, and the ratio of caught to missed abbreviations. To break up gameplay predictability, a hospital bed randomly appears and drops down. If the bed falls on the avatar, they get dramatically squashed, accompanied by a loud crashing noise, and lose all their accumulated pills (but not their points). There are two modes of play, easy and difficult. In the easy mode, the written form of the sentence is shown at the start while the audio sentence file plays, and the distraction capsules have nothing written in them. These empty capsules are easily avoided, so the player only needs to collect the capsules with the correct abbreviations written in them. This means that the player only has to concentrate on the task of listening for the abbreviations and relate them to the written

Figure 1. Catching and losing in Brevissima

counterparts as they catch them. In the difficult mode, distraction capsules with incorrect answers are presented. In both modes, capsules fall faster and at different trajectories in each game as the rounds progress through the stages.

The videogame includes visual and aural features which simulate the medical setting and add to the realism of the resource. One of the most important features is the use of an avatar who is dressed as a nursing student, in exactly the same uniform that the school's nursing students wear to clinical placement. A number of male and female avatars of different ethnic backgrounds are offered for students to choose from. Another feature is distraction hospital noises which always plays in the background during gameplay. The time restrictions of the clinical context are paralleled in the limited gameplay time for each round before new materials are presented in the next round. Finally, each level has a different background picture that sequentially shows a narrative of a patient's journey through the hospital system, arriving in an ambulance, going through the wards and to an operating theatre, finally to recover and be airlifted back to their normal life (however, the final scene is really an evocation of the 'up' metaphor to indicate 'end achievement' rather than a simulation of how a patient typically leaves the hospital).

Accessed from the opening menu, the players are instructed to do a number of things. The first is to use the easy mode which has empty capsules to avoid rather than capsules containing wrong answers. The next piece of advice given to students is to consciously relate the spoken and written forms of abbreviations as they play. They are encouraged to memorise and theorise how the abbreviation was formed. This advice is meant to encourage students to use good strategies to self-teach and familiarise themselves with the medical abbreviations.

Since the features of the videogame have now been described, it will be easier to explain how the educational theory underpins the final educational gaming product. The next section will outline the major guiding principles in the design of *Brevissima*, and perhaps provide some ideas for others who wish to build their own educational videogames.

The theoretical underpinnings of Brevissima's design

A cognitive psychology-based instructional design is the major approach used to design *Brevissima*. This approach is an evidence-based one that specifies which approaches to learning produce the best cognitive outcomes. As Bruning, Schraw, and Norby (2011, p. xvi) state, "there are few educational decisions to which the cognitive issues of memory, thinking, problem solving, and motivation are not relevant." This approach, particularly since it deals directly with memory processes as its starting point, seems to be the best fit for the educational materials. This will become evident in the detailed discussion of the method.

Exposure

An important part of *Brevissima*'s design is repeated exposure to content. This design feature is based upon the recommendation from cognitive-based instructional design research which states that "extended practice is needed to develop cognitive skills" (Bruning, Schraw, & Norby, 2011, p. 6). Extended practice supports the automated processing of basic recurrent skills (such as identification and understanding of previously learned vocabulary) which is crucial to freeing cognitive resources to allow complex meaningful tasks to be tackled. In terms of vocabulary acquisition, the research indicates that fluency is a result of repeated exposure to a word, since this builds familiarity with form. The needs analysis by Müller (2011, p. A19) indicates that exposure is a key element in addressing international nursing students' language needs. As Pigada and Schmitt (2006) indicate, around 10 encounters are needed with a word to improve learning rate, while Brown, Waring, and Donkaewbua (2008, pp. 151–4) found that 10 exposures of a word, in read or heard form, leads to consistent remembering of meaning. According to the nursing literature, international students appreciate the opportunity to repeatedly listen to materials, and Guhde (2003, pp. 115–6) reports it to be a useful teaching strategy.

The goal of *Brevissima* is to automatise the recognition process, and the repeated exposures in the videogame should provide enough input to recognise patterns and to self-teach. The gaming medium can "offer players a set of challenging problems and then let them practice them until they have routinized their mastery" (Gee, 2009, p. 318). The use of repeated exposures in *Brevissima* should not be confused with rote learning. Cognitively speaking, the brain tends to look for patterns, especially in 'confusing' environments, and this videogame appeals to this natural inclination in human cognition. Furthermore, learning is rooted in this search for meaning and is best achieved under conditions where students "relate new information to what they already know, organize it, and regularly check their comprehension" (Bruning, Schraw, & Norby, 2011, p. 6). In *Brevissima*, the student searches for links and patterns and tests their knowledge by catching the answers. Passively receiving word lists and rote-learning them is likely to result in "superficial and transitory knowledge" (Bruning, Schraw, & Norby, 2011, p. 6). Instead, as Bruning indicates, "learning is a constructive, not a receptive, process" (Bruning, Schraw, & Norby, 2011, p. 5). Active processing, manipulation, and interaction are more likely to produce long-term skills (Willis,

2009, p. 335). As mentioned previously, the gameplay of *Brevissima* relies on mental links being made between spoken and written forms.

Furthermore, since both the easy and difficult modes require a constant engagement with the videogame, through the movement of the projected character around the screen negotiating the medical abbreviations, the result is that the learner must interact with the educational content. Unlike the kind of interaction gained from a word list or website, the videogame requires constant spatial movement and a constant haptic selection. The student is required to be constantly alert, ready to respond to the educational material, and to form links between spoken and written context while furthering their understanding of medical abbreviations. If the student is distracted, or not engaging sufficiently with the content, they lose. Compare this to a task of rote-learning a word list where a student surface-learns the word, or the classroom where a disengaged student can participate in person but not in mind. The educational gaming situation discourages either from happening. Finally, the demand for student interaction is reinforced by the time limitations and pace of the videogame which the student cannot control (and reminds them of the clinical context they will face in the future).

Feedback and scoring

Bruning, Schraw, and Norby (2011, p. 234) argue that an appropriate use of technology is "to provide practice and feedback". They outline the ideal nature of a computer as "an ideal partner" which does not tire (Bruning, Schraw, & Norby, 2011, p. 234). In the case of *Brevissima*, the student gets immediate personalised feedback on their choice at the very moment they commit to that choice by catching a selected abbreviation that matches the sentence they are listening to. An emotional response from the avatar further reinforces the positive or negative nature of the player's choice. This kind of personalised immediate feedback is unlikely to be achieved in a classroom from a teacher. In the summary screen of each game round, the students are shown the abbreviations they should have recognised, and the ratio of success to failure of caught objects in the game. When the feedback shows that only a few abbreviations were missed, students know they had a good grasp of which abbreviations were in the sentence, whereas a high amount of 'uncaught' abbreviations means that the student has room for improvement. The immediate real-time feedback puts the user in a position of clear responsibility for their actions and their knowledge levels. Thus, the game makes the learner responsible for outcomes and requires them to become active goal-attainers, where the goal is abbreviation familiarity, identification, and noticing while listening. It is important that a teacher does not control this process – each student does it for themselves and each experience is unique.

There are also a number of rewards built into the videogame as such rewards have a positive effect on student motivation and engagement. In particular, it has been found that extrinsic rewards have a positive effect on students if they are given for genuine reasons, are accessible to all, not overused, and can be given continuously (Bruning, Schraw, & Norby, 2011, p. 130). In the videogame, a score is given for correct answers and everyone is subject to the same scoring system. However, in *Brevissima*, feedback and scoring are also intertwined. While the scores are used to motivate and reward any effort to improve abbreviation skills, they also serve to provide a visual representation of accumulated personal progress (which is comparable to the scores of others who have played the game, if desired). Furthermore, the scores act as a form of ipsative assessment where the student can measure current

performance against the standard of performance they have achieved in the past. Thus, at each step, the student is encouraged and rewarded, while also receiving immediate feedback on their progress and how much they have personally improved.

Multimodality and working memory

Bruning, Schraw, and Norby (2011, pp. 222–4) emphasise the importance of multimodality in technologically-based instruction. Videogames are typically based upon combining multimodal materials in a simultaneous space. The user must juggle audio, visual, and haptic tasks in a contextual environment that has naturalistic background noise, time and place cues. Multimodality is so important because of its relationship to working memory capacity. Working memory has a limited capacity to assimilate new information (Baddeley, Sala, Robbins, & Baddeley, 1996); however, according to Paivio (1991, p. 257), the working memory seems to have independent modality-specific working areas which, according to Sweller (2010, p. 135), allow an expansion of the working memory capacity for greater learning.

An example of an educational situation which takes multimodality and working memory into consideration and should improve learning is when listening to someone talk while looking at a picture related to the speech (i.e. audio and visual modalities are used simultaneously). Sadoski and Paivio (2004, p. 6) have extended the theory of working memory to language itself, and suggest that there are independent modality-specific representations and stores. Thus, it is possible that some features of both written and spoken language can be processed simultaneously. Moreover, when familiarity is achieved through multimodal input, theoretically the learning will be more comprehensive because links have been made across modalities (rather than a situation where a student only knows a word's spelling but cannot recall how it is pronounced). This is an important reason to design *Brevissima* so that it includes simultaneous spoken and written linguistic input, and even haptic associations regarding correct language choices.

Survey-based study of student opinion about *Brevissima*

In order to evaluate the reception of *Brevissima* before a full-scale quantitative study was performed, a preliminary qualitative survey-based study was conducted. The study involved 11 international nursing students who volunteered to play the videogame over a two-week period and then give feedback on the following survey questions:

- What needs to be improved in the game?
- How can the game help you prepare for clinical placement?
- What advice would you give others about playing the game, such as how to use it and when?
- Should the characters/avatars be removed from the game? Why or why not?
- Any other ideas, opinions, or comments?

These questions would give information about any perceived problems with the game and where it might be improved, since it was still in testing phase. Information would also be gathered about the perceived usefulness of the educational resource, which itself can affect motivation to engage with the resource. Complimenting this is the information given about when, where, and how participants used the game to learn, and if there were any

suggestions that could be built into the game to maximise learning. The question about the role of the avatar was aimed to elicit answers about the participants' identification with the environment and how the avatar helps personalise their experience. Finally, the participants were invited to make any other comments.

The answers were analysed and a few themes emerged from these questions. These included linguistic-based themes of listening skills, word form, and language use in context. The game-based themes were the relaxed nature of the gaming experience, the motivating role of game scores, and the avatar as a focal point for the emotion and realism of the learning experience. These themes will be examined in greater depth below.

In relation to listening skills, there were a number of positive comments. One student wrote "I find it useful to play this game because it trains my hearing to listen to abbreviations, as well as the complete sentence of the abbreviation". Some participants appreciated how Brevissima enabled them to become familiar with word form, stating that "It helps me to differentiate the similar abbreviations". One student felt that just "becoming familiar with abbreviations is good", which is echoed in another student's comment that the videogame was useful for "pre-hearing medical terms". These two statements imply that these students feel they have had a lack of verbal exposure to medical abbreviations in the educational setting.

The ability to hear how abbreviations might be used in context was also appreciated: "*I think it helps me not only know the abbreviations but how to use them in certain conversations*". Participants felt that the contextual sentence prepared them for professional spoken communications. As another student wrote, "*it provides better preparation for the clinical context*" allowing users to become "*familiar with the scenarios which we can see and hear from the clinical placement*" and "*it gave us a chance to practice before we take our clinical placement*". In the words of another participant, the videogame gives "*so much we want to know before our clinical placement*". In light of this comment, it is unsurprising that one participant felt that *Brevissima* should be played "*before clinical placement*" and another declared that they would "*tell my friends that this game is so helpful and persuade them to play it*".

It seems that participants recognised the videogame's serious educational role to familiarise and contextualise medical abbreviations, but despite the educational outcomes, these same participants did not feel serious and concentrated while playing the game. Participants suggested that the videogame should be played in your "*spare time*" or "*in your free time*", which implies that they are referring to the time put aside for non-study activities. Similar comments indicate the relaxed experience of learning through the gaming medium, that "*it is easy and interesting*" and some said that they felt it best to use the resource "*after meals*", "*when you get up*", "*everyday*", and "*before reading textbooks*". One person even commented that "*it seems relax yourself*". Indeed, it seemed that learning occurred with little effort, as one participant notes "*I found I learned more without realising it*". Essentially, participants felt "*it makes practice fun*" and it was a "*chance to encourage us*".

A key motivating factor identified among the students was the use of an avatar. Participants mostly appreciated the avatar and no-one felt that the videogame would be improved without it. For starters, the avatar made "*the game less boring and more fun!*" for one participant. The avatar was also identified as making *Brevissima* look "*like real situation*". Students commented that "*the characters in the game is lovely*" and "*avatars are good for eye pleasure and excitement*". The avatars seemed to help create an emotional response such as "*the avatars looks so funny, and if you miss some abbreviations he will cry*". An important comment was made that if there was no avatar, *Brevissima* would be "*just like taking an*

exam". Thus, while the avatar makes the gaming situation more real, it seems to remove the emotional pressure usually associated with assessment. The large amount of positive feedback about the avatar indicates its important role in the educational process and in mediating the students' responses to the educational materials.

Finally, it is notable that over a third of participants mentioned game scores in their feedback, despite being unprompted to do so by the questionnaire. Thus, the ability to self-assess progress using the scoring system was important, but in light of the comments about the relaxed nature of the videogame, the students proceeded with the self-assessment without feeling pressured. A student mentioned that *Brevissima* motivated them to "*build up my scores and reach to a high ranking*". Another student was so concerned about it that they warned others "*Do not use it when you are tired as you get a lower score*". Thus, for the videogame medium, the scoring system seems essential to student engagement.

Conclusion

This paper began by specifiying the language needs of the target student population – international nursing students who are non-native English speakers. As a result of a needs analysis involving a literature review and in-class feedback, it was decided that the target language activity would be to teach medical abbreviations and their contextual use. Thereafter, a rationale was given for a videogame and its design was outlined. This was followed by an explanation of how a cognitive psychology approach contributed to the design of the videogame and its teaching method. The specific approaches which were adopted involved providing repeated exposure to each medical abbreviation and its related forms, giving immediate feedback and scoring to help motivate students, and using multimodal input to increase learning. Finally, the results from a preliminary qualitative study of the videogame were also provided.

The *Brevissima* game addresses a number of pressing linguistic needs. The first is the current gap between predominantly text-based educational resources and the speech-based contextual use of medical abbreviations. The videogame broaches this gap by preparing the students for the various linguistic forms and uses of medical abbreviations in the clinical context. The pedagogy-driven approach to the design of the *Brevissima* ensured the technology was a tool that addressed student needs and this remained at the forefront of its design. The second advantage of the videogame is it provides experience in the rapid realistic use of medical abbreviations, improving response time and accuracy. Two important factors in creating this realism was the contextualised multimodal input and the projected identity gained through the avatar. As indicated by the preliminary feedback in the study, the participants recognised the game's role to increase exposure, familiarise, and contextualise medical abbreviations. Often, they also had a positive emotional experience from interacting with the resource. Thus, the videogame seems to provide relevant educational content that is recognisably useful for future professional interactions, yet is also motivating, engaging, and approachable.

A further study is planned for this game. The next step is to conduct a repeat measures study involving a control group and a longer qualitative survey which will be triangulated with the results of the quantitative data. This would involve a much larger group of participants. However, the preliminary results indicate that this course of action is worth pursuing.

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