

Exploring the Synergies between Technology and Socio-Cultural Approaches in Computer-Assisted Language Learning for Less Commonly Taught languages

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Abstract

Language learning is a complex task and to be successful, it involves a range of cognitive processes. Intelligent Computer Assisted Language Learning systems can be useful for enhancing the effectiveness and efficiency of both teacher-led instruction and student learning. Digital technologies are routinely employed for commonly taught languages but are less frequently used in the Less Commonly Taught Language (LCTL) context. In this study, we investigate methods for encouraging the learning and teaching of LCTLs, particularly indigenous and endangered languages. Our research blends language learning pedagogy, socio-cultural theory, and Digital Game-Based Language learning (DGBLL) in the form of games and Virtual Reality. Language learning materials are enhanced with the aid of Natural Language Processing techniques. We present a DGBLL system designed to promote language learning and student engagement. The system has been tested successfully in primary school classrooms, with positive feedback from both students and teachers.

Keywords: Computer-Assisted Language Learning · Less Commonly Taught Languages · Digital-Game-Based Language Learning

1. Introduction

Computer-Assisted Language Learning (CALL) research is heavily focused on the most commonly taught languages, particularly English. This is not surprising as there are around 1.5 billion English language learners in the world (Council, 2016). This means that most of the CALL resources developed are for learners of English. Consequently, there are fewer resources for Less Commonly Taught Languages (LCTLs) (Ward, 2015). In fact, a language can be an official language of a country and yet be a LCTL internationally. This is the case for the Irish language.

The concept of learning languages as a by-product of playing games is known as Digital Game-Based Language Learning (DGBLL). Furthermore, research (Lan, 2020; Lin and Lan, 2015) has shown that Virtual Reality (VR) has the capability to improve language learning. CALL involves the use of technology in the language learning process. It encompasses DGBLL and VR language learning but is broader in reach. Natural Language Processing (NLP) technologies facilitate human language interactions for tasks such as natural language understanding, generation and inference. NLP resources have the potential to contribute to CALL (Ward, 2019), but this potential remains largely under-utilised. In this project *Cipher*, DGBLL is used as the bridge between CALL and NLP to develop a game-based and VR-enhanced language learning application. The game's theme, centred around fairy tales, stories, and myths, is selected to actively engage and motivate learners. By choosing familiar fairy tales at the lower levels of language proficiency, we can build on the learner's knowledge from their L1. At the more advanced levels, we use folk tales and mythology which are engaging and can be made culture-specific and reflect the theme of "reconnecting to the spirit of the language" (see section 2.2.1).

An educational and entertaining game such as ours is particularly important in the context of Irish society, where Irish is a minority and threatened indigenous language. In this context, many L2 learners lack extracurricular exposure to the language. This game provides the opportunity to improve certain language skills while engaging with the language in a fun and pedagogically beneficial way. Additionally, the project adheres to robust software engineering practices making it language-independent so that the game can be adapted to other LCTLs.

2. Background

2.1. CALL for Less Commonly Taught Languages and endangered languages

In recent years, there has been a surge in the popularity of language learning applications such as Duolingo, Memrise, and BabbleAR. Blake (2011) suggests that CALL is the way forward for the learning and teaching of the more commonly taught languages. However, fewer CALL resources are available for LCTLs. For these languages, it is not easy to assemble the human and financial resources to develop engaging, high-quality language learning resources (Ward, 2015). Furthermore, motivation is a big challenge for learners of LCTLs and increasing motivation is important in LCTL CALL research. LCTL CALL researchers are creative (e.g., Millour and Fort, 2020) and aim to leverage existing technology and resources and adapt them to their own LCTL (e.g., Purgina et al., 2017).

Endangered languages have further challenges when it comes to CALL including the lack of printed and online resources in the language, dialectal issues, lack of societal support, lack of quality language documentation, lack of an active speaker community or native speakers, as well as a lack of competent linguists and teachers (Ward, 2015). Many learners of LCTLs, particularly those of endangered languages, are deprived of the benefits of CALL such as

accessibility to learning materials that is both easier and more cost-effective. Furthermore, it is more challenging for learners to access authentic language resources. For example, simply wanting to hear their languages being spoken can be an issue as learners of the languages may not have native speakers in their vicinity and some of these languages may not even have many speakers remaining (Ward, 2015). As a result, learners face more difficulties in learning these languages, leading to a reduction in the number of language learners and a corresponding decrease in demand for CALL, creating a vicious cycle.

To address this issue, our research focuses on digital resources for the learning and teaching of LCTLs. From a computational resources' perspective, the emphasis is on low-resourced languages, while from a socio-cultural standpoint, the focus is on indigenous and endangered languages.

2.2. Indigenous language revitalisation in the modern world

2.2.1. Philosophy: reconnecting to the spirit of the language

More and more languages are disappearing all over the world (UNESCO, 2022). The reason for this can be attributed in part to the dwindling number of individuals who speak the language. Indigenous people, especially younger generations, are reluctant to learn the language and their parents are sometimes reluctant to pass it on to them. For example, Napier and Whiskeyjack (2021) hold the view that there is a disconnect between the Cree language (an indigenous language in Canada) and the Cree people. Their research explored the reasons for the disconnection and provided some solutions to improve the situation of the language. This is the theory of reconnecting to the spirit of the language. The steps of reconnection are history, harms and healing. According to their research, the spirit of languages relies on the history of the land, languages and laws. As the findings are useful for the language revitalisation of the Cree language, it is possible that the theory may apply to other indigenous languages. In our project, we leverage the theory by incorporating the language, lore and mythology within the Irish context in an immersive environment.

2.2.2. Indigenous language learning in a digital age

Previous studies on indigenous language revitalisation show that digital technology plays an important role in the survival of these languages due to the advantage of digital technology being able to record, preserve, analyse, manipulate, and transmit languages in numerous ways (Galla, 2018). Digital technology has been applied to the field of indigenous language revitalisation in various forms including social media, apps, and VR (Galla, 2018) (Outakoski et al., 2018). According to Galla's (2016) survey of at least 47 indigenous languages in 2009, digital technology has a positive impact on indigenous language education. Furthermore, research has demonstrated that indigenous youth actively use digital technology, which can help their reconnection to their heritage and languages. With active engagement and interaction with digital technology, indigenous youth are gaining increasing

language exposure consciously and unconsciously. Furthermore, emerging technologies like VR allow young learners to have immersive experiences which reconnect them to the land they were born in and where the languages reside, helping them reconnect to the spirit of the language. Digital technology facilitates more efficient, cost-effective language documentation and material development through various media formats (e.g., image, audio, and video) (Outakoski et al., 2018).

Digital ancestral knowledge is essential to indigenous knowledge and education (Wemigwan, 2016). Furthermore, digitised indigenous knowledge has the potential to engage a broader audience, allowing individuals from various regions to participate in the preservation and development of the language beyond their own community. For example, our research project benefited from the digitalisation of archived indigenous language materials (project Dúchas¹), which enabled us to repurpose the materials for DGBLL.

2.2.3. Irish cultural heritage and Dúchas resource

The National Folklore Collection (NFC) is a valuable cultural repository for Ireland. Its aims are to collect, preserve and disseminate the oral tradition of Ireland (Daly, 2010). The Dúchas project (Meitheal, 2022) has been running since 2012 (Ó Cleircín et al., 2014) and its goal is to digitise historical documents. The Schools' Collection (TSC) from NFC (e.g., 450k pages) has been scanned and indexed in the project and a considerable number of texts have been transcribed (e.g., 40k pages) from the collection (Raghallaigh et al., 2022). The Schools' Collection consists of essays gathered from over 50,000 schoolchildren from 5,000 schools in Ireland from 1937-1939. The schoolchildren wrote about folklore, mythology and local traditions and in all 740,000 pages were collected. These texts provide a unique insight into Irish life and the Irish language at that time.

While the availability of this resource is highly valuable and the perusal of the children's texts is captivating, the application of NLP techniques to these handwritten texts presents a challenge. Fortunately, there is a national crowdsourcing initiative (Meitheal, 2022) that leverages support from the community to transcribe these handwritten texts into a digital format. To date, 75% of the Irish texts have been digitally transcribed (Meitheal, 2022). These texts were subsequently reviewed by the Dúchas project team for quality assurance purposes.

2.2.4. Irish language technology

Although Irish is a less-resourced language in terms of NLP resources, there are two NLP tools that have been particularly useful in this project: the Irish POS tagger (Uí Dhonnchadha and Van Genabith, 2006) and Gramadóir (Scannell, 2005). The Irish POS tagger annotates a text with part-of-speech tags and lemmas. It uses Parole morpho-syntactic tags (Monachini and Calzolari, 1999) and XML Corpus Encoding Standard (Ide et al., 2000). Irish has a rich inflectional morphology and a rule-based approach is used throughout for the POS tagging, chunking and parsing tools. A rule-based approach rather than a machine learning approach was essential as there were no annotated corpora available for this first POS tagger for Irish. Rule-based approaches are particularly important for low-resourced

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languages. While the Irish POS tagger was primarily used to supply the *Cipher* engine with POS-tagged texts, it was also helpful in the initial classification of texts so that players would be shown a text appropriate for their level of Irish. As an Irish spelling and grammar checker, *Gramadóir* is used to identify misspelt or grammatically erroneous words in Irish text. Within the NLP pipeline of *Cipher*, *Gramadóir* is employed to spellcheck manually revised texts.

2.3. Motivation

The intrinsic/extrinsic motivation theory is built based on the self-determination theory (Ueno, 2005) which suggests human behaviours are self-determined (Deci and Ryan, 1985). Intrinsic motivation is driven by the rewards or punishments that people may receive from the activity itself while extrinsic motivation is driven by external rewards or punishments (Ueno, 2005). Theodoropoulos and Antoniou (2022) have found that games, particularly those in VR, have been used to increase cultural awareness and heritage appreciation due to the highly immersive nature of VR experiences. This project intends to explore the potential of VR as a means of reconnecting to the spirit of the language and thereby increasing learners' internal motivation. Meanwhile, game rewards provide external motivation for learners, as demonstrated in language learning applications like Duolingo.

2.3.1. Motivation in the Irish context

Although Irish is one of the three official languages of Ireland, it is only spoken daily by 1.5% of the population outside of the education system (CSO, 2016). With some exceptions, Irish is a mandatory subject in both primary and post-primary education. However, many students lack the motivation to study the language, and this can make Irish lessons seem like drudgery rather than an enjoyable experience for some students. The teachers, who mostly are not native speakers, often must shoulder the responsibility of Irish language education as many parents are unable to help their children with Irish homework. Until recently, there were very few interactive resources for teaching Irish in the school context. While there are now some online resources linked to specific textbooks, they still remain few in number. As Sanacore (2007) outlined, for reluctant learners in general there is a need to provide challenging learning activities, offer student choice and provide opportunities for more active learning. A DGBLL app for Irish presents a potential means of providing these activities and opportunities.

2.4. Digital educational games

Dixon et al. (2022) mentioned that the efficacy of the DGBLL approach is heightened in games designed for entertainment as opposed to those designed for educational purposes. Nevertheless, entertaining games are less likely to provide a language option for minority languages due to a lack of commercial incentives. Educational applications incorporating gamification elements exist outside of the aforementioned classifications. Nonetheless, Dixon et al. (2022) included Duolingo in the research for DGBLL as Duolingo is an “edutainment” app with many game-like features and complex game mechanics. The *Cipher* game described in this paper primarily focuses on reading and word awareness, and leverages NLP tools and resources to

make the game more language appropriate and variable. Focus on form is important in language learning and NLP resources can help in this regard (e.g., Meurer et al., 2010).

2.5. VR

Lan (2020) notes that VR's immersion and interaction features are critical factors that render it beneficial to both educators and learners. CALL researchers have made some effort to investigate the pedagogical perspectives of VR for language learning despite its original purposes (Lin and Lan, 2015). Lan (2020) suggests that various elements must be taken into account when applying VR to language learning, including learners' language proficiency and language acquisition process.

3. Research Questions

The following research questions (RQ) are primarily focused on three strands: technology, pedagogy, and socio-cultural context. These questions came about through an analysis of the associated research around CALL for LCTLs and from the progress and plan described in Sections 4 and 5.

- RQ1 How can existing game resources for dominant languages be repurposed for low-resourced languages for CALL?
- RQ2 How can specific technology (i.e., NLP, VR) be leveraged to enhance CALL resources?
- RQ3 How can language learning pedagogy be incorporated into DGBLL?
- RQ4 How can socio-cultural approaches be integrated into CALL for indigenous languages?

4. Progress

4.1. Repurpose game resources

This section aims to contribute to research question RQ1. Irish is an under-resourced language. If it is possible to repurpose resources from dominant languages (e.g., English), it will provide many language opportunities for under-resourced languages. In line with this objective, the present study successfully adapted a computer game in English to serve as a tool for Irish language education through the DGBLL concept. Furthermore, language independence is a design feature of this project, aimed at ensuring the adaptability of our work to other LCTLs.

The educational game introduced in this paper is based on the game *Cipher* (Xu and Chamberlain), which was designed for detecting errors in English text through the idea of games-with-a-purpose and crowdsourcing. The informal feedback from players indicated that *Cipher* has the potential for facilitating language learning. This provided the foundation for the further development of *Cipher*.

Based on the original *Cipher* game, the *Cipher* engine was enhanced to enable the creation of *Cipher* games in other languages. *Cipher: Faoi Gheasa* (*Cipher: under a spell*) was designed to encourage students, especially young learners, to learn Irish. To emphasise language learning purposes, new storyline and game elements were added to the game, to encourage “noticing” (spelling) of vocabulary, reading and writing. The game presents a magical world in which an evil spirit casts spells on ancient legends in which many ancient spirits dwell in order to make people forget

the ancient spirits and the past. In the game, the player needs to complete certain “tasks” before an evil spell can be lifted from the tales and ancient spirits can be saved. Game elements (e.g., spells, power-ups and ancient spirits) help to transform language tasks (including noticing, reading and writing) into interesting game tasks. (See Fig 1 for some screenshots of *Cipher*)



Fig 1: *Cipher* screenshots

Ideally, the player needs to have some degree of Irish knowledge (beginner level). However, with game elements like power-ups, we found that players can play and enjoy the game even if they do not have previous knowledge of Irish. During a user experience study in a primary school in Ireland where most students study Irish as a subject, there were a few students who did not study Irish but were still able to play the game and even enjoy it. Therefore, for some students who did not study Irish, the game became a language exposure experience.

4.2. Repurpose language resources

In relation to research questions RQ2 and RQ4, this section provides an overview of the process of repurposing stories from The Schools Collection (TSC) of the Irish NFC for use in *Cipher – Faoi Gheasa*, a DGBLL app for Irish. As part of the Dúchas Project (Ó Cleiricín et al., 2014) approximately 450k pages were scanned, indexed and transcribed, and the transcribed text and metadata were made freely available online. This resource provided a rich source of reading material for the game. The aims of this game are to promote language awareness, vocabulary learning, reading and writing, all of which are known to be important in language learning. In the game, players are asked to spot “enchanted” words that have been selected randomly in the texts and players must also identify the type of spell (cipher) that was used. Moreover, research has shown that folklore and indigenous cultural elements can help learners reconnect to the language’s spirit, which encourages indigenous language learning (Napier and Whiskeyjack, 2021).

There was a multi-stage process in the development of texts for *Cipher - Faoi Gheasa*. A variety of NLP tools were used to process these texts, in a series of cleaning, updating and annotation steps, into a format that can be used in the game by modern language learners. In step 1, TSC was searched to find suitable texts for the game. It was important that interesting and accessible stories were used, and that they have a magical or supernatural element. The metadata for each of the stories was useful in this regard. Once the original stories had been found, step 2 involved downloading the digitally transcribed stories and their

metadata from TSC. There were several files related to each story including the actual digital text and the related metadata. In step 3, these texts were then manually reviewed and obvious changes were made to the text to convert it to modern standard Irish since these stories were written down almost a century ago by schoolchildren and some adjustments to spelling and grammar were deemed necessary.

Once the text had been adjusted, the text was then checked by *Gramadóir* for any remaining spelling errors in step 4. Once these errors had been corrected, in step 5, the cleaned text was then processed by the Irish POS tagger (Uí Dhonnchadha and Van Genabith, 2006). The POS-tagged texts were then processed by a chunker and noun phrase checker and additional errors spotted were then corrected. It is essential that only deliberately inserted errors (i.e., spells) are found in the text – other types of errors would be confusing for the players and interfere with the learning process. The XML POS-tagged file was then passed to the *Cipher* engine to produce *Cipher - Faoi Gheasa*. The POS tags include the gender of each noun in the text. This enables the *Cipher* engine to display masculine and feminine words in different colours in the game where red words are feminine and blue words are masculine.

The next stage in the processing is to determine the text difficulty level, i.e., whether a text is suitable for a beginner or more advanced learner and for progression purposes in the game. This involved the development of text complexity measures for Irish (Uí Dhonnchadha et al., 2022). Lexical diversity, lexical frequency and grammatical complexity were calculated using the POS-tagged and lemmatised text. This guided the objective classification of texts based on complexity scores and enables the *Cipher* engine to present texts of an appropriate level to the player. Further details pertaining to the NLP integration within *Cipher* are expounded upon in (Ward et al., 2022).

5. Results

5.1. Technical results

Existing and new NLP resources for Irish were leveraged successfully to provide the text resources for the *Cipher*. This involved a combination of automated and semi-automated processes. The *Cipher* development team was able to reuse the existing handwritten texts transcribed in digital format after they had been amended and adapted with the *Cipher* NLP pipeline. As the game is intended for language learning, all POS-tagged text is manually verified. The *Cipher* engine has been re-designed to be language-independent. It can accept annotated XML texts in any language and new language-specific or culture-specific ciphers can also be designed and implemented. The interface language has also been parameterised.

5.2. User experience study

The first school to use the app was an Irish medium primary school where students are taught through the medium of Irish and generally have higher levels of Irish than in English medium schools. The app was tested by approximately 20 students using Android tablets. Informal feedback from the students and teachers was positive. The second school was an English medium primary school and the students used laptops to play the game. The game was tested by more than 150 students across nine classes, who

either played the app individually or in pairs. Feedback from the students and teachers was positive. Further details on the user experience study are available in the study (Xu et al., 2022).

6. Work-in-Progress

6.1. Curriculum development

This section is intended to explore research question RQ3.

6.1.1. Game extension

The first phase of the research project was game adaptation as a proof of concept. If an Irish story is presented to students in the game, can they find the “disrupted” words and ciphers? Does the game work and is it suitable for primary school students? Moving further, the next phase is to focus on the pedagogy and make sure the game not only can encourage young learners to interact with Irish learning materials in a fun way but also improves their language skills in a standardised way. In phase 1, the game is mostly based on reading. To align with the curriculum, vocabulary learning and writing tasks are added to the game. The vocabulary part, also called “letter bricks”, will pre-teach some words so that learners will learn some vocabulary before the reading tasks. These words are related to the reading material they will be given later in the game. The writing task, also called “word bricks”, will be presented after the reading task. The writing task is also based on the reading material. This might sound slightly dull but both vocabulary learning and writing tasks are designed with game elements to make them engaging. The entire game is centred around the themes of steganography and mythology. This part of the work has already been implemented in the game and is ready to test in schools once the curriculum design is completed. (See Fig 2)

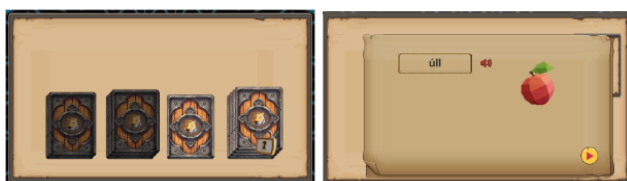


Fig 2: Vocabulary learning task in the game

6.1.2. Curriculum design

In game-based learning applications, gaming alone does not make learning happen, it is the pedagogy that supports learning in the game. We are working with primary school teachers on aligning *Cipher* with the primary school curriculum for Irish. We are designing the language learning content in the game in a way that is pedagogically appropriate. We are using stories and current versions of Irish myths to make them more appealing and suitable for gameplay and language learning. The thematic approach of the Irish curriculum might help with scaling the game or providing a framework around to build stories. Through the main theme of myths, there are sub-themes of the Irish curriculum (e.g., weather, clothes, family). We intend to add challenges to the game for tests, which are appropriate for children with a certain level (e.g., 4th grade).

6.2. VR

VR technology will be employed to provide enhanced exposure to the folklore and mythology of the target language with the aim of enhancing culture and language awareness among users (See Fig 3). This exposure will help learners reconnect to the spirit of the language, thereby augmenting their intrinsic motivation. By building the system on top of an existing language-independent game resource *Cipher*, user acceptance risk and implementation processes can be greatly reduced. This segment of the study will contribute to addressing research questions RQ2 and RQ4.



Fig 3: *Cipher* VR blueprint

7. Conclusion

While developing CALL for less-resourced languages is more challenging, it is not impossible. This paper demonstrates that a structured and creative use of existing technology and resources that are pedagogically suitable and appropriate as well as engaging for language learners can be used to good effect to develop CALL for LCTLs. There are future improvements planned and research will continue into this novel approach within our framework represented above.

Acknowledgement

This work was conducted with the financial support of the Science Foundation Ireland Centre for Research Training in Digitally-Enhanced Reality (d-real) under Grant No. 18/CRT/6224. For the purpose of Open Access, the author has applied a CC BY public copyright licence to any Author Accepted Manuscript version arising from this submission. Our gratitude extends to Tianlong Huang for providing support in game development.

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