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Towards inclusive CALL for Irish: A game-based approach for dyslexic students informed by an English language pilot study

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Abstract

Computer-Assisted Language Learning (CALL) enables learners to progress at their own pace, moving quickly through familiar material and spending more time on areas that require additional support. This flexibility is particularly beneficial for learners with specific learning differences such as dyslexia, where targeted digital interventions can enhance reading and language outcomes. In Ireland, Irish is a compulsory subject in most schools; however, there are limited resources to support dyslexic students, particularly in Irish-medium education. This paper reports on the development and evaluation of a digital game-based language learning approach designed to support dyslexic learners. Findings from a pilot study with dyslexic students using an English-language version of the game provide insights into design strategies and learner engagement. The study discusses key challenges and outlines a roadmap for developing inclusive CALL resources for the Irish language, contributing to a broader understanding of how technology can support equitable language learning.

Keywords: *CALL; digital game-based language learning; dyslexia; inclusive education.*

1. Introduction

The aim of this research is to report on the experiences of dyslexic students in English-medium schools and to provide recommendations for developing Computer-Assisted Language Learning (CALL) resources for dyslexic students in Irish. Cipher is a digital game-based language learning platform that combines storytelling and word puzzles to make language learning engaging and culturally meaningful (Xu et al., 2024). Through interactive tasks inspired by Irish folklore, learners develop vocabulary, reading, and writing skills in a playful way. Its adaptable design supports various learners' needs, including those with dyslexia, and can be customised for different languages and contexts. The Cipher team developed an English-language version of the game specifically designed to support dyslexic learners. (Ward et al., 2024) and the development of a corresponding dyslexia-friendly version of the Irish Cipher game is in progress. This involves incorporating recommendations from Irish teaching and dyslexia research literature (Stenson & Hickey, 2016; 2019; Barnes, 2017; 2025), adapting the Irish language content of the Cipher stories and adding specific ciphers. Challenges to this work include the fact that research into dyslexia in the Irish language context is nascent, and access to suitable participants in Irish-medium schools is limited due to the lack of assessment and support for dyslexic students in the Irish educational system (Nic

Aindriú & Ó Duibhir, 2022). In Irish-medium schools, students with special educational needs are encouraged to move to English-medium schools, and students in English-medium schools who are diagnosed with dyslexia are often exempt from studying Irish and would generally do a different task while their peers are learning Irish. As a first step towards an inclusive dyslexia-friendly CALL application, we explore our ideas of using ciphers to assist language learners with special needs. We begin by testing the dyslexia-friendly English language version of Cipher in the classroom. The English language version of Cipher was played by students who were officially diagnosed with dyslexia and who were exempt from studying Irish, while their peers played the Irish language version of Cipher. This paper reports on the challenges of developing a CALL resource for dyslexic students of Irish, the findings to date regarding the English Cipher game, and a roadmap to the development of a dyslexic version of Cipher for Irish.

Now is an opportune time to develop inclusive CALL resources for Irish. The Irish Government has a renewed focus on the teaching of Irish in English-medium schools (Government of Ireland, 2020; 2025). A more inclusive approach is proposed, and they are looking to increase the number of digital resources available for the language. In tandem with this, government agencies with responsibility for supporting Irish-medium education, e.g. An Chomhairle um Oideachas Gaeltachta agus Gaelscolaíochta (COGG) are aware of the need to support dyslexic students in Irish-medium schools. To develop an inclusive version of Cipher for Irish, we propose a series of steps that form part of the roadmap for the development process, which includes a co-creation approach, involving teachers, students and educational specialists as well as the Cipher team. While these recommendations pertain to Irish specifically, they could also map to other lower-resourced languages, and the Cipher team will endeavour to make the app adaptable for other (low-resource) languages in order to build more sustainable CALL resources (Ward, 2015).

2. Background

2.1. CALL and additional learning needs

CALL allows learners to learn at their own pace, enabling them to move quickly through familiar elements and spend more time on less familiar items. This applies to language learning in general, but it is also true for learners with additional learning needs (e.g. students with dyslexia). Dyslexic learners can use digital resources to learn work at their own pace.

Dyslexia is a learning difference that affects the development of reading, spelling, and writing skills. This can lead to the phenomenon where children who find reading a struggle are less inclined to read, resulting in less opportunity to improve their reading fluency, whereas the opposite is true for children who find reading easier and more enjoyable. One of the ways to counteract this phenomenon is to make the reading experience more fun and enjoyable through CALL applications, especially game-based language learning. Hall et al (2023) report that dyslexia is an area where specialist intervention can enhance students' learning outcomes, in particular reading interventions that provide explicit, systematic instruction in foundational skills such as phonological awareness, phonics knowledge, word reading, spelling, and connected-text reading with focus on meaning and comprehension in connected text can lead to significant positive effects.

Dyslexia not only limits a student's access to information (through slower reading and greater comprehension difficulties) it can also affect their self-esteem if support is not provided. In the absence of interventions, children with reading difficulties are at risk of developing psychosocial and behavioural difficulties (Morgan et al, 2008, cited in Hall et al, 2023). Targeted CALL applications can be beneficial in avoiding such additional difficulties. In practice, students tend to share their progress with each other across the classroom. However, the use of adaptive CALL where the specific level of the task is determined by the student's progress can make direct comparisons between students less likely. Furthermore, CALL resources designed specifically for dyslexic students can be beneficial to all learners (see Ward et al., 2024).

2.2. Dyslexia: Language specific features

There has been extensive research into dyslexia in L2 language learning in general (Nijakowska, 2010) and for English in particular (e.g. Helland & Kaasa, 2005) and there are many resources for dyslexic students of English (Dawson et al., 2019). Nevertheless, most teachers of English as a Foreign Language lack formal dyslexia-specific training which leads to insufficient classroom support (Folia & Malisiova, 2025). In the case of Irish, the situation is even more acute. There is limited research into dyslexia in the Irish language context and little or no support in the classroom (Barnes, 2017:18; Nic Aindriú et al, 2020)

Fluent reading requires a reservoir of 'sight words' (words that are recognised instantly) and a knowledge of letters to sound rules for decoding unfamiliar words. Knowledge of syllabic structure and morphology (e.g. prefixes and suffixes) is also helpful in decoding unfamiliar written words. These elements are language-specific and require explicit teaching. Sight words are acquired through repeated exposure when reading. Research has shown that typical readers may become familiar with a word after as few as two to ten encounters (Uchihara, Webb & Yanagisawa, 2019), however dyslexic readers require greater exposure to words before they are automatically recognised. Games provide an ideal way of providing the repetition necessary to build up reading skills. The Cipher game can provide repeated reading and spelling practice in an enjoyable manner.

2.3. Education system in Ireland

The education system in Ireland has both English medium and Irish medium schools. Most schools are English medium, while approximately 7% of children attend Irish-medium schools (Central Statistics Office, 2025). Within the Irish medium sector, there are two types of school; those located in Irish speaking areas (called Gaeltacht areas) and those outside Gaeltacht areas. Regardless of the medium of instruction, all schools are required to teach Irish which is a compulsory subject up until the end of secondary education. Some students are exempt from studying Irish, either due to a learning difficulty (e.g. dyslexia) or having arrived in Ireland towards the end of primary school (age 11-13). In recent years, there has been an increase in students seeking and getting an exemption from studying Irish and the motivations are a source of some debate (Ó Duibhir, 2025). On the other hand, there is increasing interest from parents in enrolling their children in Irish medium schools and the demand for places exceeds supply (Comhairle, 2023). The cohort of children in Irish-medium schools includes children with dyslexia, which is typically not diagnosed when the child initially starts school (at age 4 or 5 in the Irish context). Children need to be at least six years old and have had at least 18 months of education before they can be assessed for dyslexia in Ireland. In addition, there is very limited support and very few resources available for dyslexic students in Irish-medium schools (Barnes, 2017).

Decisions as to whether a student with dyslexia stays in an Irish medium school are complex and involve parents, students and teachers. Principal attitudes also play a role when deciding if a dyslexic student continues in Irish medium education (Patton & Matthews, 2020). In recent years there has been research into the challenges facing learners with additional needs in Irish medium education (Nic Aindriú & Ó Duibhir, 2023) and a bilingual literacy screening test for post-primary schools (Barnes & Ó Duibhir, 2023) is currently being developed and piloted. A diagnostic assessment tool for special education needs through the medium of Irish has recently been developed and is being piloted in several schools (The Irish Times, 2025). Upskilling will also be required for teachers and educational advisors especially, given their own limited understanding of Irish orthography in the context of dyslexia.

Research suggests that children with special education needs are advised against bilingualism and immersion education, and this view is supported by the lower numbers of students with special needs in Irish medium schools compared to English medium schools (Nic Aindriú et al, 2023; 2024). However, according to Nic Aindriú et al (2023) there has been an increase in the number of students with special education needs attending Irish immersion schools over the last decade. In recent years, there has been an increasing focus on looking at ways to support dyslexic students when learning Irish, both in Irish medium and English medium schools. The Department of Education and Youth (Ireland) is preparing an Action Plan for the teaching of Irish in English medium schools (in

progress) and there will be a focus on an inclusive approach to teaching Irish and an increased use of digital resources for teaching and learning the language (Government of Ireland, 2025). The aim is to support all learners, including those with dyslexia, rather than leaving them with no knowledge of the language (as happens if they are exempt from studying Irish). While initially getting an exemption might seem beneficial to the student e.g. more time to study another subject, there may be long term implications, e.g. the student might not be able to apply for government jobs without Irish or may have a sense of missing out on an important aspect of Irish culture. The ideal solution is to provide support for dyslexic students in both English and Irish medium schools, which requires the creation of targeted resources and targeted teaching.

3. Pilot study: User acceptance of English dyslexia-friendly Cipher

Cipher is a digital game-based language learning platform designed to integrate linguistic and cultural learning through interactive gameplay (Xu et al., 2024). The game presents a narrative world where players advance by decoding "spells" that represent language puzzles. These include tasks focused on vocabulary, reading comprehension, and writing, all embedded in short stories inspired by Irish folklore and mythology. Players engage in activities such as identifying word forms, reconstructing sentences, and matching sounds to spellings, earning rewards that unlock new sections of the story. The game environment combines visual cues, text, and audio features, including text-to-speech options, to support learners with diverse needs.

This pedagogically grounded design encourages incidental language learning through play, while also promoting cultural connection and learner motivation. The game was enhanced with new features to support dyslexic students (see Figure 1). This was developed for English initially as a proof of concept, as there are more supporting research and expertise available for the English language than for Irish. There were several enhancements to support dyslexic students. The game content was simplified by displaying less text on each screen. The game rules were adjusted to take into account the specific difficulties of English for students with dyslexia – both the text and the storyline were less complex. AI-generated text-to-speech audio was added to provide audio instructions along with written instructions. The ElevenLabs AI-generated voice was chosen based on alignment with the game narrator and was considered suitable for young learners. Several ciphers tailored for dyslexic students were added to the game e.g. a new cipher was created that removed the 'h' from words starting with 'ch', sh' and 'th'.

Figure 1 shows a screen shot where there are less than 30 words on the page (there were normally 40-50 words per page), the text is simpler than in the non-dyslexic version and it uses a new English dyslexic cipher (the letter 'h' has been removed from certain words). Further information is available in Ward et al. (2024). The English dyslexia-friendly version of Cipher was co-designed with a dyslexia intervention researcher and developed from translated Irish content in the Irish version of Cipher. The English texts were adapted from the Irish version to ensure equivalent vocabulary and storyline while simplifying structure and language to meet the needs of dyslexic learners. Building on the results from this pilot study, analogous upgrades are in development for Irish.

Figure 1. A screenshot of English dyslexia Cipher.

3.1. Schools and participants

Three English-medium schools were invited to participate in testing the English language dyslexia version of Cipher, of which two schools accepted. This testing ran in parallel with a larger research project into the Irish version of Cipher. While 88 students in these two schools played the Irish version of Cipher, only 6 students played the English-medium dyslexia-friendly version. In Ireland, given that approximately one in 10 people are affected by dyslexia (Dyslexia Compass, 2022) - 6 students out of 94 represents approximately 6% of the student population, which is lower than expected. There may be several reasons for this, including the fact that students are not usually tested for dyslexia until around 7 years of age and the long delays in the dyslexia testing services in Ireland (Gaab, 2017). Some teachers reported that there were several students in their classes who were at risk of being dyslexic, but they had yet to be formally assessed. They anticipated that they would be assessed in the next two years and would most likely apply for an exemption from Irish. In the meantime, they continue to study Irish along with their classmates. Ideally, there should be supports to enable them to continue to study Irish following a dyslexic assessment. Of the six students, three students were from a boys-only English-medium school, while the other three students were from a girls-only English-medium school. While single sex school may be unusual in other countries, it is not uncommon in Ireland for historical reasons where many schools were initiated and run by religious orders. Irish-medium schools tend to be newer than English-medium schools and are invariably mixed schools.

The students had the opportunity to play Cipher once a week for approximately 30 minutes over a period of 3–5 weeks. This was usually during the normal Irish class time. In the first week, they were given an overview of the game including an example of the vocabulary game and the different ciphers that they might see. The research was approved by the university's Research Ethics Committee and student participation was voluntary. Each student was randomly given a sticker with an anonymised ID which they put into their copybook, so that they could reuse the same ID each time. Their teacher maintained a backup list of student name and ID in case of difficulties, as this had been an issue in the past. Only the teacher had access to the backup list, and it was destroyed at the end of the school year. Each student was given an individual tablet to play the game at their own pace. In classrooms where there were no headsets, students were asked to keep the audio at a relatively low volume, which was sufficient to hear it but not loud enough to distract others. The students usually played the game on their own, sometimes asking for help from the teacher, a Cipher team member or one of their peers. In general, the students were able to play the game with minimal support. The dyslexic students played the English language version of Cipher, while their peers played the Irish version.

3.2. Results

Although six students played the English language version of Cipher, only five students filled out the survey (one student declined to participate in the survey). All the students were in 4th class and were aged between 10 and 11 years of age and were exempt from Irish due to formally diagnosed dyslexia (in Ireland, dyslexic students are exempt from Irish). They reported playing digital games quite frequently, either a few times per week (40%: n=2) or almost every day (60%: n=3). They reported a slightly less frequent use of education games in school (a few times a month (40%), a few times per week (40%), almost every day (20%)) and a lower rate for the use of educational games at home (never (40%), once in a few months (20%), a few times per week (20%), almost every day (20%). Most of the students enjoyed playing the dyslexic-friendly version of Cipher, with 80% saying they liked playing the game and 20% saying 'maybe'. A majority of students found the stories easy to read (60%) while 40% said they were difficult.

Overall, they were happy to play the game (60% very happy, 20% happy) with only 20% saying they were not interested. Their overall experience of playing the game was positive (80%) with one student (20%) saying it was boring. Most students would be happy to play the game again (60% yes, 40% maybe) and would recommend it to their friends (60% yes, 40% maybe). Most students said they thought they learnt new words (80%) with only 1 student (20%) saying 'not at all'. The results on the question "Did it help with your reading?" were less positive, with 60% said maybe, while 40% said no. They thought it compared favourably with learning new words through

normal classroom teaching (60% OK, 40% good). They were slightly more positive when comparing reading through the game to normal classroom teaching (80% good, 20% OK). Table 1 provides an overview of the survey questions and the responses.

Table 1. Summary of survey questions and responses.

Question	Responses
How often do you play games (including video games and board games)?	A few times a week (40%), almost every day (60%).
How often do you play any educational games in school?	A few times a month (40%), a few times per week (40%), almost every day (20%).
How often do you play any educational games at home?	Never (40%), once in a few months (20%), a few times per week (20%), almost every day (20%).
Did you like playing the game?	Liked playing (80%), maybe (20%)
How easy was it to read the stories in the game?	Easy to read (60%), difficult (40%).
How willing were you to play the game?	Very happy to play (60%), happy to play (20%), not interested (20%)
How would you describe your overall experience of playing the game?	Positive (80%), boring (20%)
If you could play the game again, would you want to?	Yes (60%), maybe (40%)
Would you recommend this game to your friends?	Yes (60^), maybe (40%)
Do you think you learned new words while playing the game?	Yes (80%), not at all (20%)
Do you think playing the game helped with your reading?	Maybe (60%), no (40%)
How would you compare learning new words through the game to normal classroom teaching?	OK (60%), good (40%)
How would you compare reading through the game to normal classroom teaching?	Good (80%), OK (20%)

It must be acknowledged that the number of students involved in the study is very small and it is not possible to draw any firm conclusions from the survey results. However, as a proof-of-concept study, it is reassuring to see that they were generally positively disposed to Cipher from a user-experience perspective, and their less positive perception of learning gains merits further attention. In terms of playing the game, students required almost no support, and this was reassuring from a game design perspective.

4. Challenges of developing a dyslexic version of Cipher for Irish

There are many challenges associated with developing a dyslexic version of Cipher for Irish and these undoubtedly mirror similar challenges in other less-resourced language contexts. There is limited research into dyslexia in the Irish language context, and this means that CALL researchers have limited resources upon which to base the design of dyslexia-friendly versions of CALL resources. Questions such as 'What phoneme/sound mappings are difficult?' 'Are there specific orthographic conventions in the language that are challenging for learners?' Are there spelling conventions that are unpredictable/different from the learner's L1?' are key issues that need to be taken into consideration.

Several factors contribute to whether reading in a language is challenging for learners. One of the most important factors is orthographic depth (Seymour et al., 2003; Landerl et al., 2013). English is considered to have a deep orthography due to its many irregular spellings, silent letters, and complex pronunciation rules where the same letter combination (digraphs and trigraphs) can sound very different (e.g., 'through,' 'though,' 'tough'). English language teachers are aware of these characteristics and can adapt their teaching to the needs of their students.

Languages with shallower (transparent) orthographies e.g. Italian and Spanish are easier for dyslexic students to read whereas languages with deep (opaque) orthographies e.g. English are more difficult for dyslexic readers (Wimmer et al., 2010). The concept of orthographic depth, (Katz & Frost, 1992; cited in Barnes, 2017:14), encompasses two separate elements: complexity i.e. number of grapheme-to-phoneme rules, and consistency, i.e. adherence to the rules.

Irish orthography while relatively consistent is has a highly complex system (Stenson & Hickey, 2016). The system of grapheme-phoneme mapping includes many two- and three-letter sequences (digraphs and trigraphs) which map to single phonemes. This is because over 50 phonemes are represented using approximately 23 alphabetic symbols. According to Stenson & Hickey (2016) over 70% of the 1000 most frequent Irish words in a corpus of children's literature were spelt with digraphs, often having more than one per word. They illustrate this effectively using the Irish word buachaill 'boy' which contains four different types of digraphs. Orthography is language specific, therefore grapheme-to-phoneme mappings require explicit teaching. This is particularly important in a bilingual and biliteral context such as Irish and English, where the orthographies are significantly different. Stenson & Hickey, (2016) show that there is very little overlap between the grapheme-to-phoneme mappings for Irish and English. In a context where the teaching of English phonics (grapheme-to-phoneme mappings) is prioritised (Nic Aindriú & Ó Duibhir, 2022) this can have a negative impact on the Irish reading, writing and spelling. Explicit teaching of Irish phonics is necessary not only for dyslexic learners of Irish, but for all learners.

In the Irish dyslexia-friendly version of Cipher we are working on incorporating gamified Irish grapheme-to-phoneme mappings, controlled vocabularies and graded texts, adhering to the principles of Structured Literacy as advocated both internationally (e.g. International Dyslexia Association (n.d.); Earle & Sayeski, 2017) and by Irish researchers (e.g. Stenson & Hickey, 2016; Barnes, 2017). Learners of Irish outside of Irish speaking areas (i.e. most learners), can encounter multiple Irish dialects during their schooling, depending on how and where their teachers learned or acquired Irish and this is a complication matters (Stenson & Hickey, 2016). The dialectal variation in pronunciations can cause confusion and anxiety among learners and adds to the challenges of acquiring the grapheme-to-phoneme system. Some educational resources provide separate versions to represent the three main dialects. This is an issue which we will have to address in the dyslexic-friendly version of Cipher. Ideally, the learner will be able to select the preferred dialect for the game itself and for the audio support.

5. Roadmap towards an inclusive CALL resource for Irish

Step 1: Review the specific issues relating to Irish: Recent research has provided some insights into the specific issues affecting students with dyslexia when it comes to learning Irish, e.g. phonological, orthographic and morphological errors (Barnes, 2025). These elements will be addressed in the dyslexia version of Cipher for Irish.

Step 2: Adapt the current Cipher texts: We will investigate using controlled vocabularies, e.g. words with complex vowel and consonant combinations may be replaced with simpler words creating graded versions of Cipher texts.

Step 3: Discuss possible ciphers with Irish language pedagogical specialists: Ciphers (i.e. magic spells applied to words) play a key role in the Cipher game, and these will be developed and/or adapted for dyslexic learners.

Step 4: Develop new ciphers: new ciphers, that focus on vowel or consonant combinations (digraphs and trigraph for initial and internal word mutations), may be helpful for learners. In conjunction with language and pedagogical specialists, they will be developed and incorporated into the Cipher framework.

Step 5: Build new version of Cipher: Once the language content and ciphers have been developed the Cipher team will use the Cipher framework to implement the dyslexia-friendly version of Cipher for Irish.

Step 6: Evaluate with target user group: Once the dyslexia-friendly version of Cipher for Irish is available, it will be tested with the target user group. This will involve feedback from both teachers and students. Suggestions for improvements will inform the development of the dyslexia-friendly version of Cipher for Irish.

Step 7: Release to public: After several iterations of testing and evaluation with the target user group, the dyslexia-friendly version of Cipher for Irish will be made available to the public. See Figure 2 for an overview.

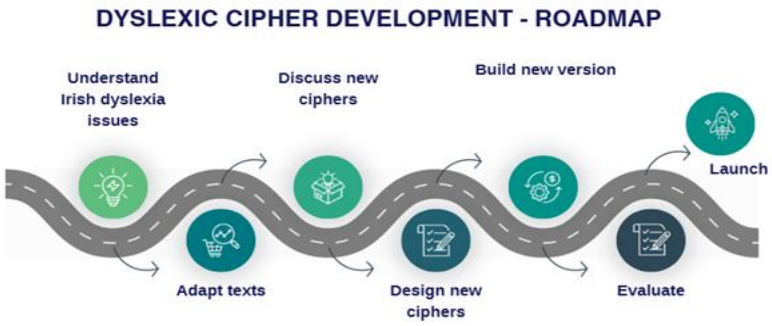

Figure 2. Overview of the dyslexia Cipher development roadmap.

6. Limitations and future work

This study involved a small sample of six formally diagnosed dyslexic students (five survey respondents) drawn from two single-sex English-medium schools. Participation length was limited to 3–5 weeks (approximately 30 minutes per session per week), and outcomes were based solely on self-report data from pupils aged 10–11. Future work will incorporate objective measures of vocabulary (pre/post tests), reading development, enhanced statistical tests and reporting (where feasible). It will also expand to mixed and Irish-medium schools and will include a comparison or control group to assess learning efficacy. The minimum sample size with a desired power of 0.8, a significance level of 0.05 and expected effect size of 0.5 is 124 participants.

7. Conclusions

There is a need for dyslexia-friendly versions of CALL resources for Irish. A dyslexia-friendly version of Cipher was developed for English, and this was tested by a small number of students in two English-medium schools in Ireland. The initial findings from the students are that the app is suitable for them and they can play it without difficulty. The findings will inform the development of a dyslexia-friendly version of Cipher for Irish that will be based on a co-creation approach with teachers, students and educational specialists.

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