

# Cipher – Faoi Gheasa: A Game-with-a-Purpose for Irish

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## Abstract

This paper describes *Cipher – Faoi Gheasa*, a 'game with a purpose' designed to support the learning of Irish in a fun and enjoyable way. The aim of the game is to promote language 'noticing' and to combine the benefits of reading with the enjoyment of computer game playing, in a pedagogically beneficial way. In this paper we discuss pedagogical challenges for Irish, the development of measures for the selection and ranking of reading materials, as well as initial results of game evaluation. Overall user feedback is positive and further testing and development is envisaged.

**Keywords:** CALL, game-based language learning, reading pedagogy, text ranking measures, adaptive learning.

## 1. Introduction

This paper describes *Cipher – Faoi Gheasa*, a 'game with a purpose' (Von Ahn, 2006, Vajjala, 2021) designed to support the learning of Irish in a fun and enjoyable way. The aim of the game is to promote 'noticing' (Skehan, 2013) and to combine the benefits of reading with the enjoyment of computer game playing, in a pedagogically beneficial way. As electronic game playing is a popular leisure time activity, a 'game with a purpose' such as *Cipher – Faoi Gheasa* facilitates language learning while playing a digital game. The game has been piloted in two primary schools to date (see section 4) and initial feedback from students and teachers is positive. Although this game has been developed for Irish, we believe that this model can be adapted for use with any language.

Irish is an endangered language (Moseley, 2012) with most users learning it as a second language at school. Students have limited opportunities to use the language outside of the classroom. However, success in second language acquisition has been linked to the quantity and quality of language input (De Cat, 2020). This game provides exposure to valuable language input in the form of stories and myths. Reading is widely acknowledged to be an effective way of increasing vocabulary, and in the case of L2 language learners, it is a particularly important way of gaining exposure to grammatical structures (Heilman et al., 2007). Playing this game involves reading and paying attention to the spelling of the words, which promotes 'noticing' of word forms, an important aspect of language learning.

The game is designed to be adaptive to the learner's level of language proficiency. When a player plays the game for the first time, they provide their age (or 18+ for adults), class/year and type of school. Based on this information, a first-time player is assigned a story with a suitable level of challenge, and depending on their performance in the game, they will subsequently see harder or easier stories. In section 2 we discuss some of the challenges in teaching and learning Irish, and review the role of reading in language learning, 'games with a purpose' and readability and complexity measures used in the ranking of reading materials. In section 3 we describe the game in more detail and in section 4 we present some results of a pilot study in a primary school. Section 5 presents conclusions and future work.

## 2. Background and Related Research

### 2.1 Irish – Some Pedagogical Challenges

Irish, apart from some exceptions, is a compulsory subject for most primary and secondary school children in Ireland. Most L2 Irish learners are L1 English speakers, which means that they learn Irish through an English speaker's lens. One area where this causes difficulties for learners is with Irish orthography. English orthography is very opaque and schoolchildren spend a lot of class time in the early years of primary school learning sound/orthography combinations. Irish orthography, though complex, is relatively regular (Hickey and Stenson, 2011). However, there is a general perception that it is irrelevant and not transparent (Ward, 2016). Teachers are often unaware of the logic behind the patterns in Irish spellings and they do not teach them to their students. This leaves students with gaps in their knowledge, which they fill with intuitions from English. For example, the Irish word *seachtain* 'week' could be pronounced as 'say-ach- tayne' on first reading by an L1 English speaker. However, the actual pronunciation is closer to 'shokht-en' or 'shocht-en' (ʃaxtʰvənʲ). The 'e' after the 's' in *seachtain* indicates that the 's' should be pronounced as /ʃ/ ('sh') and the 'e' itself does not reflect an actual vowel. Irish language learners are generally not taught about these types of patterns and thus often mispronounce Irish words on first sight. Irish language learners often 'ignore' the accents on vowels, as they do not understand their importance. An accent lengthens a vowel, so that 'á' is pronounced /a:/ 'aw', whereas 'a' is pronounced /ə/ 'ah'. 'Mo' means 'my' whereas 'mó' means 'more'. Another challenging feature for learners of Irish is the presence of unusual combinations of letters, especially when marking initial mutations such as eclipsis at the start of words, e.g., *bp, mb, bhf, dt, nd, gc, and ng*. Hickey and Stenson (2011) recommend that these be taught explicitly but unfortunately this does not always happen. There are also digraph combinations that can cause difficulties for students including *ei, ea(i), eo(i), ae(i), and ao(i)*, as well as unstressed final syllables e.g. *-(a)igh, -(a)idh, amh, -adh*. These letter combinations look confusing to students, but there is logic behind them and if learners knew more about these patterns it would increase their understanding and enjoyment of reading texts in Irish. Table 1 summarises some of the orthographic issues for Irish language learners – see Hickey and Stenson (2011) for more details.

Issue	Example
Different orthography from English	Seachtain - 'e' indicates 's' should be pronounced 'sh'
Accents indicate vowel length	'mo' is different from 'mó'
Unusual consonant combinations due to eclipsis	<i>bp, mb, bhf, dt, nd, gc, and ng</i>
Unusual digraph combinations	<i>ei, ea(i), eo(i), ae(i), and ao(i)</i>
Unstressed final syllables	<i>-(a)igh, -(a)idh, -amh, -adh</i>

Table 1: Some orthography related issues for Irish language learners

Another aspect of Irish grammar which receives surprisingly little attention is noun gender. All nouns in Irish have either feminine or masculine gender, which has wide ranging consequences in the grammar and spelling. Many initial mutations and modifier agreements vary according to the gender of the noun. In the Cíphir – Faoi Gheasa game, we draw particular attention to spelling including initial mutations and to the gender of nouns.

## 2.2 Reading and Readability Measures

Reading practice is a vital component of first and second language learning, particularly for vocabulary learning (Hafiz and Tudor, 1989, cited in (Heilman et al., 2008)). Matching the level of the text with the language proficiency of the learner is particularly important. Harris et al. (1996) suggest that the language input needs to be challenging to provide opportunities for learning, and they caution against over-simplification of written texts, which can result in stories that are bland and unnatural. They note that there is scope for using more complex language in the context of stories which are already familiar to the learners. For the beginner levels we use well known fairy tales, which will be familiar in the learner's first language (L1), followed by less well-known folktales and myths that are presented as they progress through the levels in the game.

However, choosing reading material of an appropriate level for the learner is a complex task which needs to take several factors into account, including both reading ability and reading interests. Both readability and complexity measures have been used in attempting to match the reading materials with the learner's proficiency level. Readability measures tend to focus on the text and its characteristics, while complexity measures focus on language learner output (Vajjala and Meurers, 2012). Commonly used text-based readability measures include average sentence length, average word length in characters or syllables (Flesch, 1948, Kincaid et al., 1975), and word frequency lists (Dale and Chall, 1948). Discourse features and text cohesion are also used in some readability measures (Graesser et al., 2014). Complexity measures which focus more on the learner's capabilities tend to measure lexical diversity, number and types of clause per

sentence or other unit, and other features such as verb tense, mood, voice etc. Vajjala and Meurers (2012) maintain that both types of measure are important for choosing appropriate learning materials. Of the lexical and syntactic measures they implemented for English, they found type-token ratios, verb variation, modifier variation, and number of characters/syllables per word to be among the most useful lexical measures. Mean length of clause, as well as number of co-ordinate phrases or complex nominals per clause were among the most useful syntactic measures. See (Vajjala, 2021) for a survey of the most recent automatic readability assessment research. Gutierrez-Vasques et al. (2018) discuss measures of morphological complexity measures. This topic is of relevance to languages such as Irish which encode substantial semantic and grammatical information in their inflectional paradigms.

Ó Meachair (2019) investigated a range of complexity metrics for Irish educational materials using the EduGA corpus compiled for this purpose. These measures include (a) a comparative frequency of prescribed lexicogrammatical features, (b) an analysis of sentence and word length, and (c) an analysis of terminology topicality. Of particular interest to our research are the sentence and word length metrics. He found that sentences in lower-level Irish educational materials contained fewer words on average than sentences in higher levels materials, indicating that this metric behaves as an indicator of increasing complexity for Irish educational materials. This finding is in line with results for other languages. However, he found that increases in average word length did not correlate with increases in educational materials level, and average word lengths fluctuated significantly across all sub-corpora.

Hickey (2007) discusses the importance of developing fast, accurate, word recognition skills in young readers, which facilitates satisfying independent reading. She echoes Gardner's (2004) view that "high-frequency words must be mastered in order to achieve minimum levels of reading proficiency in both L1 and L2". She analyses a list of the 100 most frequent words in a corpus of Early Reader books (18K words) for 7-13 years and suggests ways of teaching the most frequent words.

## 2.3 Digital Educational Games for Language Learning

Digital Educational Games (DEGs) are a type of informal learning which have been proven to be beneficial to learners, particularly children in school (Sørensen and Meyer, 2007). In recent years, DEGs designed for language learning and teaching have become increasingly popular. This type of game is often used to motivate students to practise authentic communications in the target language. According to Gee (2005), this works because DEGs can provide a learning experience that schools normally do not offer to students. Many studies have shown that games can be used to help language learning. This research area is also known as digital game-based language learning (DGBLL) (Dixon et al., 2022). However, Dixon suggests that games designed specifically for language learning still need improvements in terms of engagement and authentic language interaction, as DEG development is relatively underdeveloped compared to the enormous effort that has been put into games designed for entertainment.

Games with a purpose (GWAP) (Von Ahn, 2006) have been used to collect data for solving real-world problems, such as labelling images (Von Ahn and Dabbish, 2008),

identifying semantic connections (Chamberlain et al., 2008), correcting optical character recognition (OCR) errors (Chronis and Sundell, 2011) and so on. These tasks often involve language annotations, which can provide useful resources for natural language processing (NLP). The *Cipher – Faoi Gheasa* game is inspired by the game developed by Xu and Chamberlain (2020) to find errors in English Corpora using GWAP methodology and crowdsourcing. In the next section we describe *Cipher – Faoi Gheasa*, a digital game with the purpose of supporting the learning of Irish in a fun and enjoyable way.

### 3. *Cipher – Faoi Gheasa*: A Game-with-a-Purpose

#### 3.1 Game Narrative

The game is set in a magical world where an evil spirit ‘Syfer’ has put the ancient tales and myths under a variety of spells (*faoi gheasa* in Irish) causing them to be forgotten over time. The challenge for the player then is to defeat the evil spirit and restore the tales by discovering the enchanted words and identifying which evil spells (ciphers) were used.

The ciphers change the spelling of words in systematic ways. For example, the "Double Tail" cipher doubles the last letter of a word. This quite an easy cipher to find, but the player must be wary as not all words ending in a double letter are enchanted. In Figure 1 we see a page from a story where the Reverse (*Taobh Thiar Aniar*) spell has affected the words *suga* (agus), *rabot* (tobar) and *ehiannaeb* (beannaithé) and the Bottom-Up (*Tóin Aníos*) spell has swapped the first and last letter of the words *hacacb* (bacach), *neab* (bean) and *r'iard* (d'iarr). Figure 2 shows a help message associated with these two ciphers.

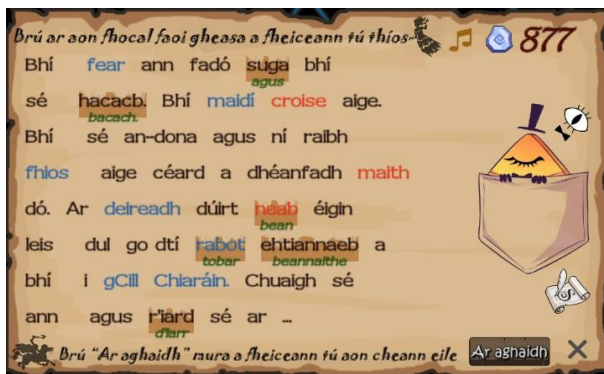


Figure 1: A page of ciphered text with noun gender highlighting

In Figure 1 the correct forms (green text) are shown for illustrative purposes. They are not normally present unless the player uses power-ups to make them visible. However, using power-ups will cost them points.

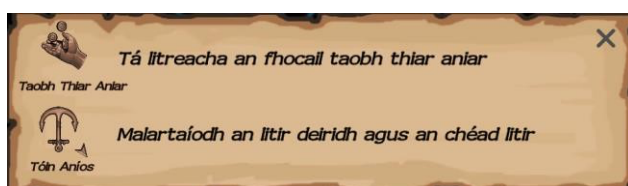


Figure 2: Ciphers - “Reverse” and “Bottom-up”

Note that the nouns in Figure 1 have gender highlighting. In the game narrative, feminine nouns are ruby red because they are loyal to the Spirit of Fire, and masculine nouns are sapphire blue because they are loyal to the Spirit of Water (see Figure 3).



Figure 3: Spirits of Water and Fire

#### 3.2 Pedagogical Features

*Cipher: Faoi Gheasa* has several pedagogical features that are helpful for Irish language learning. It encourages players to ‘notice’ spelling errors (or ciphers) in the texts. Often, Irish language learners ignore errors or are not aware there is a problem (Stenson and Hickey, 2018). The focus of *Cipher* is to get the players to notice the ciphers in the texts. They must pay attention to the words and decide if a word is spelt correctly or not. Orthographical features such as accents can either make a word correct or incorrect and players will have to carefully decide if a word is a cipher or not each time they read texts.

Another pedagogical benefit of this game is that it encourages the reading of Irish texts. Schoolchildren in English medium schools (most Irish schoolchildren) are only exposed to Irish during the Irish lessons. They neither hear nor read Irish outside of school. *Cipher: Faoi Gheasa* presents texts in a game context so that players are more inclined to read the texts (as compared to ‘dry’ text in a textbook).

Most Irish language learners are unaware of the fact that Irish words have an associated gender - either masculine or feminine. This means that they are prone to making errors in the initial mutations on lexical words following functional words such as articles and prepositions, and in agreement marking on modifiers such as adjectives and nouns. *Cipher: Faoi Gheasa* highlights masculine words in sapphire blue and feminine words in ruby red. This indicates to players that there are two categories of words and they will become familiar with the concept of two types of noun. They will see its word’s colour each time it appears in a text. Meurers et al. (2010) refer to the highlighting of such language features as "input enhancement".

For many Irish school children, Irish is not the most popular subject and sometimes teachers struggle to make it interesting for their students (Ward et al., 2019) There are very few digital resources available for Irish, particularly for schoolchildren. *An Scéalai* developed by Ní Chiaráin & Ní Chasaide (2019) allows students to write their own stories. However, most of their learning takes place via textbooks which are static resources that leave little room for variable-paced teaching and learning. *Cipher: Faoi Gheasa* is a digital game and, although it has an olde world feel about it, it is a modern game. Students are used to

playing digital games (Dixon *et al.*, 2022) and initial feedback (Xu *et al.*, 2022) suggests that they enjoy learning Irish with something other than a textbook. They can gain points when they correctly identify a cipher and move through the levels, which is motivational for them. Players can progress through the game at their own pace - more capable students can move through the texts faster than other students. Table 2 summarises some of the pedagogical benefits of *Cipher: Faoi Gheasa*.

Feature	Benefit
Reading	Students can read Irish outside of textbooks and can benefit from increased language exposure and vocabulary
Noticing of errors	Students have to pay attention to spellings (detect ciphers)
Gender highlighting	Students can become aware of the concept noun gender and the gender of individual nouns
Digital game	Students are not restricted to static textbooks as they would normally be
Personalisation	Students can progress at their own pace

Table 2: Pedagogical features and benefits of *Cipher: Faoi Gheasa*

### 3.3 Adaptivity

*Cipher* is an ‘adaptive’ game. Texts are chosen to suit the individual learner’s level of Irish and, depending on how they perform in the game, they will be presented with easier or more challenging texts. This personalisation of learning is recognised as an important element in motivating students (Sanacore, 2007). Ciphers are also graded according to difficulty and become more challenging as the game progresses.

### 3.4 Choice of Materials

We chose to use stories with a magical or mythological theme for several reasons. Firstly, we believe these types of stories will appeal to language learners both young and old, and will help to overcome the common dilemma for L2 learners that their language abilities often lag behind their reading interests (Heilman *et al.*, 2006). Secondly, a mythological theme can be made culturally relevant in different language settings. In this way we hope that the game can be adapted for other languages and that the stories will be interesting and relevant for learners. We also hope that folktales and mythology will raise the language learners’ cultural awareness and pride in their heritage (Restoule *et al.*, 2010). In addition, in order to build up a bank of stories, it is practical to use stories and tales which are free from copyright restrictions whenever possible. As the *Cipher* game centres around tales and myths which have been enchanted by the evil spirit, *Syfer*, it is important to build up a collection of stories. As this is an ‘adaptive’ game the stories need to be ranked from easiest to most challenging. In the following sections we describe the sourcing and pre-processing of story texts and the metrics used to rank them.

### 3.5 Sources of Materials

Currently, our main sources of data are online archives. *Bailiúchán na Scol* (The Schools Collection) made available online by the Dúchas Community Transcription Project, dúchas.ie, is a valuable source of material for this DEG project. The Schools Collection contains folklore, stories and myths which were written down by primary school children aged 12-14 years of age and are therefore very appropriate for our purposes. As these children were native speakers of Irish, the language is intermediate to advanced level. There is also a small amount of Irish material on Gutenberg.org, which is also at advanced level. For the lower levels we have created Irish versions of common English fairy tales. The familiarity of the story in their L1 helps the less proficient players to understand the stories more easily and facilitates ‘scaffolded’ learning.

### 3.6 Pre-processing of Materials

As the texts in “The Schools Collection” on dúchas.ie are from the 1930’s and the Irish texts on Gutenberg.org are from the 1900s, they were written before the official language standards were published (Rannóg an Aistriúcháin, 1958, Tithe an Oireachtas, 2017). This means that the spelling and grammar of the material in both archives requires standardisation.

The following is an example of the original transcribed text from Dúchas.ie with pre-standard forms and spelling mistakes underlined:

1) *Bhí daoine amuigh ag iasgairacht oidhche amháin. Bhí siad ag iasgairacht sghadán. Nuair a bhí siad ag teacht na bháile. Chonaich siad trí tonna ag tarraingt ortha.*

‘People were out fishing one night. They were fishing for herring. When they were coming home. They saw three waves drawing towards them’

Manually standardised text:

2) *Bhí daoine amuigh ag iasgairacht oíche amháin. Bhí siad ag iasgairacht scadán. Nuair a bhí siad ag teacht abhaile chonaic siad trí thonn ag tarraingt orthu.*

In the case of the Gutenberg.org Irish texts the Gaelic font characters also needed to be converted, e.g., *B̂* to *Bh* etc. The following is an example from Gutenberg Project:

1) *B̂í cú breá ag Fionn. Sin Bran. Ĉualaid̂ tu caint air Bran.*

‘Fionn had a fine hound. That is Bran. You have heard talk about Bran.’

2) *Bhí cú breá ag Fionn. Sin Bran. Chuala tú caint ar Bhran.*

The updated texts were manually checked for accuracy using the online the electronic version of *Ó Dónaill’s Irish English Dictionary*<sup>1</sup> and *Gramadóir*<sup>2</sup> spelling and grammar checker for Irish, and put in sentence-per-line format. They were automatically tagged using the Irish rule-based POS tagger (Uí Dhonnchadha and van Genabith, 2006), and the POS-tagged output was manually checked and corrected.

<sup>1</sup> <https://www.teanglann.ie/en/fgb/>

<sup>2</sup> <https://cadhan.com/gramadoir/foirm-en.html>

### 3.7 Ranking of Reading Materials

A number of lexical, grammatical and frequency statistics are calculated and combined in order to rank the materials from easy to more challenging.

#### 3.7.1 Lexical Measures

Lexical diversity is a measure of the number of different words used in a text. There are a variety of measures in use. Type/token ratio (TTR) is the ratio of unique words (types) to total words (tokens) in a text. This measure is sensitive to text length, as longer texts will have repeated function words which reduce the type-token ratio, resulting in a lower lexical diversity for longer texts. This can be overcome to an extent by using a fixed sample of the text. We calculate TTR100 using the first 100 words only, in order to standardise across texts of different lengths, however this will not capture the effects on lexical diversity of repetition which is a common feature of fairy tales. We therefore calculated the CTTR and Uber/Maas Indices (Malvern et al, 2004) which are independent of text length. Morphological diversity is a measure of the number of inflected or derived words per lemma used in a text. As Irish texts may contain several inflected forms (and derived forms) associated with the same lemma, we calculate Lemma/Token ratio (LTR) i.e., the ratio of lemmas (headwords) to total words, as a measure of morphological diversity.

#### 3.7.2 Grammatical Measures

A number of statistics, which are indicators of readability and grammatical complexity, are calculated:

- Average sentence length in words and syllables. Longer sentences are a good indicator of more grammatically complex language.
- Maximum sentence length. This is calculated as a text may have a mix of long and short sentences and the average length might not fully reflect the complexity of a text.
- Average word length in characters and syllables.
- Average number of clauses per sentence, as indicated by the number of verbs per sentence.
- Average number of modifiers per sentence, as indicated by the number of adjectives/adverbs per sentence.
- Average number of complex nominals per sentence, as indicated by the number of nouns in the genitive case.

#### 3.7.3 Word Frequency Measures

As a measure of the semantic challenge for learners, we use vocabulary frequency lists which help us to distinguish the proportion of familiar words (i.e., frequently used) and less frequently-used words in a story. The word types in each story are compared with frequency wordlists based on a subset of the NCI<sup>3</sup> corpus (Kilgariff et al., 2007) and Breacadh wordlists. Texts in the NCI corpus are categorised under two broad genre categories: 'imaginative' and 'informative'. We use a frequency word list based on 'imaginative' writings only (6.6 million words), which excludes non-fiction writing such as reports, newspapers, textbooks and legal documents. Breacadh, an organisation which promotes adult literacy in Irish, published Liostaí

Bhreacadh which contains a number of frequency words lists (Breacadh, 2007). We use the frequency lists drawn from writings for 0-6 year olds, 7-11 year olds and teenagers. We compare the word types in each story with frequency wordlists from NCI and Breacadh, and calculate the proportion of words that are among the 100, 300, 500, 1000, 5000 and 5000+ most frequent words. Additional relevant sources of frequency wordlists include the EduGA Corpus (Ó Meachair, 2019) and the CLGP Corpus (Hickey, 2007).

#### 3.7.4 Testing of Ranking Measures

The Lexical, Grammatical and Frequency measures are combined to provide a ranking for the stories currently in the Cipher story bank. We tested the efficacy of the measures against 10 stories from the Taisce Tuisceana<sup>4</sup> graded collection of reading comprehension material, using samples from the Sraith 1 (A, B and C) collections of reading material which are aimed at 7/8 year olds, and Sraith 2 (D and E) collections aimed at 9/10 year olds.

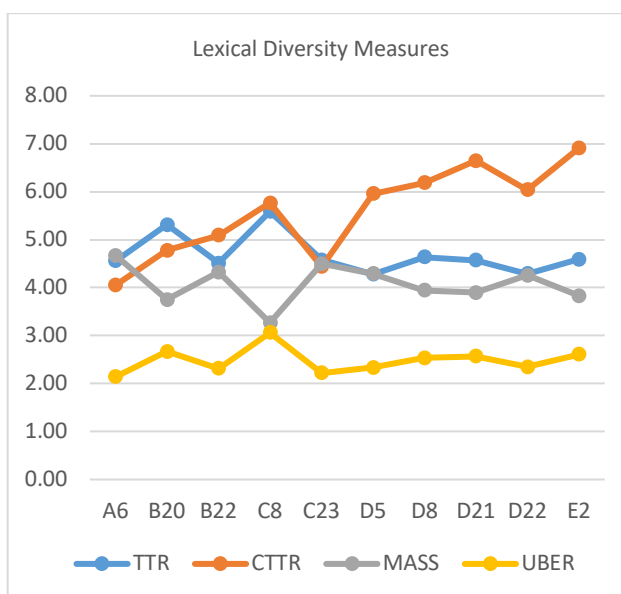


Figure 4: Lexical Diversity Measures for Taisce Tuisceana texts

In Figure 4, the preliminary results show that the CTTR measure indicates an overall increase in lexical diversity in the 10 short stories from Sraith 1 (A-C) and Sraith 2 (D-E) of Taisce Tuisceana. The TTR, Mass and Uber indices are inconclusive. Further testing with a larger data set is required to investigate which are the most appropriate lexical density measures.

<sup>3</sup> <http://corpas.focloir.ie/>

81 <sup>4</sup> <https://www.cogg.ie/taisce-tuisceana/>

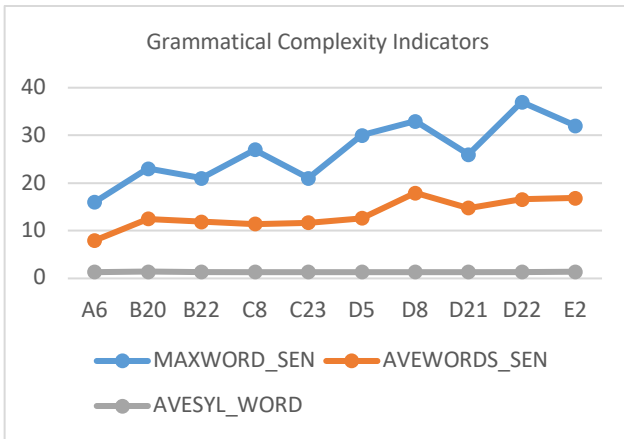


Figure 5: Grammatical Diversity Measures for Taisce Tuisceana texts

Figure 5 shows that for this small sample, the average words per sentence indicates an overall increasing grammatical complexity. Maximum words per sentence also shows an increasing trend but with fluctuations. Average syllables per word remains relatively constant for all texts.

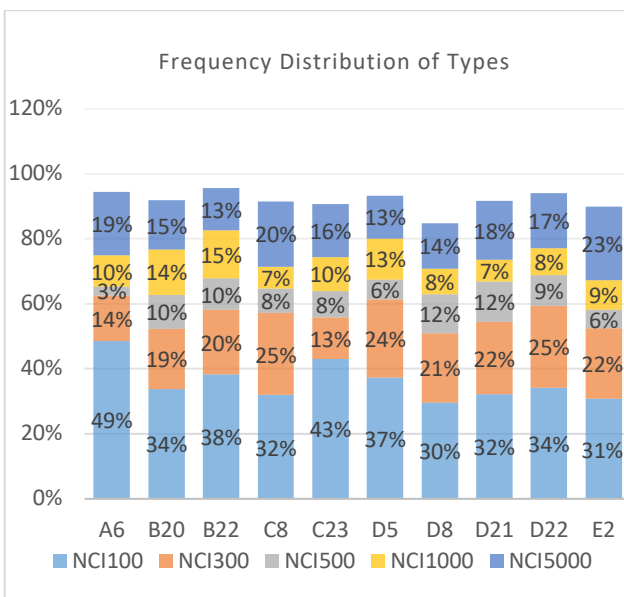


Figure 6: Frequency Distribution for Taisce Tuisceana texts.

Figure 6 shows the percentage of word types that are in the 100, 300, 500, 1000 and 5000 most frequent words in the NCI wordlists. For example, for text A6, 49% of word types are within the 100 most common words, and in total 95% of word types are within the 5000 most frequent words, with the remaining 5% being outside of the 5000 most frequent words. Overall, there is a trend for lower level texts (A, C and C) to have a greater proportion of more frequent words than the higher level texts (D and E). However, for this data sample this is quite a weak trend, with relatively little variation overall.

#### 4. Game Evaluation

The game has been tested in two primary schools in Dublin. Initial testing took place in a Gaelscoil. Following user feedback, the game was improved and the following year

was tested in an English-medium school. This paper focuses on the second test.

A total of nine classes participated in the experiment, with 20-30 students in each class. The students were aged 10-12 and were in 4th, 5th or 6th grade, with each grade having three classes. The experiment was run over two consecutive weeks. For each class, students had at least 30 minutes to play the game each week. Students were paired to play the game due to limited available laptops. In some smaller classes, individual students each had a laptop. However, it is interesting to note that students generally had a better gaming experience when playing in pairs. Afterwards participants were asked to fill out a questionnaire. In total, 64 questionnaire responses were collected. Figures 7 to 9 present the answers to some of the questions that were asked in the questionnaire.

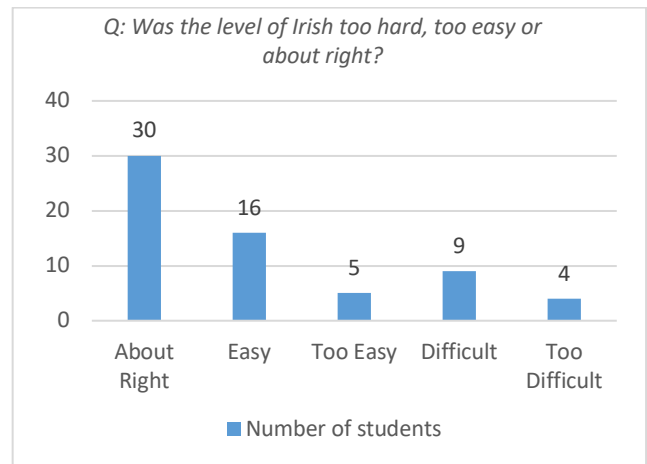


Figure 7: Students' opinion on text difficulty

In Figure 7 we see that most respondents felt that the difficulty level of the texts was appropriate, while in Figure 8 we see that most of the respondents enjoyed playing the game.

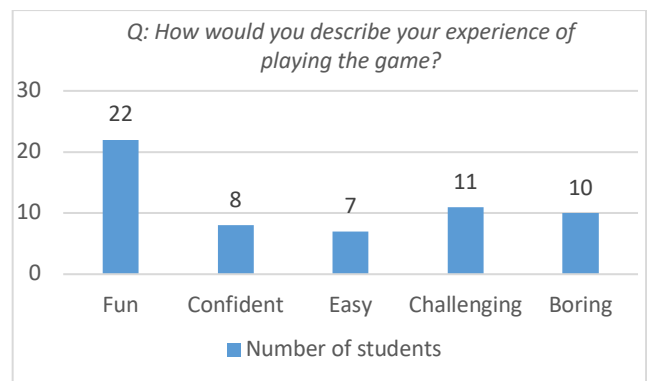


Figure 8: Students' opinion on their gaming experience

#### 5. Conclusions and Further Work

The overall feedback received from students was positive. After the game testing session in class, many students asked the researchers if this game was publicly available online and so they could play at home. Some teachers also provided positive feedback regarding students' overall reactions to the game in class. In Figure 9 we see that more than 50% of students felt it was "very good" or "good" to

learn Irish through the game compared to learning Irish in the classroom.

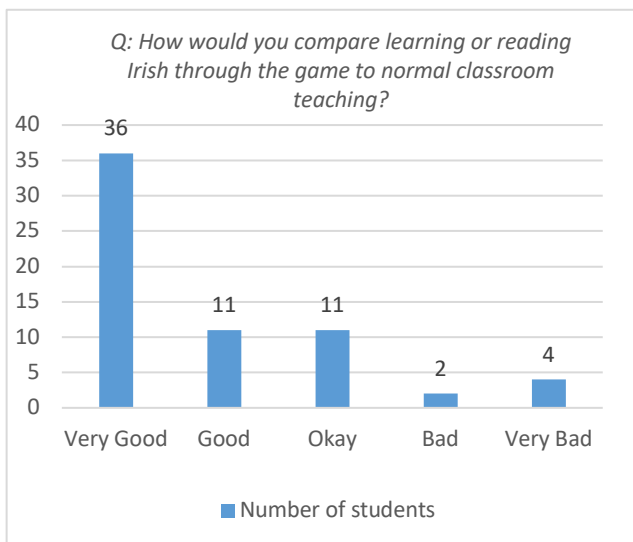


Figure 9 Students opinion of learning Irish through a game

These responses indicate a strong need for games like *Cipher* in Irish language learning education. Enjoyable language learning games have great potential for engaging children in learning a language.

The Cipher game is flexible and can easily be adapted for other languages. It is easily extensible in that new texts and new ciphers can be added at any time. Given the positive feedback received to date, we intend to carry out further development and testing in schools and also to trial it with adult learners. Testing of measures for ranking texts is ongoing, and while these results are tentative, results to date are promising.

## 6. Acknowledgements

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