THE POTENTIAL OF MOBILE-BASED AND PATTERN-ORIENTED CONCORDANCING FOR ASSISTING UPPER-INTERMEDIATE ESL STUDENTS IN THEIR ACADEMIC WRITING

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Faculty of Culture and Society

DEDICATION

To my beloved parents, Yiran and Nancy,

who have been so patient with me

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ATTESTMENT OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signature _____

Name: Zhi QUAN

Date_____

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ABSTRACT

This research was an attempt to investigate whether (and how) mobile technology and a pattern-based concordancing method, Patterns in Context (PIC), could enhance ESL students' positive experience and uptake of DDL (Data-driven Learning). DDL is a self-directed discovery process in which learners are encouraged to study extracts of authentic texts to identify how words are used. In order to partly address the problems with DDL, the concepts of mobile DDL and PIC have been proposed and combined in this thesis. Mobile DDL aims to make DDL more accessible and appealing to students at large by utilising new affordances of mobile technology. PIC is designed to search and retrieve patterns, a multi-word unit which combines lexical choices and grammatical forms, so as to provide more easily observable search results. This adapted DDL was used to assist ESL students in academic writing in this research.

This research was cross-disciplinary, involving corpus linguistics, technology-enhanced language education and software engineering. Based on the overarching worldview of pragmatism, it adopted a design of action research with mixed methods. Over the three phases of the research, 58 voluntary participants in total were involved to experience and evaluate the two specifically developed mobile apps, which underwent continuous changes and improvements according to their feedback and requests. The mixed methods to collect qualitative and quantitative data included automatic logging, questionnaires, interviews and focus groups.

Triangulated data revealed that PIC, as an alternative concordancing method, was advantageous over KWIC in efficiency, perceived effectiveness and user acceptance. The participants were in general positive about their experience working with the apps, and they seemed to have high requirements involving technical affordances and great expectations for mobile learning. Finally, it can be concluded that upper-intermediate ESL students' positive experience and uptake of using concordancing to help with

academic writing can be enhanced by mobile-based concordancing tools and the pattern-oriented search and retrieval approach of PIC. The benefits of mobile DDL and PIC imply that DDL can be made more accessible and acceptable to students by incorporating emerging technologies and findings of applied linguistics.

KEY ABBREVIATIONS

app: (mobile) application

CALL: computer-assisted language learning

CL: corpus linguistics

COBUILD: Collins Birmingham University International Language Database

COCA: Corpus of Contemporary American English

DDL: Data-driven Learning

EAP: English for Academic Purposes

ESL: English as the Second Language

KWIC: Key Words in Context

MALL: mobile-assisted language learning

m-learning: mobile learning

PaG: Pattern Grammar

PIC: Patterns in Context

POS: Part-of-Speech

TTS: text-to-speech

AVL: Academic Vocabulary List

CHAPTER 1:

INTRODUCTION

1.1 Introduction

Data-driven Learning (DDL) is a self-directed discovery process in which learners are encouraged to study extracts of authentic texts from the target language to identify the way words are used, in particular, the way they naturally pattern with other words. This process typically requires access to a suitable corpus and a user-friendly concordancer. A corpus consists of a large body of authentic texts stored in electronic form, while a concordancer refers to the software which can search a corpus for multiple examples of how a particular word or phrase is used. Search results are presented as lists of lines retrieved from the corpus that are vertically aligned around the centrally positioned target word, a format known as Key Words in Context (KWIC). While DDL is increasingly acknowledged as having potential for language learning, it has not been widely employed by language teachers and learners. Hence, decades after the inception of the concept, DDL remains more of a proposal by corpus enthusiasts, rather than a pedagogical practice commonly found in the language teaching classroom. The problems that hinder the widespread application of DDL include, firstly, the problem of access, i.e. most concordancing software is still limited to desktop computer use, and secondly, the difficulties that language learners have in using existing concordancing technology to successfully establish rules regarding the way words are used.

In an attempt to address the first of these issues, this thesis investigates whether new mobile-based concordancing software tools can encourage English as a Second Language (ESL) students' positive experience and uptake of DDL. In doing so, and in an attempt to address the second issue, it also seeks to determine whether a pattern-based approach for searching concordances, Patterns in Context (PIC), can contribute to their experience and uptake of mobile-based concordancing software. Given the programming complexity of this task, the thesis also attempts to establish and test the nature of the technical requirements to develop such mobile-based concordancing tools. Importantly, the

particular language focus of the concordancing software, and the group of student users in this study, is written academic English, as this is an area that I believe new mobile-based concordancing software tools can support.

This introductory chapter will begin by describing some of difficulties faced by ESL learners as they attempt to engage in the writing practices of English medium universities. It will then identify how corpus linguistics, notably DDL, can enhance students' abilities to write academically. After a thorough account of what DDL entails, the chapter will go on to provide a more detailed description of the challenges that DDL presents to students, followed by a discussion of how these challenges might be addressed by new mobile-based concordancing software tools. The chapter will conclude with a brief outline of the study and a summary of the ensuing chapters.

1.2 Academic writing and ESL learners

Academic writing is viewed as an important constituent of the knowledge, disciplines and professionalism of academia (Hyland, 2013b). Training students to write academically is therefore a crucial focus of higher education (Coffin et al., 2003) with most institutions providing a plethora of workshops, websites, courses, and one-to-one tuition to help students in this area. While students typically find academic writing difficult, it presents a particular challenge to ESL students studying at English-medium universities. This cohort of students tends to continually struggle to meet the requirements of their essays, reports and theses (Bailey, 2011).

There are a number of reasons why academic writing is challenging to these students. Firstly, the writing must be largely detached and authoritative to hold an impersonal stance; it needs to be concise to present information in an effective and clear manner; it requires the use of diverse and precise academic lexical forms containing both cross-disciplinary and discipline-specific meanings, and it should be well-structured and well-organised (Snow & Uccelli, 2009). Due to the high requirements on language proficiency, the difficulties in writing the type of English accepted by the academic community are

"particularly visible or acute for second-language speakers" (p. 114). Secondly, most ESL students in English-medium universities are also faced with disciplinary specificity of academic English at both micro- and macro-levels. The following is detailed discussion.

1.2.1 Micro-level disciplinary differences

On the micro-level, lexical-grammatical features in academic texts, i.e. the usages of specific vocabulary and grammar, tend to vary across disciplines. At the turn of this century, Hyland (1999) investigated reporting forms for citations in eight different disciplines based on his in-house corpus of 80 research articles. The results are set out in Figure 1.1 below. It seems that researchers in philosophy and sociology often quote views from others for debate or discussion, and thus reporting forms involving *suggest*, *argue* and *note* are frequently used. Contrary to this, their peers in the field of physics cite in a much less frequent manner, and the verbs involved, such as *develop* and *study*, tend to describe a process.

Discipline	Reporting structures		Most frequent forms
	per paper	% of citations	
Philosophy	57.1	67.0%	say, suggest, argue, claim, point out, propose, think
Sociology	43.6	42.0%	argue, suggest, describe, note, analyse, discuss
Applied Ling.	33.4	44.4%	suggest, argue, show, explain, find, point out
Marketing	32.7	34.5%	suggest, argue, demonstrate, propose, show
Biology	26.2	31.7%	describe, find, report, show, suggest, observe
Electronic Eng.	17.4	40.6%	propose, use, describe, show, publish
Mechanical Eng.	11.7	42.5%	describe, show, report, discuss
Physics	6.6	27.0%	develop, report, study
Averages	28.6	42.6%	suggest, argue, find, show, describe, propose, report

Figure 1.3 Different reporting forms for citations across eight disciplines (Hyland, 1999, p. 349) (formerly Table 4)

Recent research continues the probe into disciplinary variances of language use. Snow (2010) found that, out of the seven scientific terms picked up from a professional passage,

only two appeared in a general list of frequently used words across different academic disciplines. Snow suggested that students who study science should learn discipline-specific language use rather than general academic English or usage in other disciplines. Durrant (2014), using selected texts from the BAWE (British Academic Written English) corpus, investigated vocabulary use of students from different disciplines (and different levels of students, i.e. master students and undergraduates). The research found that less than half of the words tailored for particular student groups can be classified as 'generic', and that more than half of the contextual uses of generic forms differed across different student groups. The finding indicates that vocabulary use in different disciplines differs, and that is the reason why a cross-disciplinary wordlist of academic English is challenged (Hyland & Tse, 2007). Grammar use also tends to differ across various disciplines. Hiltunen (2010) identified a few disciplinary differences when investigating three grammatical constructions: declarative content clauses (*it is obvious that*…), interrogative content clauses (*analyse whether/how*…) and *as*-predicative constructions (*take it as obvious*). It was found that all the constructions tend to have higher frequent occurrences in 'soft' disciplines like law and literature. As all the three constructions are commonly used for citations, it implies that researchers in soft knowledge domains typically draw on a rich literature and revisit ideas previously expressed by other scholars.

In the academic sub-corpus of COCA, which was partially used in this research, the diversity of collocations between disciplines seems significant. Table 1.1 sets out the top 10 adjective and noun collocates of *provide* in the texts across nine disciplines. It should be noted that the collocates are not picked up by frequency. This is because raw or absolute frequency, which measures overall repetition of word use, may not best represent regularity and predictability of collocations (Gablasova, Brezina, & McEnery, 2017). Thus, mutual information (MI) is adopted here as the alternative indicator. MI score, the difference between the observed and expected frequency of word co-occurrence, "indicates the strength of a collocation" (Hunston, 2002a, p. 71). For detailed explanation of the statistical processing, please see Church and Hanks (1990) and also Stubbs (1995/2007).

Table 1.1 Most Significant Collocates of *provide* by MI Score in the Academic Sub-corpus of COCA

Discipline	Most significant adjective collocates	Most significant noun collocates
History	adequate, ample, excellent, useful, additional, new, interesting, good, detailed, sufficient	opportunity, clue, information, support, overview, impetus, basis, example, insight, evidence
Education	additional, valuable, appropriate, effective, instructional, descriptive, useful, special, individualized, gifted	information, opportunity, support, assistance, service, feedback, instruction, training, encouragement, insight
Social sciences	additional, descriptive, adequate, valuable, empirical, appropriate, behavioral, specific, great, strong	information, counselling, cue, service, feedback, access, instruction, baseline, rehabilitation, reinforcement
Law	adequate, safe, sufficient, legal, judicial, useful, new, great, detailed, valuable	information, enforcement, guideline, mechanism, advice, notice, justification, relief, incentive, liability
Humanities	additional, visual, valuable, excellent, useful, unique, positive, detailed, aesthetic, useful	opportunity, feedback, clue, information, insight, guidance, context, materials, sense, model
Religion	theological, empirical, cognitive, partial, comprehensive, emotional, good, brief, detailed, meaningful	information, clue, feedback, validity, shelter, insight, basis, reason, explanation, means
Science and technology	thermal, optical, graphical, automated, economical, intuitive, mechanical, digital, optimal, quantitative	compost, corrosion, calibration, bandwidth, functionality, interface, compression, habitat, nutrient, feedback
Medicine	clinical, static, adequate, medical, reliable, safe, valuable, excellent, accurate, additional	healthcare, seal, feedback, nursing, insight, overview, guidance, pain, information, insight
Miscellaneous	wonderful, adequate, valuable, professional, useful, additional, easy, wide, academic, necessary	feedback, guidance, insight, suggestion, tool, opportunity, access, foundation, instruction, information

It can be seen from Table 1.1 that a few collocates seem to be generic across disciplines,

such as *adequate*, *additional*, *support*, and *opportunity*. Consequently, the formulaic words *provide additional support* and *provide valuable feedback* are highly frequent in most disciplines. At the same time, certain disciplines have their own preference on collocates with *provide*. Some expressive collocates, i.e. *interesting* and *valuable*, are favoured in disciplines like history and humanities; similar examples include *gifted* in education and *wonderful* in miscellaneous subjects. Contrary to this, significant adjective collocates for social sciences, technology and medicine tend to use words such as *empirical*, *quantitative* and *reliable*; other disciplines tend to use adjectives with specific meaning to the fields, for example, *legal* to law and *meaningful* to religion.

1.2.2 Macro-level disciplinary differences

At a more macro level, writing styles, conventions and expectations of different academic disciplines also tend to differ. It was found that, in published academic writing, the use of definition and evaluation of new concepts, reader-friendly narrative and so on tended to have disciplinary differences (Egbert, 2015). Student writing also has differences on the macro level among disciplines. Hardy and Römer (2013) adopted a multi-dimensional approach to analyse disciplinary variation in student writing in MICUSP (Michigan Corpus of Upper-level Student Papers). Among other findings, it was revealed that student writing in philosophy and education often involves academic narrative, while writing in physics is mostly descriptive and informational. As noted by Hyland (2002):

> Disciplines have different views of knowledge, different research practices, and different ways of seeing the world, and as a result, investigating the practices of those disciplines will inevitably take us to greater specificity (p. 389).

Hyland (2017) reiterates the benefits and necessities of introducing macro-level disciplinary differences to students. He argues that through writing students are expected to learn to display their critical and analytic skills, their use of English for reasoning and persuasion, their grasp of subject matter issues and their ability to shape an argument using the conventions of their field. In other words, students should write in community-

specific ways accepted by researchers of their fields.

1.2.3 Implications of disciplinary differences for language education

As can be seen from the above discussion, academic English exhibits differences at both micro and macro levels across disciplines. As a result, as Hyland notes, "effective language teaching in the universities involves taking specificity seriously. It means that we must go as far as we can" (p. 394). This, as Murray and Moore (2006) suggest, involves an emphasis on the identification of discipline-specific features and norms in academic writing instruction, in order to better prepare students for discipline-specific contexts. Their view concurs with recent research indicating that both university teachers and students must be aware of the notion that academic writing is disciplinary-specific (e.g. Hyland, 2013a; Kuteeva & Negretti, 2016; Wilcox & Jeffery, 2015). Even though it is seen as "less effective and counterproductive in a number of ways to ignore the sophistication and subtleties of variations across disciplinary boundaries" (Bhatia, 2002, p. 39), fully incorporating a focus on discipline-specific writing largely poses a challenge to teachers of academic writing.

In short, the linguistic demands and discipline specificity of academic English make academic writing challenging for ESL students from various backgrounds. It has been long proposed to adopt some non-traditional measures to meet the disciplinary demands and individual needs in the context of academic writing (A. Johns, 2001). However, it was noted that only a small number of discipline-specific writing instruction examples had been reported in the past years, and most such initiatives were driven by individuals or individual departments (Wingate, Andon, & Cogo, 2011).

Students who wish to enhance their performance in academic writing may take an 'apprentice' model, that is, learning through the observation and analysis of academic texts written by professional researchers in their own disciplinary contexts, followed by writing practice which uses these scholarly texts as exemplars (Roozen, 2010). This approach involves not only "language re-use" (J. Flowerdew & Li, 2007, p. 441) of expert

writing, but also following the established modes, moves, generic features, and writing styles of the target discipline. Hyland (2000) believes that such an approach is effective since "academic writing is a limited textual practice" and "[b]y appropriately setting out the expected moves novices can, near enough for their purposes, approximate the writing of experts" (p. 144). Thus, it is useful for students to be exposed to 'expert' writing by academics. The disciplinary-specific nature of academic texts is also important in this process, since they "contain traces of disciplinary activities in their page; a typical clustering of conventions … [t]hey offer a window on the practices and beliefs of the communities for whom they have meaning" (p. 5). Furthermore, discipline-specific texts can help the development of disciplinary knowledge (Beaufort, 2004). It has been empirically shown that this kind of text exposure to the complexities of disciplinary practice leads to "student engagement with the processes of knowledge construction and reflected better thinking in the subject" (Hunter & Tse, 2013).

1.3 Corpus linguistics (CL) and Data-driven Learning (DDL)

1.3.1 The affordances of corpus linguistics

Corpus linguistics (hereinafter referred to as CL) has appropriate resources and methods to enable enhanced exposure to discipline-specific academic texts. In corpus linguistics, large collections of electronically processed and stored authentic texts can be analysed using dedicated software to find evidence of the way that language is used in real situations. Before discussing the role that corpus linguistics might play in helping ESL students write academically in English, a few core CL terminologies, which will be used frequently in this thesis, are explained.

Corpus: an electronic or computer corpus is defined as a large, principled and planned collection of naturally occurring examples of language. A corpus is typically machine-readable, so that it can be processed and analysed automatically using dedicated software (Bennett, 2010, p. 1; L. Flowerdew, 2012, p. 7; Hunston, 2002, p. 2). Corpora (the plural form of *corpus*) are the main feature and strength of CL. Annotated corpora, unlike 'raw' corpora comprising only plain text data, contain words attached with labels/tags which

indicate various kinds of linguistic information, e.g. grammatical, syntactic, semantic, discourse, stylistic, etc. (McEnery, Xiao, & Tono, 2006). Texts annotated with Part-of-Speech (POS) tags were used in this research. To carry out the annotation, the Constituent Likelihood Automatic Word-tagging System (CLAWS) developed by Garside, Leech, and McEnery (1997) was employed.

Collocation: 'collocation' can be defined as the conventionalised and habitual co-occurrence of more than one word. A word frequently occurring in the company of another is labeled as a 'collocate'. Such multi-word combinations range on a continuum from loose to fixed relationships according to the Open Choice Principle and the Idiom Principle (Sinclair, 1991). In most cases, collocational information is derived from statistical data, which can show higher-than-usual frequencies of word co-occurrence and preference. However, collocational tendency may also be revealed through manual observation.

Colligation: 'colligation' refers to the grammatical company a word keeps and the position in a clause that it prefers. As Hoey (2000) puts it, colligations of a word "describe what it typically does grammatically" (p. 234). Colligation is closely associated with collocation, in that the former is described as "a form of collocation which involves relationships at the grammatical rather than the lexical level" (Baker, Hardie, & McEnery, 2006, p. 36).

Concordance: a concordance is a list of all of the occurrences of a particular search term (also called 'node word') in a corpus, "presented within the context in which they occur – usually a few words to the left and right of the search term" (Baker et al., 2006, pp. 42-43). This display format, where concordance search results are presented as lists of lines extracted from the corpus that are vertically aligned around the centrally positioned target word, is called Key Words in Context (KWIC). While corpus linguists often rely on statistical information to produce descriptive results, concordancing, in contrast, provides a particularly accessible way for non-specialist corpus users to observe and analyse authentic language use in context, since "concordances enable the visual display of

collocations" (Oakes, 1998, p. 195).

Text authenticity is a major principle of CL, whose emphasis is on "actual, attested, authentic instances of use, rather than intuitive, invented, isolated sentences" (Stubbs, 1993, p. 2). This is because corpora-enabled findings are seen to be more reliable than introspective human intuition. According to Fillmore (1992):

> The most convincing part of the case for using a corpus was that it makes it possible for linguists to get the facts right. Authenticity was the keyword. There was a lot of evidence that linguistic intuition, so-called, isn't always reliable, but what one finds in a corpus more or less has to be taken as authentic. (p. 38)

To best represent or reflect real language in use, corpora tend to be large in size, ranging from tens of thousands of words to several hundred million words[1]. In addition, mainly due to its involvement with EAP, CL has witnessed the development of many Academic English corpora. Such specialised corpora, e.g. the British Academic Written English (BAWE) corpus (Heuboeck, Holmes, & Nesi, 2010), categorise included academic texts by academic discipline. As a result, CL has the resources to facilitate great exposure to disciplinary-specific academic writing. A special pedagogical approach, Data-driven Learning (DDL), which is based on the affordances and principles of CL, engages students with corpus-based technologies to assist them with their academic writing.

1.3.2 Major elements of DDL

DDL was pioneered by Tim Johns (1991, 1994), who was subsequently known as 'Mr. DDL'. This approach is described as "the use in the classroom of computer generated concordances to get students to explore the regularities of patterning in the target language, and the development of activities and exercises based on concordance output" (T. Johns & King, 1991, p. iii). In his seminal paper which introduced DDL, Tim Johns (1991, p. 16)[2] demonstrated how learners might establish the similarities and differences between

[1] Theoretically there seems no threshold of corpus size. Specialised corpora do not have to be very large.
[2] The number of concordances for each node word is reduced to five due to limited space.

the verbs *convince* and *persuade* by observing a list of concordance lines generated in the KWIC format:

```
1) ays that universities urgently need to convince academics that popularising research is re
2) rviews by Professor Ian Fells ought to convince producers elsewhere that talking heads are
3)  produce literature detailed enough to convince the prospective buyer. Ivanov's major inte
4) hbouring system will find it harder to convince their own establishment that they need new
5) ggling sister or even the queen should convince us that behaviour can seem intelligent in

1) manager for remote sensing will try to persuade different parts of the government to spend
2) in of sense. Incidentally, how did you persuade Michael Heseltine to write it for you? Gal
3) n early stage. Second, it is trying to persuade researchers that it is a good thing to wor
4) t two years trying, unsuccessfully, to persuade the British government to make some contrl
5) ogy, is planning a mission to India to persuade the country to invest in British satellite
```

As seen in the extract above, KWIC concordancing generates a list of many truncated but context-embedded sentences with the target word aligned in the middle. In DDL students are encouraged to learn about the target words themselves by noticing recurring patterns of usage across the concordance lines. In the extract, for example, it is evident that the verb *convince* is directly followed by a noun, while the verb *persuade* is followed by a to-infinitive. Johns witnessed the benefits that such computer-generated concordances brought to linguistic professionals and believed that concordancers, due to their capacity to generate large lists of authentic examples of language use on request (Higgins & Johns, 1984), could similarly become "one of the most powerful tools that we can offer the language learner" (T. Johns, 1988, p. 15).

The two central pedagogical principles of DDL are, therefore, language exposure and active learner engagement. As can be seen from the above example, a concordancer is able to generate lists of concordances from a corpora of source texts which may contain hundreds of thousands of words, so as to "confront the learner as directly as possible with the data" (T. Johns, 2002, p. 108). When confronted with the data, learners are supposed to conduct research-like tasks to find answers themselves. It is believed that "research is too important to be left to the researchers" (T. Johns, 1991), and a learner is in fact "a research worker whose learning needs to be driven by access to linguistic data" (p. 2).

During this process, it is supposed that "the learner can take part in building up his or her own profiles of meaning and uses" (T. Johns, 1994, p. 297).

1.3.3 Benefits of DDL

DDL brings multiple benefits to language learning. Firstly, concordance lines offer an intensified and condensed exposure to authentic language use (Gabrielatos, 2005) and can provide learners with "enhanced and enriched input" (R. Ellis, 2012, p. 285) of language. The concordance-enhanced language input can lead to various learning outcomes, as noted by Boulton (2009a):

> Where DDL seems to be most useful is for extending or deepening knowledge of existing language items, distinguishing close synonyms, detecting patterns of usage, collocation, colligation, morphology, and so on. It can sensitise learners to issues of frequency and typicality, register and text type, discourse and style, as well as the fuzzy nature of language itself. (p. 83)

Secondly, DDL activities can enhance the motivation and independence of learners. Boulton (2011) describes the three stage DDL model by Johns, which involves student-led manual observation (of concordanced evidence), classification (of salient features) and generalisation (of rules), for the purpose of "empowering learners to explore language corpora and come to their own conclusions" (p. 575). Without explicit instructions from teachers or tutors, learners are encouraged to discover resulting in more spontaneous, proactive and self-directed learners. Hence, DDL is believed to encourage "maximum learner motivation" (Hunston, 2002a, p. 171).

A number of empirical studies have highlighted the potential pedagogical and developmental benefits of DDL. In Cobb's (1997) research, first-year Arabic-speaking university students using hands-on concordancing to work out the meanings of new words, achieved 12% higher scores in subsequent vocabulary tests than they did when concordancing tools were not available. In another example, eighty-one second-year Taiwanese senior high school students participated in a study designed to improve their

collocation performance (Sun & Wang, 2003). The results showed that the inductive group using concordancers improved significantly more than their peers in the deductive group. A study involving eighteen intermediate ESL undergraduates (mostly from Asian countries) found that using an online concordancer helped them achieve a statistically significant transfer of vocabulary knowledge to the writing task (Kaur & Hegelheimer, 2005). The generally positive effects of DDL on vocabulary acquisition can also be supported by other recent studies (e.g. Celik & Keser, 2010; Guan, 2013; Poole, 2012; Shi, 2013). DDL may also help learners with grammar awareness. Stevens (1991), for example, found that DDL could enhance students' competence in both semantic and syntactic elements. Furthermore, recent studies on the instruction of lexico-grammatical items show that DDL can be helpful in grammar teaching (Huang, 2014; D. Liu, 2011; D. Liu & Jiang, 2009). In short, DDL can contribute to the acquisition of vocabulary and grammar of learners from various linguistic and cultural backgrounds.

DDL can also assist the instruction of academic writing. For example, Hyland (2003) demonstrated how concordance lines could be used to guide students to use appropriate language in academic writing; a few other studies show that students generally hold a positive view towards using concordancing and corpora in writing (Sun, 2007; H. Yoon & Hirvela, 2004). Tribble and Wingate (2013) successfully incorporated corpus use in writing instruction, and L. Flowerdew (2015) effectively used online concordancing to inform discussion writing. Studies also show that corpora, used as exemplars of good writing, can improve the writing performance of the participants (Alshaar & AbuSeileek, 2013; Chang, 2014). Furthermore, in another two-phase study, participants were also found to actively improve writing skills with the help of direct corpus consultation (Chambers & O'Sullivan, 2004; O'Sullivan & Chambers, 2006). Similarly, H. Yoon (2008) found that DDL did not only enhance the participants' language awareness to help their writing, but also enabled them to be more responsible, independent and confident in writing. C. Yoon (2011), upon a review of twelve DDL-focused studies, concluded that the use of concordancing could increase learner autonomy. In short, it is evident that DDL not only serves as a source of linguistic reference in academic writing, but also enhances the developmental skills of learners.

1.3.4 Problems with DDL

While DDL's pedagogical focus on language exposure and learner engagement sees it underpinned by 'best practice' in language teaching and learning, a number of concerns have been identified by both opponents and proponents of the approach. As a result, DDL has been largely omitted from mainstream language teaching practice. As T. Johns, Lee, and Wang (2008) have noted, "although various educational uses of concordancing are frequently talked about, they are not so frequently tested with real learners" (p. 494). There are three reasons for this lack of uptake: technological concerns (Chambers, 2010), pedagogical problems (Stevens, 1991), and teacher and learner reticence (Boulton, 2009a).

Technological concerns

Concordancing typically requires desktop computers. In many institutions, however, there are often not enough computers in the classroom for individual or small-group use (Romer, 2008). This is described as a problem of 'logistics':

> If learners are to actually use corpora in the classroom, they need computers (ideally one per student, but at least one for every two or three students), but also corpora and text retrieval software. All this costs a lot of money, which schools and universities are not always able to afford … (Gilquin & Granger, 2010, p. 366)

In addition, as mentioned above, concordancing software is also needed. Concordancers are reported to be overly complicated (L. Flowerdew, 2012, p. 204). This is because they are often designed to meet specific research needs, or to only work with a designated corpus (the concordancer Xaira, for example, was specifically designed to work only with the British National Corpus). Furthermore, appropriate corpora need to be prepared in advance for classroom use. Most available corpora were developed for linguistic research purposes, and the unfiltered and unprocessed texts in these corpora do not necessarily make appropriate learning materials for language education purposes in terms of the

content and level (J. Flowerdew, 1996, p. 98). Osborne (2004) notes that, when the texts are presented to ordinary learners, "many of the contexts are likely to be linguistically and culturally bewildering" (p. 252). While corpora useful for language learning do exist, they are usually stored in in-house databases, e.g. of universities, and not made freely available to outside users.

Pedagogical problems

DDL is in essence an inductive rather than rule-based deductive approach, featuring bottom-up rather than top-down processing of text. As a result, pedagogical problems are often related to its emphases on autonomous and independent inquiry and the direct exposure of learners to such large amounts of language data. It has been observed, for example, that "there is a large subset of language learners who through cultural influences or academic immaturity cannot be expected to search automatically for patterns in a welter of linguistic data" (Stevens, 1991, pp. 35-36). In addition, as concordances are notoriously difficult to read, analysing corpus data may be rather mechanical, laborious, and even tedious for learners (Chambers, 2007; Cheng, Warren, & Xu, 2003), especially when they have to do it on their own from start to finish wihout sufficient training and guidance. Furthermore, overexposure to concordances may tire or bore learners (Hyland, 2003; Thurstun & Candlin, 1998). Some empirical studies have shown that learners have difficulty identifying patterns and rules (Huang, 2014; D. Liu & Jiang, 2009). Taken as a whole:

> Learners will quickly become frustrated if they cannot find enough (or any) examples of items selected for concordancing; they will equally quickly become frustrated, on the other hand, if they are overwhelmed with too many examples. Finally, even where a manageable number of concordance lines are found, if a certain item has a variety of usages, then some usages might be better represented than others. (J. Flowerdew, 1996, p. 98)

In short, DDL as an inductive-based approach to language learning may result in a lack of learning outcomes. Despite the potential benefits of DDL found in a few controlled research contexts, its inductive-based focus, which involves the autonomous processing of large quantities of language data, can prove frustrating for learners.

Learner and teacher reticence

DDL has still not yet been accepted by learners and teachers at large. A two-phase study which aimed to enhance learners' writing skills in French through corpus consultation resulted in many negative reactions (Chambers & O'Sullivan, 2004; O'Sullivan & Chambers, 2006). Learners noted that working with corpora tended to be tedious, time-consuming and laborious, and that there might not be significant advantages over the traditional resources like the course book (Chambers, 2005, 2007). Vannestal and Lindquist (2007) attempted to introduce corpus-based methods to grammar teaching, but only received lukewarm feedback from students due to their unfamiliarity with DDL principles and methods.

Similarly, many teachers are also reluctant to use DDL and related concordancing approaches. This is possibly due to a lack of the knowledge, expertise and skills required to successfully engage with corpora. Seidhofer (2002, p. 216), for example, discovered that "there is very little awareness amongst teachers and students" of the benefits and use of corpora for language education. Similarly, McCarthy (2008) has suggested that "teachers have heard of corpora, but they are not quite sure what they are" (p. 563), and a recent survey reveals that teachers are still quite unfamiliar with computer corpus data (Belkhir, 2013). Corpus advocates, therefore, have to encourage teachers to take the very first step, and not to "feel intimidated or overwhelmed at the thought of working with corpora" (Bennett, 2010, p. 94).

Another reason might be the view that DDL is most suitable for advanced language learners. T. Johns (1986) has noted that DDL is most appropriate for "well-motivated" and "sophisticated" (p. 161) learners with research experience and a strong motivation to develop learning skills, however he is less sure about the suitability of DDL for other learners. Hunston (2002a) has also argued that DDL is more suitable for "advanced students who are filling gaps in their knowledge rather than laying down the foundations of language leaning" (p.171). This was confirmed by Boulton (2012), who reviewed 116 empirical studies on DDL conducted worldwide, to find only nine of them clearly targeted

high school learners, and one a pre-university language centre.

Admittedly, students exposed to DDL approaches often lack the adequate language proficiency and research experience to handle the sophisticated processing of linguistic data, and make sense of the often long lists of densely-aligned concordance examples they are presented with in the DDL classroom. As Gardner (2007) puts it:

> Certainly, such an approach to language training presupposes that learners will know most of the words (co-text) that surround a key word or phrase in context (KWIC), and that they can connect their meanings - an assumption that seems unreasonable for many groups of language learners (children, beginning L2 learners, learners with low literacy skills etc.). (p. 255)

However, many researchers have attempted to make DDL less difficult and more beneficial to less proficient language learners. Since T. Johns' first attempt to introduce DDL to lower-level learners (T. Johns et al., 2008), there have been a number of other studies which focus on the use of DDL with lower-proficiency language learners. Some have reported very positive results (Boulton, 2008, 2009b, 2010a; Braun, 2007; Vyatkina, 2016).

The in-depth reason for the reticence of learners and teachers might also be a preference for the traditional teacher-centred classroom model. It has been pointed out that "many [students] may prefer to be told what to do, accepting that it is the teacher's role as expert to show them, and resent having to take any responsibility for their own learning" (Boulton, 2009a, p. 93); many teachers also view their role as being at the centre of the classroom, and therefore may not enjoy "taking a back seat" (p. 93) in the learning process. Likewise, the vast amounts of language data that students are exposed to may pose a threat to the authority and expertise of teachers who may not be so familiar with the different linguistic forms observed by the students in the data.

Ultimately, and as a result of the issues described above, a quarter of a century after its inception, DDL largely remains a proposal of corpus advocates, rather than a commonly

used practice in the language learning classroom.

1.3.5 Some attempts to address the problems of DDL

Efforts to address the problems of DDL are ongoing and at times can produce some encouraging results. In terms of the technological concerns, the easier procurement of computers with ever decreasing prices has meant their increasing inclusion as an integral part of the infrastructure of schools and universities. Furthermore, students tend to have access to at least one computer at home, or carry a laptop or tablet to school with them. From the pedagogical perspective, the processes of DDL might be mediated, so that the approach stimulates rather than frightens students, or inspires rather than intimidates them (Kilgrriff, 2009). One way that this might occur is through the development of pedagogic corpora (J. Willis, 2011). Pedagogic corpora are corpora created specifically to meet learners' needs (Chambers, 2010). Such specialised corpora can provide texts suitable for specific groups of learners (Gavioli, 2005). Alternatively, existing corpora can be used, but they require 'pedagogical processing', that is, the tailoring of their included texts for the specific needs of less proficient learners (Braun, 2005, 2007). This could involve making texts included in a corpus more linguistically simple (Gavioli, 2001), selecting texts with content that is already familiar, or of interest, to the learners, (Kilgrriff, 2009), or selecting texts which involve predictable context (Partington, 2001). This kind of pedagogical adjustment requires further annotation and classification of existing corpora.

The emphasis of DDL on inductive learning is potentially more difficult to mediate. One suggestion involves giving deductive instruction before engaging students in inductive activities to enhance their confidence and motivation (D. Liu & Jiang, 2009). A recent study, for example, successfully implemented teacher-guided DDL on 145 participants in Japanese universities, to find that DDL can be beneficial for both deductive and inductive learners, irrespective of their preferred learning styles (Mizumoto & Chujo, 2016). Interestingly, inductive learning itself is not necessarily inferior to a deductive approach. According to a comprehensive review of the advantages and disadvantages of inductive and deductive approaches, although it tends to be more time consuming, inductive

learning facilitates long-term knowledge intake and internalisation (R. Ellis & Shintani, 2014).

To address teacher and learner reticence, training for teachers and learners to understand and utilise corpora may be required. Training learners can contribute to effective corpus consultation (Scipicharn, 2010), even for lower-level learners (Boulton, 2009b). However, teachers still provide the vital link between students and corpora. As Breyer (2009) states "the decision to incorporate corpora into language teaching lies ultimately with the teacher" (p. 154), and hence in the wider context of technology-enhanced learning, teachers determine whether the successful and effective integration of technological innovation into language teaching and learning will take place (Wong, 2013). Thus, it has been highly recommended to include corpus knowledge and skills in teacher education and development (Frankenberg-Garcia, 2012; Krajka, 2007; McCarthy, 2008; O'Keeffe & Farr, 2003).

1.4 The thesis: Mobile DDL and Patterns in Context (PIC)

As discussed in Section 1.2, the DDL approach, which draws upon the resources, methods and principles of CL, can assist ESL students with their academic writing by exposing them to authentic and discipline-specific academic texts, and encourage spontaneous language queries to meet their personal learning needs. This research was inspired by such arguments regarding the benefits of CL for assisting ESL learners with academic writing, and also took into consideration the shortcomings of DDL. In particular, the research was designed to address the demands that autonomous learners face identifying language patterns in language data, as well as the limitations of current corpus consultation tools. Briefly, this thesis examined how such ESL learners' uptake and positive experience of corpus-based methods, notably concordancing, might be enhanced. It involves the concepts of mobile DDL and PIC to achieve this aim.

1.4.1 Mobile DDL

Mobile DDL means concordancing on the new platform of mobile apps. The concept was inspired by the emergence of existing DDL tools, and is in line with recent shifts in education that respond to the rising mobile technology. In this wirelessly connected world, students as "digital natives" (Prensky, 2001a, 2001b) no longer learn only in the classroom, but also in a range of different modes and locations. The following is a review on electronic or digital concordancing tools, and how a mobile concordancer can make some difference.

Recent technical developments in concordancers have greatly improved the accessibility of DDL for both teachers and students. The first- and second-generation concordancers which operated on mainframes and early personal computers were accessible only to programmers and programming-literate linguists. Compared with these forerunners, the third-generation concordancers have become much more user-friendly, and feature visualised Graphic User Interfaces (GUI), as well as cross-platform compatibility with mainstream operating systems. Some of these are commercially available, e.g. MonoConc (Barlow, 1999) and WordSmith (Scott, 2014, the first version was released in 1996), while others are freeware and downloadable from the homepages of the developers or their affiliated institutions, such as AntConc (Anthony, 2015, the first version was created in 2002). Though it is less difficult to learn how to work with such concordancing tools, users still need to select and load appropriate texts in advance for later searching. As such, it is necessary that they already have relevant corpora available on their local hard drive, or otherwise the preparatory work of developing a corpus of texts and loading these into the software would be too time-consuming and laborious.

In recent years, the fourth-generation web-based concordancers have prospered in amount and influence (McEnery & Hardie, 2012). These concordancers operate and access their corpora via web servers, and the results are presented through web browsers, without the texts being physically distributed to the users' computers. This has solved the problem of copyright protection, and more importantly, enabled users to work immediately with ready-to-use corpora. A few prominent examples of the fourth-generation web-based concordancing tools, which fully embody the concept of 'Web as Corpus' (Kilgarriff &

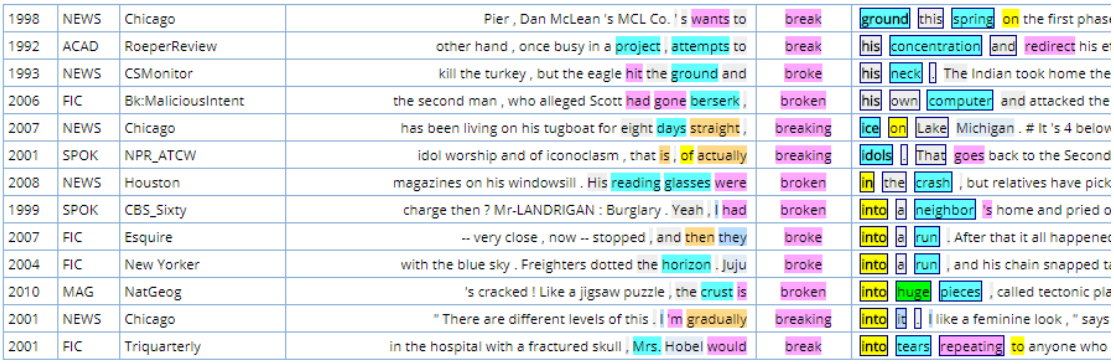
Grefenstette, 2003), are introduced and evaluated below.

Online concordancers based on large general corpora

The most notable is the BYU (Brigham Young University) corpora[3]. The website currently consists of up to 14 large corpora, including the ever-growing iWeb (14 billion words), News on the Web (NOW; 6 billion words) and Wikipedia Corpus (1.9 billion words). Another example, Sketch Engine[4], also provides web-based easy access to numerous corpora (see the review by Kilgarriff et al., 2014). Sketch Engine allows a 30-day free trial, while SKELL (Sketch Engine for Language Learning) is free of charge. In addition, Hardie (2012) designed a so-called CQPweb interface to imitate the BNCweb, an online access to the BNC (British National Corpus), and the corpus linguistics team of Beijing Foreign Studies University built a similar platform to make a number of corpora (more than 10 and growing) available online[5] (Xu & Wu, 2014).

These online portals of corpus consultation have greatly improved the accessibility of concordancing. Even users with no corpus resources (texts and tools) are enabled to generate a number of concordance lines, which are displayed on the webpage in a short time and can be downloaded or quoted. Concordancing which involves regular expressions is also supported by the online concordancers, so it is possible to make more complicated queries through corpus data, provided that the users can write scripts of regular expressions themselves. Figure 1.2 reproduces a screenshot of the concordances of *break* in the BYU corpora. Please note that the search is inflection-insensitive, that is, other verb forms of *break* are also included. This is a relatively new feature of recent online concordancers, while most freeware desktop concordancing software does not support inflection-insensitive queries.

[3] See https://corpus.byu.edu/
[4] https://www.sketchengine.eu/
[5] http://corpus.bfsu.edu.cn/content/cqpweb-family ; authorisation is required for access.



1998	NEWS	Chicago	Pier , Dan McLean 's MCL Co. ' s wants to	break	ground this spring on the first phas
1992	ACAD	RoeperReview	other hand , once busy in a project , attempts to	break	his concentration and redirect his e
1993	NEWS	CSMonitor	kill the turkey , but the eagle hit the ground and	broke	his neck . The Indian took home the
2006	FIC	Bk:MaliciousIntent	the second man , who alleged Scott had gone berserk ,	broken	his own computer and attacked the
2007	NEWS	Chicago	has been living on his tugboat for eight days straight ,	breaking	ice on Lake Michigan . # It 's 4 below
2001	SPOK	NPR_ATCW	idol worship and of iconoclasm , that is , of actually	breaking	idols . That goes back to the Second
2008	NEWS	Houston	magazines on his windowsill . His reading glasses were	broken	in the crash , but relatives have pick
1999	SPOK	CBS_Sixty	charge then ? Mr-LANDRIGAN : Burglary . Yeah , I had	broken	into a neighbor 's home and pried o
2007	FIC	Esquire	-- very close , now -- stopped , and then they	broke	into a run . After that it all happene
2004	FIC	New Yorker	with the blue sky . Freighters dotted the horizon . Juju	broke	into a run , and his chain snapped t
2010	MAG	NatGeog	's cracked ! Like a jigsaw puzzle , the crust is	broken	into huge pieces , called tectonic pla
2001	NEWS	Chicago	" There are different levels of this . I 'm gradually	breaking	into it . I like a feminine look , " says
2001	FIC	Triquarterly	in the hospital with a fractured skull , Mrs. Hobel would	break	into tears repeating to anyone who

Figure 1.4 Screenshot of 'break' concordancing results in the BYU corpora

The above DDL tools have some limitations. Since the concordancers are underpinned by large general corpora, there are always a huge number of results, most of which tend to be irrelevant to academic English. Although the concordancing interfaces of the web-based tools have been made much more user-friendly, they still tend to be suitable only for professional researchers. A learner seeking reference of academic English will find there are too many examples that are not what they are looking for. Hence, concordancers based on special corpora of academic English would be more helpful.

Online concordancers based on special corpora of academic English

Specific to academic English, some of the web-based corpora contain an academic sub-corpus, like the BNC, and some are special academic corpora themselves, such as MICASE (Michigan Corpus of Academic Spoken English) and MICUSP (Michigan Corpus of Upper-Level Student Papers). MICASE and MICUSP have their own web interfaces[6]. The counterparts of the two corpora in Britain, that is, British Academic Spoken English Corpus (BASE) and British Academic Written English Corpus (BAWE), are often included in general web corpora portals, one of which is operated by the Hong Kong Polytechnic University[7].

There is no doubt that the concordancing results from these corpora are more suitable for leaners seeking to improve their academic English. With the specialised web resources, researchers increasingly employ online concordancing in the education teaching of

[6] https://quod.lib.umich.edu/cgi/c/corpus/corpus?c=micase;page=simple and http://micusp.elicorpora.info/
[7] http://lamalcorpora.engl.polyu.edu.hk/cqpweb/

academic English, particularly academic writing. In recent studies, query results produced by web-based concordancers were used in the instruction of proofreading (Sun, 2003), transfer of word knowledge for academic writing (Kaur & Hegelheimer, 2005), teaching reporting verbs (Bloch, 2009) and writing the discussion section of a thesis (L. Flowerdew, 2015). However, it is still challenging for ordinary students to learn to run the web-based concordancers independently. This is because the online tools are designed mainly for researchers, so they still involve some advanced terminology and sophisticated operation. Without special introduction and training, students are not likely to benefit from concordancing via the online sources.

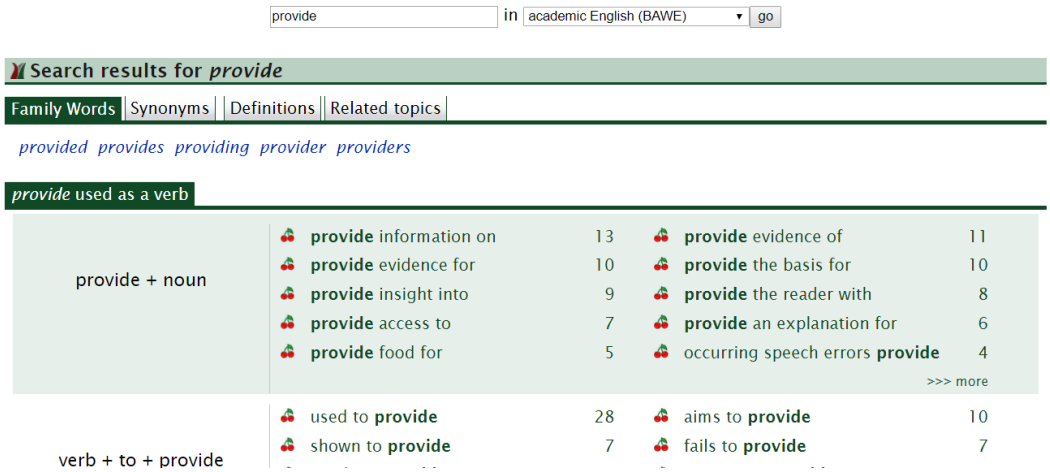


Figure 1.5 Screenshot of search results of *provide* in online FLAX

Other corpus-informed tools for academic English

Some online learning tools, which contain optional academic English sources, may also help academic writing. Compleat Lexical Tutor[8] is designed to present a variety of lexical information on searched words, including concordance lines, and there are a few academic English corpora to choose from. One disadvantage with the tool is that the interface seems dense with a complex structure. FLAX[9], another online tool created by a team at the University of Waikato in New Zealand, mainly provides collocations of user-input search words (Wu, Witten, & Franken, 2010a, 2010b). As is shown in Figure 1.3 above, BAWE (British Academic Written English) is an optional source for academic

[8] https://www.lextutor.ca/
[9] http://flax.nzdl.org/greenstone3/flax?a=fp&sa=collAbout&c=collocations&if=flax

English from the online portal. However, the search results of this concordancer only provide the frequency of collocates, and no truncated or extendable sentences in context are made available, as commonly carried out by other concordancing tools.

Related mobile apps

Both Compleat Lexical Tutor and FLAX have produced mobile apps for language learning. However, the apps mainly provide simple games and exercises for lexical learning. The apps may represent a feature of current mobile apps for language education: mainly transferring existing learning materials to the mobile platform. A team of researchers in University College London developed an app for grammar learning, named iGE (Aarts, Clayton, & Wallis, 2012). The *Internet Grammar of English*, an online-grammar course, was put into the app with shortened paragraphs, exercises and examples to fit the smaller screens. The team also developed another app to help academic writing, named Academic Writing in English (Mehl, Wallis, & Aarts, 2013), and this app shared one thing in common with iGE: loading existing instructional materials on academic writing into a mobile app for users to do self-directed practice. Apart from these, there are quite a few other commercially available apps for language learning (see the review by Gangaiamaran, 2017). With the emergence of such apps, there have been a limited number of studies on using mobile apps that can help students learn academic writing (Al-Wasy & Mahdi, 2016; Lee & Kim, 2013; Noriega, 2016). Despite the positive trend, one shortcoming of the existing apps for education is that they tend to only adapt existing materials to mobile apps (mainly the smaller screen), and the resources provided are often limited in both size and type (certain books, a small number of exercises, etc.). Without the support of multiple categories of materials, student users may only read through the available texts, more sophisticated and interactive request and retrieval of resources seem to be inaccessible.

My apps

The change of concordancing platform from desktop computers to the web, together with the ensuing positive results, implies that DDL can and should be made more accessible to learners. Mobile DDL, i.e. operating the basic function of concordancing on mobile

devices of learners, should further the development of DDL in this digital age. My apps were designed to implement and enhance mobile DDL by providing more accessible concordancing resources for students to use autonomously.

To achieve 'mobile DDL', the research process will involve *firstly* the development and *secondly* evaluation by student users of concordancing apps for mobile devices in order to provide ESL learners of academic English with accessible, convenient and instant access to concordance lines anytime, anywhere at the point of need. Mobile technology aims to provide this new generation of learners, already accustomed to the use of mobile communication devices for their learning, with an engaging concordancing platform that can support their academic writing practices in ways that were not possible before (Traxler & Vosloo, 2014).

The mobile apps in this research are aimed to capitalise on the benefits of existing learning tools associated with DDL, and at the same time extend the affordances of such tools to meet the specific interests of this research. These concerns have made the apps, in particular a pattern-based concordancing app, different from existing mobile concordancers.

Firstly, the apps contain preloaded discipline specific texts from a subcorpus of academic English. Users need to select a certain discipline before carrying out a concordancing search. Discipline-specific texts are currently not available in existing tools.

Secondly, the mobile apps facilitate offline concordancing of these academic subcorpora. The existing online concordancing portals, such as BYU corpora and Sketch Engine, do not provide API (Application Program Interface) for mobile development. It is inconvenient and unfriendly for users who want to do corpus queries from mobile devices, because they have to visit the websites from a browser. Since the interfaces of the online concordancers are designed for visitors from computers and laptops, rather than those using mobile devices with much smaller screens, the user experience of visitors from mobile devices tends to be unpleasing and discouraging: probably there are too many

words, graphic elements and other affordances on a webpage. Thus, there needs to be suitable apps to enhance positive experience of mobile concordancing by displaying results to app users in a comfortable way. The apps developed in this research can enable users to carry out concordancing search anytime and anywhere, and not be affected by an unavailable or poor Internet connection.

Thirdly, while the existing concordancing resources traditionally use the KWIC (key words in context) approach for retrieving searches, one app developed in this research uses an approach referred to as PIC (patterns in context). PIC involves texts with annotated information of word classes for each word, and also a special query language called 'regular expression' ('regex'). Although current concordancing software and some online concordancers support regex-based search, users of these tools need to formulate the regex themselves, which is challenging to most non-experts. My app for PIC concordancing contains pre-set sequences of regex for each pattern to be used (see Appendix E). The notions and technical details are explained in detail in the next section.

1.4.2 Patterns in Context (PIC)

In order to avoid the difficulties faced by learners as they attempt to read and analyse concordance results (see Section 1.3.4), the *second* important component of the research process will involve the development and student evaluation of an unconventional search and retrieval approach for concordancing that assists users to identify language patterns in the concordancing data. As exemplified earlier, concordancing approaches traditionally use the KWIC (Key Words in Context) format of search and retrieval. A KWIC search for any word (or group of words) generates a list of many truncated but context-embedded sentences with the target word aligned in the middle (see Section 1.3.2). Students attempt to learn about the target words by noticing recurring patterns of usage across the concordance lines. However, by simply listing concordance lines with the target word in context, KWIC concordancing often only exacerbates the challenges that learners face, leaving them feeling frustrated, overwhelmed, or bored.

The alternative search and retrieval approach is referred as Patterns in Context (PIC). PIC is designed to extend the basic search unit from individual words to multi-word patterns. Patterns, the key concept in Pattern Grammar (Hunston & Francis, 2000), can be defined as the structured combinations of lexical choices and grammatical forms. The most important advantage of PIC is that unlike KWIC-based software, which simply retrieves indiscriminate lists of concordance lines around a selected node word leaving the student learner responsible for identifying relevant patterns of use, PIC retrieves the node word within specified patterns. Importantly, in retrieving these patterns, PIC allows for different phrasal combinations, while sticking accurately to the target pattern.

For example, '*require* + noun phrase + infinitive + verb' is a useful structure. Given the varying noun phrases and verbs, and other usages of the target word, e.g. *require* + *that*-clause, it would be difficult for learners to observe this pattern in a traditional KWIC display format. By contrast, PIC can accurately retrieve and clearly present all instances of the pattern, as shown in the following PIC results:

scientific experimentation [requires us to think] in terms striving
which [required each pre-service teacher to plan] and
This [requires practitioners to be] sensitive to specific
Strategies [require students to share] information
it will [require popular educators to give] up the view that

As seen in this example, a PIC search result uses square brackets to display the pattern. Unlike KWIC, learners do not need to go through an overwhelming number of results to identify the usage. For a more detailed description of PIC, please refer to Chapter 2 of this thesis. Important aspects related to this component of the research will involve the process of training students to use the PIC concordancing software on the mobile platform.

1.5 Thesis outline

Chapter 1 has set out the motivation for the research. This commences with a recognition that corpus resources and methods (referred to in a pedagogic context as DDL) can assist ESL learners with their academic writing. However following this, a number of issues

and problems were identified as to why these resources and methods, for the most part, have not been accepted by teachers or students as a routine part of language learning practice. The chapter then sets out the aims of the research, i.e., an attempt to encourage ESL learners increased uptake and positive experience of corpus resources and methods for their academic writing. The aims are achieved by the development and evaluation of mobile concordancing software tools, and an unconventional pattern-oriented approach, Patterns in Context (PIC), for searching and retrieving concordances.

Chapter 2 reviews the relevant literature, including the convergence of CL and language education throughout the years, especially the interaction of CL and EAP. In addition, Pattern Grammar, the theoretical underpinning of PIC, is discussed in detail, focusing in particular on its origin, profile and application in language education. The remaining part of the literature review is concerned with the concept of mobile DDL, which is rooted in the emerging topic MALL (mobile-assisted language learning). This component of the literature review focuses on the broader area of technology-enhanced education, i.e. how learners have been learning with technology from computers to smartphones. The focus gradually shifts from the well-established term CALL (computer-assisted language learning) to mobile learning and MALL. The distinctive features and caveats of the field are discussed in detail. At the end of the chapter, the concepts of PIC and mobile DDL are further elaborated.

Chapter 3 sets out the details of methodology and research design. Three research questions are identified at the beginning of the chapter. Based on a pragmatist worldview, the approaches of mixed-methods and action research are adopted to carry out the development and evaluation of the concordancing apps. Thus, this research is designed as cyclic and progressive through three phases, with improvement in each phase based on feedback from users in the prior phase. The research process is reviewed in the chapter, and the methods for data collection are explained in preparation for the presentation of results in the subsequent chapters.

Chapters 4 to 6 present detailed results of the research phase by phase. Each of these three

chapters starts with a section explaining the technological research involved in the development of mobile concordancing app. Following this, the quantitative results are presented, followed by the qualitative results. Based on these results, each chapter concludes with a reflection and discussion of tentative conclusions. Chapters 4 and 5 involve a comparison of the two concordancing approaches KWIC and PIC, while Chapter 6 focuses on the evaluation of the PIC concordancer only.

In Chapter 7, conclusions are drawn in response to each of the three research questions. The implications from this research for the future development of mobile concordancing software, DDL and mobile learning are also discussed in detail. The chapter concludes by discussing the limitations of the present research and calls for further, more in-depth research into the topics of corpora, technology and language education.

CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

This literature review provides an overview of the academic areas that underpin the design and development of the mobile-based concordancing software designed and evaluated for this research, including the new Patterns in Context (PIC) approach for searching and retrieving concordance lines that may increase students' uptake and positive experience of concordancing software tools. As a result, there are two major strands to this literature review. The first strand reviews the convergence of corpus linguistics (CL) and language education, including how corpora have been used for language teaching and learning via indirect and direct approaches, as well as the development of academic vocabulary lists based on specialised corpora of academic texts. The chapter then examines the concept of Pattern Grammar (PaG), another focal point of CL-related literature. The main features of PaG, the combination of lexical and grammatical elements and the association with meaning, are explained together with the phraseological nature and the pedagogical potential of PaG. The principles of PaG have directly influenced the conceptualisation of the PIC search and retrieval approach, which is profiled in more detail in the next section of the chapter. Differences between PaG and PIC are also be discussed. The second major strand to the literature review reviews the emergence and use of mobile technology for educational purposes. Given the short history of both mobile learning ('m-learning') and mobile-assisted language learning (MALL), this chapter also includes a review of the relevant literature on computer-assisted language learning (CALL) in the broader context of technology-enhanced education. The chapter concludes by discussing the new concept of mobile DDL.

2.2 CL and language education

2.2.1 Indirect and direct uses of CL in language education

CL has developed substantially in the past three decades to become the methodological

basis for much language research. Nowadays "the corpus is considered the default resource for almost anyone working in linguistics" (Teubert, 2005, p. 1), and similarly, Hoey (1998) described CL as "the route into linguistics" rather than a branch of linguistics (as quoted in G. Sampson & McCarthy, 2004, p. 5).

It has been long acknowledged that corpus-based work helps to provide additional pedagogical perspectives for the language teacher, shedding light on what to teach and how to teach (Murison-Bowie, 1996). Leech (1997) notes that the convergence of corpora and language pedagogy has taken place in both direct and indirect ways. Indirect applications include reference publishing (e.g. dictionaries) and materials development (e.g. syllabuses and word lists), whereas direct applications involve teaching about corpora, teaching to exploit corpora and exploiting corpora to teach. In other words, corpora are often used indirectly by linguistic researchers, lexicographers and materials developers, while the direct convergence of corpora and language pedagogy entails hands-on interactions ('explore') between corpora and teachers and/or learners. Romer (2008) illustrates the distinction between the direct and indirect uses with a graph, and indicates that DDL is a representative form of the direct applications. The classified uses of corpora in language learning and teaching are shown in Figure 2.1.

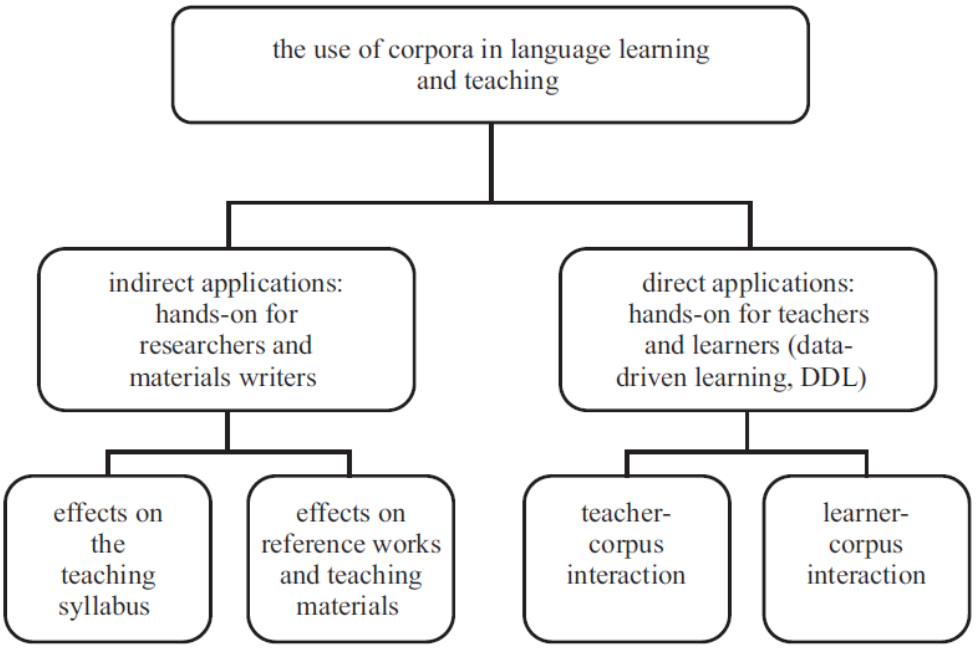


Figure 2.1 Indirect/direct applications of CL in language pedagogy (Romer, 2008, p. 113)

Indirect applications

Reference works and teaching materials are the major outcomes of the indirect uses of corpora in language education. In the first place, it is noted that corpora are 'game changers' in English lexicography (Heuberger, 2016). Corpus-based development of learner's dictionaries has become well-established among major dictionary publishers. In the late 1980s, the *Collins COBUILD English Language Dictionary* (Sinclair, 1987a) was published based on the enormous amount of language data from the COBUILD (Collins Birmingham University International Language Database) (see Sinclair, 1987b). This dictionary, aiming to help learners with 'real English', set an important precedent for the development of such publications. Later, another dictionary for learners, *Cambridge International Dictionary of English* (Procter, 1995), was published based on a one-million-word corpus (see Baugh, Harley, & Jellis, 1996). Almost all the following learner's dictionaries are based on corpus evidence, including the recent *Oxford Learner's Dictionary of Academic English* (Lea, 2014). Nowadays, as noted by McCarthy (2008), "no self-respecting publisher would dream of publishing a learners' dictionary that was not based on a corpus" (p. 564). In fact, all mainstream dictionary publishers have established their own mega-size corpora, many of which are still growing in size (see Table 2.1).

Table 2.1 Corpora Established by Leading Dictionary Publishers

Publisher	Corpus	Size
Cambridge	Cambridge English Corpus	Multibillion words (including the 50-million-word Cambridge Learner Corpus)
Oxford	Oxford English Corpus	2.5 billion words
Collins	Collins Corpus	4.5 billion words (including the 650-million-word COBUILD)
Longman	Longman Corpus Network	330 million words (including the 12-million-word Longman Learner's Corpus)

The development of materials other than learner's dictionaries has also benefited from the use of established corpora. The COBUILD corpus inspired the *Collins COBUILD English Course* (D. Willis & Willis, 1989) and the *Collins COBUILD Student's Grammar*

(D. Willis, 1991). The *Longman Student Grammar of Spoken and Written English* (Biber, Conrad, & Leech, 2002) and *Real Grammar* (Conrad & Biber, 2009) are two reference works based on Longman corpora. In addition, the *Touchstone* series textbooks are a successful example of the integration of frequency information from corpus analysis into course units (see McCarthy, 2010).

In short, corpora and corpus-derived data have been widely used in learner's dictionaries, grammar books and other materials for language teaching and learning. In the light of the effect that published English language teaching materials and learner's dictionaries have on what is taught by language institutions and educators, the indirect uses of CL have a major impact on second language education. According to Hunston (2002a):

> [I]t is by now virtually unheard-of for a large publishing company to produce a learner's dictionary or grammar reference book that does not claim to be based on a corpus… even people who have never heard of a corpus are using the product of corpus-based investigation. (p. 96)

As mentioned above, corpus analysis may also inform the formulation of word lists and teaching syllabuses. Corpus-informed word lists in the context of academic English are discussed in Section 2.2.3, and corpus-inspired syllabuses are explained in Section 2.3.3 with the pedagogical potential of Pattern Grammar.

Direct applications

The direct applications of corpora in language education require teachers and/or learners to actively interact with corpora. Corpora may be used in the classroom by teachers who employ it to extract useful information about language use. Also, students can be encouraged to consult corpora to find information about language use on their own. This often involves "corpus-designed activities" (Bennett, 2010, p. 24), which engage students in the examination and investigation of corpora to acquire target language features. DDL (Data-driven Learning), developed by Tim Johns (1991, 1994), is a representative model of the direct use of corpora in language education. Johns advocates that students should 'discover' language use from concordance lines with minimal teacher intervention.

Compared to the direct uses mentioned above, DDL has experienced a much slower uptake by language educators and their students (Leńko-Szymańska & Boulton, 2015). As discussed in Chapter 1, DDL remains largely a proposal by corpus advocates rather than a general practice in the language learning classroom.

2.2.2 CL and EAP

English for Academic Purposes (EAP) can be briefly defined as "the study of English for the purpose of participating in higher education" (Bruce, 2011, p. 6). EAP has been greatly influenced by CL, and the term EAP was even coined by 'Mr. DDL' Tim Johns in the 1970s (Hyland, 2006b). In addition, two of the leading figures of EAP, Swales and Hyland, are both active advocates of corpora resources. Swales (1990), a scholar of the type of genre analysis widely used in EAP research, was also one of the main creators of the Michigan Corpus of Academic Spoken English (MICASE). Similarly, Hyland often builds specialised corpora to provide evidence for his research on academic discourse (e.g. 2008a; 2008b). As he notes, "it is difficult to imagine a domain of applied linguistics where corpus studies have had a greater influence than in the description of academic discourse" (Hyland, 2012b, p. 30). Methodologically, corpus research and genre analysis take different approaches - bottom-up and top-down respectively, which are considered difficult to reconcile (Swales, 2006). However, it is also believed that the approaches can form a useful continuum (L. Flowerdew, 2005).

The interactions between EAP and CL are especially noticeable in the emergence of academic English corpora. Large general corpora, e.g. BNC (British National Corpus) and COCA (Corpus of Contemporary American English), often contain academic English sub-corpora. There are also specialised in-house EAP corpora built by leading publishers, such as Cambridge, Oxford and Pearson. Individual researchers may build their own corpora for EAP research, such as Hyland (2008a, 2008b; see also Hyland & Tse, 2005) and Coxhead (2000). A number of EAP corpora established by universities around the globe are listed below in Table 2.2.

Table 2.2 Examples of EAP Corpora

Corpus name	Year of completion	Building institution
JDEST (Jiaotong Daxue English for Science and Technology) corpus	1985	The Shanghai Jiao Tong University
USE (Uppsala Student English) corpus	2001	Uppsala University
ICLE (International Corpus of Learner English)	2002/2009 (Version 2)	Universite Catholique de Louvain
BASE (British Academic Spoken English)	2005	The Universities of Warwick and Reading
BAWE (British Academic Written English)	2007	The Universities of Warwick, Reading and Oxford Brookes
MICASE (Michigan Corpus of Academic Spoken English)	2002	The University of Michigan
MICUSP (Michigan Corpus of Upper-level Student Papers)	2009	The University of Michigan
ELFA (English as a Lingua Franca in Academic Settings) corpus	2008	The University of Helsinki
WrELFA (Written ELF in Academic Settings) corpus	2015	The University of Helsinki
ELC (Engineering Lecture Corpus)	Under development	The Coventry University, Universiti Teknologi Malaysia, Auckland University of Technology

As shown in Table 2.2, the development of EAP corpora is relatively broad in terms of disciplinary focus, form (spoken or written) and level (learner or expert user of language). For example, MICASE is described as "a time capsule of academic speech" (Swales, 2006, p. 31) focuses on spoken English in the academic context, whereas the ELC (Engineering Lecturer Corpus) focuses on the academic language of engineering lectures.

2.2.3 CL-enabled academic word lists

A word list can be defined as "a list of the basic and most important words in a language or in a register of a language, generally intended for use as a basis for language teaching

or for the preparation of teaching materials" (Richards & Schmidt, 2010, p. 638). Drawing upon the definition, an academic word list can be seen as a list of the most important words, often the frequently occurring ones, in the context of spoken or written academic language. As academic vocabulary can be general or domain specific (Baumann & Graves, 2010), there are lists of broad and all-purpose terms used across academic disciplines or content-specific words which appear in certain academic domains.

There has been great effort by researchers to compile general academic word lists based on collections of academic texts for the pedagogy and materials development of EAP. During the 1970s, four important word lists for academic purposes were developed: the American University Word List (Praninskas, 1972), and three other unnamed word lists by Campion and Elley (1971), Lynn (1973) and Ghadessy (1979). These four word lists were later edited and combined to create the University Word List (UWL) (Xue & Nation, 1984). The UWL also introduced the concept of 'word family' in academic word lists. According to Bauer and Nation (1993), "a word family consists of a base word and all its derived and inflected forms that can be understood by a learner without having to learn each form separately" (p. 253). For example, *interest*, *interested* and *interesting* belong to the same word family. The UWL contains 836 base words, presented at 11 levels ranked by frequency in academic texts.

Problematically for the UWL, the four academic word lists from which it was developed were created during the pre-computer-corpora period, and thus were based on a limited number of textbooks and other materials. The paper-based corpora for these word lists ranged from 27,000 to 48,000 word in size, and often required manual counting and analysis (Coxhead, 2000). As she was unsatisfied with the selection principles, size and representativeness of the earlier UWL, Coxhead (2000) developed the Academic Word List (AWL). The underlying corpus for AWL amounted to 3.5 million words across four broad disciplines of arts, commerce, law and science. Similar to the UWL, the AWL contains 570 academic word families presented in 10 rank-ordered sub-lists. The AWL is influential, as it has been adopted by a wide range of dictionaries, material and websites for academic English learning (Coxhead, 2011).

Given the recent developments in computing technology and corpus linguistics, the AWL corpus is now viewed as relatively small. Consequently, a more recent word list, known as the Academic Vocabulary List (AVL) (Gardner & Davies, 2014), has been developed. The AVL is based on the academic sub-section of the 120-million academic corpus of COCA (Corpus of Contemporary American English), which is 35 times larger than that for AWL. In addition, since the sub-corpus of COCA comprises academic texts of nine broad disciplinary areas[10], AVL users are provided with an improved opportunity for investigating discipline-specific features of academic language use. Academic core words in the AVL are presented according to frequency rather than alphabetically. There is currently another project titled the New Academic Word List under construction by researchers in Japanese universities (Browne, Culligan, & Phillips, 2015). The project features the even larger Cambridge Academic Corpus of 288 million words. A list of 963 core academic words has been released by this project.

With the increasing awareness of EAP disciplinarity, the validity of the general academic word list has been challenged (Hyland & Tse, 2007). As a result, there have been attempts to set up discipline-specific word lists based on disciplinary corpora, e.g. for engineering (Shamsudina, Husinb, & Manand, 2013) and environmental science (J. Liu & Han, 2015). Another new development in academic word lists is a shift in focus from individual words to multi-word items. This development is supported by researchers such as Coxhead (2008), who provides a detailed analysis of the challenges and opportunities of using phraseology in EAP. Completed multi-word lists include the Academic Formulas List (Simpson-Vlach & Ellis, 2010) and the Academic Collocation List (Ackermann & Chen, 2013). The convergence of these two recent trends in academic word list development means that it is now possible, for example, to find phrase-based, disciplinary specific word lists. An example is the Engineering Phrases List (Graham, 2014).

[10] The nine areas are: i) education, ii) humanities, iii) history, iv) social science, v) philosophy and religion, vi) law and political science, vii) science and technology, viii) medicine and health and ix) others.

2.3 Pattern Grammar (PaG) and Patterns in Context (PIC)

Findings from CL have also had an important impact on language education by helping to develop new grammars of English. One of these is Pattern Grammar ('PaG' for short). PaG is a descriptive grammar, i.e. a set of rules based on observations of how English is actually used. It is an integrated approach to vocabulary and grammar based on the concept and phenomenon of language patterning as evidenced by the work on large corpora (Hanks, 2008; Hunston, 2010; Hunston & Francis, 2000). The Patterns in Context (PIC) concordancing approach, evaluated in this thesis as having the potential to enhance EFL students' uptake and positive experience of mobile-based concordancing, is based on the underlying tenets of PaG. This section will provide a background and theoretical overview of PaG and other influential pattern-based pedagogical approaches.

2.3.1 Development and definition of 'patterns'

The concept of 'pattern' is the core focus of PaG, and accounts of 'pattern' can be found in the literature in previous decades. Roberts (1956) carried out an investigation into the patterns of English, where he identified multi-word 'function units' such as 'subject' and 'verb modifier'. Another scholar Hornby (1976), stressed that the combination of words in the right order is as equally important as word meaning; he particularly noted the importance of verb patterns. Although Hornby did not give a clear definition of 'pattern' in the book, the examples he cited as patterns are very similar to the use of 'pattern' in this thesis. For example, he noted that *you're looking lovely*, *she married young* and *please keep quiet* shared the same pattern 'subject + *vi* + adjective' (p. 27).

Hunston and Francis (2000) acknowledged the impressive number of patterns dealt with by Hornby. They particularly underscored the potential value of patterns for grammar teaching to students, suggesting that "the priority given to pattern over structure represents a radical reinterpretation of grammar from the point of view of the learner rather than the academic" (Hunston & Francis, 2000, p. 7).

Based on patterns, PaG was primarily developed by Francis, Hunston and Manning (1996, 1998). The patterns identified from large corpora were presented in the two volumes of *Collins COBUILD Grammar Patterns*, focusing respectively on verb patterns and noun/adjective patterns. PaG theory has been explained in detail in the book *Pattern Grammar: a Corpus-driven Approach to the Lexical Grammar of English* (Hunston & Francis, 2000). The frequent use of concordance lines to show how particular syntactical structures pattern around different words is one of the features of this book.

Hunston and Francis (2000) define a grammar pattern as:

> … all the words and structures which are regularly associated with the word and which contribute to its meaning. A pattern can be identified if a combination of words occurs relatively frequently, if it is dependent on a particular word choice, and if there is a clear meaning associated with it. (p. 37)

Their definition highlights the two essential features of patterns. Firstly, patterns are, in essence, phraseological items containing elements of both vocabulary and grammar. As an example, Hunston and Francis (2000, p. 48) provide lists of *afraid*-related patterns in three different grammatical structures and lexical groups as follows[11]:

ADJ *of* n
15 ership is that they are afraid of the people’s awakening.
18 o wipe out. Everyone is afraid of the Khmer Rouge. Myself t
19 e who had not come were afraid of America and had no courage
20 hit me again, I wasn’t afraid of his actions but his words
ADJ *of* -ing
16 hen she says. ‘They are afraid of losing their friends. They
17 guy, I was desperately afraid of being alone again and a bi
25 way, both because I was afraid of seeming too needy and bec
26 ld in college – but was afraid of disappointing his father.
ADJ to-inf
46 h sweat. He lay frozen, afraid to close his eyes and fall as
47 in his approach and not afraid to be shocking. We met in San
48 e, to placate them, but afraid to oppose them. Her weakness
49 Family on holiday. I am afraid to say that it looks as thoug

[11] The number of examples for each pattern is reduced to four due to the limit of space. This reduction can be shown by the discontinued serial numbers of concordances.

Through the use of concordances, Hunston and Francis show how the word *afraid* patterns with three different grammatical forms: noun, present participle and infinitive. Hence, they note that "a pattern is a description of the behaviour of a lexical item, or one of the behaviours of that item … to describe everything about the phraseology of a word" (p. 247). Hunston (2001) also states that "a pattern can be used to identify the recurring grammatical behaviour of individual lexical items, and that these behaviours can be represented as grammar patterns" (p.31). Patterns, therefore, "bridge the gap between lexicalisations and rules" (Hunston & Francis, 1998, p. 63).

This means that grammar forms are associated closely with the individual word, rather than its word class. Adjectives, for example, may not pattern with other words in the same ways. The adjective *capable* shares two of the same patterns as *afraid*, but is unlikely to pattern with an infinitive. For instance, someone may be *capable of painting*, but not *capable to paint*. In contrast, *able* often patterns with an infinitive, but not with *of* plus a noun or –ing form. For example, someone may be *able to paint*, but not *able of painting*. Therefore, it is possible to "specify all major lexical items in terms of their syntactic preferences, and all grammatical structures in terms of their key lexis and phraseology" (Francis, 1993, p. 155).

Secondly, patterns are closely associated with meaning, as explained by Hunston and Francis (2000):

> [A] pattern is a phraseology frequently associated with (a sense of) a word, particularly in terms of the prepositions, groups, and clauses that follow the word… patterns are closely associated with meaning, firstly because in many cases different senses of words are distinguished by their typical occurrence in different patterns; and secondly because words which share a given pattern tend also to share an aspect of meaning. (p. 3)

The above definition contains two points on the form-meaning connection. A word may have several patterns, each of which tends to represent a particular word sense. The verb *reflect* is a case in point. It has three main meanings, and each is typically connected with

a specific pattern: V prep, V n; *be* V-ed; V, V *on* n, or V *that*. The connections are demonstrated as follows:

> a. one has to do with light and surfaces, and is exemplified by
> (15) *The sun reflected off the snow-covered mountains* and
> (16) *The glass appears to reflect light naturally*;
> b. another has to do with mirrors, and is exemplified by
> (17) *His image seemed to be reflected many times in the mirror*;
> c. the third has to do with thinking, and is exemplified by
> (18) *We should all give ourselves time to reflect*
> (19) *I reflected on the child's future*
> (20) *Things were very much changed since before the war, he reflected.*
>
> (Hunston & Francis, 2000, p. 255)

Furthermore, a pattern can be associated with a number of specific words, which all share a certain aspect of meaning. For example, not all verbs can fit into the pattern V n n, but those that do fall into five meaning groups. The verbs presented below belong to one of these meaning groups, and are all concerned with 'doing something for someone':

assure	cut	knit	pour
bear (someone a *child*)	do	land	prescribe
book (someone a *room*)	fetch	leave	secure
bring	find	make	sing
buy	fix	mix	wangle
carve	get	order	
cook	guarantee	play	

(Hunston & Francis, 2000, p. 88)

Therefore, there is little separation of lexis and grammar, or distinction between form and meaning, in grammar patterns. It can finally be concluded that a pattern "represents a link between lexis, grammar and meaning" (Hunston, 2002b, p. 168). Romer (2009) explains in more detail:

> Patterns are phraseological items, i.e. neither single words nor empty grammatical structures (the slots of which are filled with words) but results of a synthesis of the two. Patterns show how words are typically associated with each other and how they form meaningful units. (pp. 143-144)

Patterns are found to be so ubiquitous that they can be seen as "the building blocks of language" (Hunston, Francis, & Manning, 1997, p. 215). This is so-called 'pattern flow', a common phenomenon that "each utterance moves from one pattern to another" (Hunston & Francis, 1998, p. 68). More examples for 'pattern flow' can be found in Hunston and Francis (2000, pp. 207-224). PaG is intended to be a descriptive grammar based on the ubiquity of pattern flow, or patterning. This approach is so integrated that syntax and lexis are fully combined in a single system of language description in PaG:

> In fact, we would prefer ultimately not to use the terms 'syntax' and 'lexis' at all, and to reserve the term 'grammar' for a single descriptive system comprising words and patterns. In other words, we would prefer to speak of one system, rather than of two interdependent systems. (Hunston & Francis, 1998, pp. 62-63)

2.3.2 Benefits for language learning

Patterns, or phraseological items[12], are believed to have multiple benefits for language learning, in that they promote understanding, accuracy, fluency and flexibility (Hunston et al., 1997). Firstly, since patterns are associated with word meaning, they may assist learners in establishing the meaning of unknown words. For example, *coerce* shares the same pattern 'V n *into* -ing' with *force* and *frighten*. Hence, it may be easier for a learner to establish the meaning of *coerce* if they are already familiar with the pattern for *force*, and *frighten*. Secondly, patterns can enhance accuracy of language use, as they provide "detailed information about the behaviour of individual lexical items" (Hunston & Francis, 1998, p. 70), and the information is additionally "not random but is organized by the meaning groups that words having a particular pattern form" (p. 70). Thirdly, by learning patterns rather than isolated words, learners do not need to consider every word separately, so that they may "compose lengthy utterances with the minimum of effort" (Hunston & Francis, 2000, p. 271). Fourthly, if teachers introduce patterns and associated vocabulary together, learners can be encouraged to develop flexibility in expressing ideas.

[12] Phraseological items incorporated in language pedagogy have been given a number of different names, including 'chunks' (N. Ellis, 2003), 'formulaic language' (Meunier, 2012; Wray, 2012, 2013), 'formulaic sequences' (Boers & Lindstromberg, 2012) and 'lexical bundles' (Biber, Conrad, & Cortes, 2004; Hyland, 2012a). The names share something in common, i.e. multi-word combinations that are structured to a greater or lesser extent.

For example, to describe someone liking an idea through different patterns ‘V n n’, ‘V n adj’ and ‘V n *as* adj’ with appropriate verbs, examples may be:

> *She thought the idea a cracker.*
> *She considered the idea brilliant.*
> *She regarded the idea as brilliant.*
> (Hunston et al., 1997, p. 215)

A number of researchers have identified the benefits of using patterns or phraseological units. Boers, Kappel, Stengers, and Demecheleer (2006), for example, found in a small-scale empirical study that helping learners notice and store formulaic sequences could effectively improve their oral proficiency. Similarly, Wood’s (2010) study showed that the development of speech fluency in English as a second language was related to and could be enhanced by the use of formulaic language. The study by (Jiang & Nekrasova, 2007) showed that non-native speakers could have significantly faster understanding of formulaic sequences and responded with fewer errors. Given the patterned nature of language, it is not “unreasonable to propose that phraseology should occupy a central and uncontroversial position” (Granger & Meunier, 2008, p. 247) in language pedagogy.

In short, PaG proposes an integrated and holistic approach to language education in line with other attempts to remove the dichotomy of vocabulary and grammar. Due to the phraseological nature of patterns, the focus on language as consisting of patterns appears to be potentially helpful for language learners.

2.3.3 Pattern-based pedagogical approaches

Given the potential benefits of patterns for language education as discussed above, the researchers who proposed PaG developed a pattern-based pedagogical approach which can be evidenced in their publication of *Collins COBUILD Verbs: Patterns and Practice* (Francis, Manning, & Hunston, 1997). This book, which introduces verb patterns for classroom and self-study use, was adapted from their empirical study on verb patterns - *Collins COBUILD Grammar Patterns 1: Verbs* (Francis et al., 1996). The book *Verbs:*

Patterns and Practice introduced more than 100 basic verb patterns to students, and each pattern was explained with the associated verbs listed in meaning groups. In addition to the pattern-centred organisation, the book also featured a wealth of examples as course and practice materials. Due to the density of authentic language examples, the book was suitable for intermediate learners of English or higher.

Other language educationalists, some of whom may be influenced by the work of Hunston and Francis (2000), have also advocated and developed pattern-based approaches for language teaching and learning that attempt to blur the boundaries between vocabulary and grammar. These efforts include *Natural Grammar* (Thornbury, 2004) and the Lexical Approach (M. Lewis, 1993, 1997).

Natural Grammar, a language teaching course developed by Thornbury (2004), indicates that a holistic integration of grammar and lexis is potentially beneficial for students. In contrast to a traditional language teaching course, which is based around a number of discrete units, each one focusing on one or several grammar points, Thornbury used 200 frequently used words ('keywords') to explain basic grammar. For example, he used the pattern 'past participle + *by* + noun phrase' to explain passive voice. The content is organised along an alphabetic word list, so in contrast to most language teaching conventions, the introduction to *a*/*an* (indefinite article) is separated by some distance from the introduction to *the* (definite article). In the introduction section, Thornbury (2004) provides the reason for organising the grammar book around words: "[v]ery simply, words have grammar" (p. i), and he believes that learning English grammar through words is natural and hence helpful to students. As well as grammar notes attached to each key word, detailed grammar patterns, collocations and set phrases associated with the word are also included. It seems that learners are expected to learn grammar in Thornbury's *Natural Grammar* by observing how a word forms certain structures with other words. For example, a number of patterns with *stop* are set out: *stop* + -ing (*stop running*), *stop* + *to*-infinitive/*for* (*stop to think about*, *stop for lunch*). It should be noted that the grammar patterns used by Thornbury are very close to the multi-word units used in the development of PIC.

The Lexical Approach is a lexis-centred method of language teaching developed by Lewis in the 1990s. Lewis (1997) gives a brief summary of the Lexical Approach as follows:

> [L]anguage consists not of traditional grammar and vocabulary but often of multi-word prefabricated chunks. Teachers using the Lexical Approach will, instead of analysing language whenever possible, be more inclined to direct learners' attention to chunks which are as large as possible. (p. 3)

This summary stresses two major principles of the Lexical Approach. Firstly, the dichotomy of vocabulary and grammar is invalid, and secondly, the learning of multi-word chunks is a central task for language teaching and learning. Regarding the first principle, Lewis views grammatical structures as subordinate to lexical units. As he notes, "[l]anguage is grammaticalised lexis, not lexicalised grammar" (Lewis, 1993, p. vi). Thus, language learning involves the mastery of a variety of lexical items rather than the grammatical system. One point that should be noted is that 'lexis' in Lewis' Lexical Approach comprises "different kinds of multiword chunks" (1997, p. 15) rather than isolated words, and as stressed in the second principle, "raising students' awareness of, and developing their ability to 'chunk' language successfully" (Lewis, 1993, p. vi) becomes central to language teaching. Learners are expected to understand and produce lexical chunks to achieve smooth communication of meaning. Chunks as a phraseological concept share much with grammar patterns.

Compared to the above attempts to introduce grammar patterns directly into the classroom, patterns seem to have been better recognised and integrated in lexicography (Krishnamurthy, 2008). This is especially the case in the development of learners' dictionaries. In fact, it was noted that Hornby's emphasis on the patterned nature of English had a profound influence on generations of the development of the *Oxford Advanced Learners' Dictionary* (see Hanks, 2008). Klotz (1999) examined the coverage of patterns in leading learners' dictionaries to find that more grammar patterns could be included in the dictionaries. He also showed that verb patterns were in general the most strongly represented in the learners' dictionaries, followed by noun patterns and then

adjective patterns. Among other learner dictionaries, one that provides a central emphasis on patterns is the *BBI Combinatory Dictionary of English* (M. Benson, Benson, & Ilson, 2010; the first edition dates back to 1986). The benefits of including patterns in dictionaries is pointed out by Hunston (2004) who states that grammar patterns can help present grammatical information to non-expert learners.

The *BBI Combinatory Dictionary of English* (M. Benson et al., 2010) is a specialised learners' dictionary designed to help English learning by identifying collocations and semi-fixed combinations of words. The dictionary divides collocations into two groups, grammatical collocations and lexical collocations, both of which are in fact related to grammar. A grammatical collocation is associated with a 'dominant word' involving a special grammatical construction, e.g. *adhere* (*to*). A lexical collocation, on the other hand, tends to have more general grammatical structures, such as verb + noun (*a dog barks*, under the entry *dog* or *bark*). This dictionary lists grammatical collocations and lexical collocations under an entry, in addition to common word definitions, so it includes a considerable amount of word-associated grammar information. When looking up a certain word in the dictionary, learners are exposed to related grammatical information so as to learn English more holistically.

2.3.4 Patterns in Context (PIC)

Granger and Meunier (2008) believe that teachers and learners should find needed phraseological information rapidly and easily, and that "the phraseological (r)evolution in language learning and teaching will be electronic or will simply not be" (p. 248). The introduction of Patterns in Context (PIC) in this research aims to retrieve word-associated patterns from corpora, so that learners can be exposed to this type of phraseological unit directly through the use of concordance lines. Influenced by the contributions of PaG and DDL, PIC uses a pattern-based approach to concordancing in order to make the search and recognition for patterns in concordancing software easier and faster. This section expands on Section 1.4 of Chapter 1 by providing a more in-depth explanation of PIC. It

firstly explains the relationship between PIC and PaG, followed by detailed examples describing how PIC works.

Differences between PIC and PaG

PIC, an acronym for 'Patterns in Context', is a proposed search and retrieval method for pattern concordancing. PIC draws upon the notion of 'grammar patterns' in PaG (Hunston & Francis, 2000) as described above. However, there are two important differences, both of which address some of problems identified with PaG at the pedagogical level.

Firstly, while PaG organises patterns into meaning groups, the categorisation of these meaning groups is complicated and messy. As an example, for the essential pattern 'V', there are as many as 24 meaning groups identified by Francis et al. (1996), containing hundreds of verbs with various senses. This can result in a number of problems. Learning these simple patterns, for instance, requires a challenging bottom-up focus where teachers may have difficulty explaining the meaning groups, and students are likely to be daunted when confronted with the large number of verbs. In addition, there is also often a lack of one-to-one correspondence between a pattern and a meaning group. As Hunston and Francis (2000) admit, "there may well be a 'ragbag' of words which do not fit into any other meaning group" (p. 256). For example, 32 verbs are listed for the pattern 'V *of* n', and grouped into five meaning groups, such as 'talking' (*complain*, *speak*), 'to know' (*learn*, *know* and *hear*) and so on, while there are five verbs (*beware*, *come*, *die*, *partake* and *permit*) that do not fit in any group. It may be difficult for learners to acquire these exceptions, which in fact account for a considerable share of the 32 listed verbs.

In contrast, PIC focuses on grammatical constructions of word combinations rather than meaning grouping. For example, when learners encounter the word *approve*, they will be presented with examples of the patterns associated with the word: 'V n' (*approve a plan*) and 'V *of* n' (*approve of smoking*). They will not be informed that some words with opposite or irrelevant meanings, such as *disapprove* and *boast*, share the same patterns. In this way, learners are encouraged to pay attention to the lexical behaviour of individual words with the focus on the recurrent and fixed structures of associated patterns.

Secondly, the treatment of word-class information presents a dilemma for PaG. PaG, which takes a corpus-driven approach, aims to build a whole new system of language description and explanation based on the raw data collected (Tognini-Bonelli, 2001). A corpus-driven approach, therefore, prefers as little annotation as possible (ideally no tagging at all), and involves the manual processing of raw language data (see McEnery et al., 2006). In PaG, word-class information is seldom referred to in pattern identification, since it is believed that "the division into word classes may be seen as a matter simply of administrative convenience, rather than a reflection of the language" (Hunston & Francis, 1998, p. 70). However, the description of patterns has to use word-class information (and some pre-existing syntactic terms like 'clause'), since there is no newly-built system of signs on an entirely lexical basis to describe the grammatical items. The other problem with the exclusion of word-class information is that it makes the observation of patterns laborious and often inconclusive. Hunston (2013b) admits that manual observations of textual patterning are "inevitably 'messier'" (p. 618) and therefore difficult for learners.

In contrast, PIC relies on the established word class system and part-of-speech (POS) tagging to retrieve patterns from corpora. Lu (2014) has shown that the examination of patterns using POS categories is well recognised and accepted. Although inaccurate tags may cause incorrect results (see Appendix E), it has been evidenced that POS-based concordancing can make patterns more easily accessible to non-expert learners.

PIC profile

On the technical level, PIC is an acronym for 'Patterns in Context', a concordancing method derived from KWIC (Key Words in Context). Unlike KWIC that mainly deals with individual words (and phrases), PIC retrieves KWIC results which share the same pattern and presents them as a list of aligned concordance lines. The practice of PIC is not newly created and coined; in fact, observing the patterning behaviour of a word can be carried out in KWIC concordancing, albeit with some effort (Partington, 1998). However, the focus on the term 'Patterns in Context' and the use of its acronym PIC may help non-expert users become more aware of this extended concordancing method and

the importance of pattern-focused grammatical constructions. There are three aspects where PIC is distinct from the traditional KWIC method.

Firstly, PIC can focus on one pattern of a certain word class. For example, *need* can serve as a general verb, as in the pattern '*need* + *to*-infinitive' (*need to go*), or a noun, as in the pattern 'adj. + *need*' (*great need*), and also a modal auxiliary, as in the pattern '*need* (*not*) + verb' (*needn't stay*). PIC can search and present the concordances which contain only the noun usage of *need* while excluding the other patterns.

This feature relies on POS tagging and regular expressions ('regex' in short), which have been utilised in lexicography for a while. The POS-based searching of patterns in PIC cannot be fully achieved in KWIC with plain texts. Wildcard symbols ('*' in particular) are often used in KWIC to retrieve 'fuzzy' results, i.e. the matched results may not be exactly identical to the search term but allow for inflections and different noun phrases. For example, using the string '*do**' as search term will also include searching *do*, *doing*, *don't* and *does* in one query. However, the irregular form *did* is excluded from the search, since it does not match the search term from the second letter (using '*d**' to search will produce too many irrelevant results, e.g. *dad*). In addition, wildcards themselves vary a lot across different operating systems. Furthermore, no POS filtration can be conducted on the matched strings in KWIC. For example, it is impossible to retrieve only the noun usage of *need* in KWIC, since different word classes of *need* share the same letters and order.

PIC extracts matched results from POS-tagged texts by using regular expressions. A regular expression is a sequence of characters that forms a search node to match a string of characters. Regex including POS tags can match words or combinations of words with certain word classes. Geeb (2009), for example, provided an example of searching "HOME COOKING" via regex. Wider application of regex with POS tags can also be seen in many online concordancers which use the corpus query language (CQL) (Kilgarriff & Kosem, 2012).

However, both POS tags and regex can be dauntingly complex for non-expert users. As a result, in the APIC app designed for this research, all PIC searches are based on prepared regex, i.e. learners may simply enter search words and click buttons as instructed to get generated PIC concordances without formulating the regex themselves. In addition, the POS tags are removed before the PIC results are presented on the screen for comfortable reading and to make the search process more accessible. The regex strings used in this research are all set out in Appendix E. As the matched patterns are probably not of the same length, the PIC results cannot be aligned right in the middle as in KWIC, but they can still be highlighted by other means, e.g. colour.

Secondly, PIC is capable of lemmatisation and is insensitive to inflections, i.e. changes of word forms. In other words, one search in PIC can cover all lemmas of the search word, e.g. the plural form of a noun and the past participle of a verb. With this feature, a user may launch a single query of a word without a clear knowledge of its inflections, especially irregular changes. The inflection-insensitive function has been developed and adopted in some online portals providing keyword concordancing, such as Sketch Engine. However, for concordancers at large, it seems that inflection-insensitivity is not available during word queries.

Thirdly, and most importantly, PIC focuses on the grammatical structure of a certain pattern, and accurately retrieves matched results. As may be noted, the components of a pattern construction, especially noun phrases, may vary a lot in specific words across different examples. A noun phase here is defined as having a core noun or pronoun with changeable and optional adjectives, adverbs, articles, determiners and other modifiers. This makes it more challenging for a learner to find out a pattern through manual observation out of various word combinations. For example, the pattern '*leave* + noun phrase + adj.' is shared by many different word combinations, e.g. *leave me alone* and *don't leave your belongings unattended*. Learners may probably fail to notice the pattern when it is mixed with other usages of *leave*. PIC can accurately extract examples of this usage out of all patterns with *leave*, whatever the noun phases in the middle of the pattern

may be. The following are four PIC concordance lines retrieved from academic texts (the matched patterns are placed in square brackets to highlight):

constituent part of society) [leaves it susceptible] to criticism from psychologists
who found Nora 's decision to [leave her family insupportable] , perhaps did not appreciate I
information recorded logically [leaving the information fragmented] and dislocated. //This
but even hive pests were [leaving these colonies alone] . /Now bees have periodically

It can be seen that PIC retrieves only the results of the pattern '*leave* + noun phrase + adj.' while allowing for different forms of objects in the middle of the pattern, i.e., *it*, *her family*, *the information* and *these colonies*. By organising the search results in this way, the pattern is made much more conspicuous and accessible to untrained eyes of common users, as the same structure is presented recurrently in the middle of a number of aligned examples, despite a range of different lexical combinations. In contrast, observation by word order at a glance may produce wrong pattern results. For example, in the KWIC results of the search word *leave*, the example *she left me ruthlessly* seems like one under the above pattern, as *ruthlessly* here may be taken for an adjective. PIC, however, can recognise this is an adverb and thus screen out the wrong examples associated with it. The aim is for PIC to reach a high level of diversity and accuracy in pattern concordancing. Furthermore, since PIC results have already been selected around patterns. Hence, sorting, a common function in KWIC to help identify collocations and further patterns, is not necessary in PIC.

In conclusion, PIC is designed to make frequent multi-word patterns more observable and accessible to learners by exempting the non-expert users from the demanding technical requirements usually associated with pattern-focused concordancing. In this research, the approach is integrated into the mobile platform to make a PIC search more convenient and accessible for students. Furthermore, as long as the central elements of DDL can be maintained, the affordances of emerging mobile technology can be integrated to enhance the PIC experience. The following sections will therefore review the literature on language education with technology, in particular emerging mobile technology.

2.4 Learning with technology: From computers to smartphones

While computer-assisted language learning (CALL) has been well-established in the context of language education (Davies, Otto, & Rüschoff, 2013), 'mobile learning' or 'm-learning' is beginning to gain a foothold in educational settings with recent development of mobile technology (Traxler, 2009a). Accordingly, MALL (mobile-assisted language learning) has also attracted increasing attention (Godwin-Jones, 2011; Kukulska-Hulme, 2009b). This section focuses on CALL and MALL in the wider context of e-learning and m-learning.

2.4.1 CALL: Past, present and future

CALL is broadly defined. Levy (1997), for example, has described CALL as "the search for and study of applications on the computer in language teaching and learning" (p. 1). The history of CALL spans more than half of a century since the 1960s (see the recent review by Davies et al., 2013). Hence it has been a well-established field, evidenced by a large body of ever-expanding literature on a large number of topics. As early as three decades ago, there was already a book-thick bibliography of CALL, consisting of 240 pages (Stevens, Sussex, & Tuman, 1984); about 10 years ago, Jung (2005) developed an international bibliography of CALL, containing a total of 5,301 entries, most of which have been published since the turn of the century. These studies have shed light on how computer-mediated technology can be applied to language learning.

The development of CALL can be divided into three phases, according to a widely recognised classification by Warschauer and Healey (1998): *behaviouristic* (until the 1980s), represented by repetitive language drills; *communicative* (1980s-1990s), focusing on language use and encouraging learners to generate original utterances with computer-assisted activities; *integrative* (1990s onwards), featuring not only integration of language skills but full integration of technologies, including recent multimedia and interactive technologies. Bax (2003), however, disagrees with the phases as they are historically confusing and based only on underlying theories of learning. He shifts his classificatory

focus to actual CALL practice, which includes the software and activity types in use, the teachers' role, and the feedback offered to students. Consequently, Bax labels the first stage as *restricted*, as these dimensions were relatively restricted, and the second stage as *open*, as there was an increasing openness in these dimensions; the third stage is marked as *integrated*, which is similar to Warschauer and Healey's description. However, Bax (2003) believes that "does not yet exist to any significant degree, but represents instead an aim towards which we should be working" (p. 22). Table 2.3 sets out the historical phases of CALL with the terms used in the above two classification systems, and corresponding timeline, computer upgrading and linguistic theorisation.

Table 2.3 Historical Phases of CALL

Warschauer's terms	Behaviouristic	Communicative	Integrative
Bax's terms	Restricted	Open	Integrated
Timeline	1960s – 1970s	1980s-1990s	21st century, or yet to come
Technical basis	Mainframe machines	Personal computers	Multimedia networked computers
View of language	Structural	Cognitive	Socio-cognitive

As can be seen from the above Table 2.3, the development of CALL is not only directly influenced by technical advances (Levy, 1997), but reflects the evolution of pedagogical theories and practices over time. For example, during the first phase, large and expensive mainframes could not handle tasks beyond drill-like exercises based on formal rules, nor could they provide a user-friendly interface to users throughout the input-output process. From a pedagogical perspective, this was problematic because grammar drills on the computer had few advantages over what could be delivered by teacher instructions and textbook, and worse still, the practice was counter to the emerging consensus on communicative language learning (J. Thomas, 1986).

Contrary to the early limitations, technical development during the 1980s and 1990s, especially the advance of artificial intelligence (AI), made it possible for CALL to keep abreast of new developments into language education. The advent of more powerful personal computers, with increasingly user-friendly input and output mechanisms (e.g.

graphic interface, multimedia features, etc.), resulted in a shift towards user-computer interaction, in that more importance was attached to what learners could do with the software, than what programs themselves could do (Jones, 1986). The maturity of so-called 'humanistic CALL' (Fox, 1985), which emerged with the developing trend of communicative language learning, was considered greatly significant:

> This watershed development has not only brought CALL more in line with current thinking about language teaching methodology, but also heralds the emergence of CALL as a versatile tool, as an aid to learning, and as an informant on language rather than a preceptor, task-master, or programmed instructor. (Stevens, 1992, p. 11)

This progress introduced a new dimension, referred to as 'intelligent CALL' (Chapelle, 1989), in which, with the help of improved AI, computers could respond to students in a way similar to human interaction. For example, computers could provide checkers to correct surface grammar features as a human instructor could do. Nyns (1989) believed that it was possible for ICALL to be employed by teachers and learners in language pedagogy despite technical limitations at that time. As a result, ICALL was a popular topic in this phase. A bibliography on ICALL in the mid-1990s (Bailin, 1995) contained over 200 entries, including theoretical explorations and specific applications. Although ICALL is not widely discussed at present, 'intelligence' has become an integral and intrinsic attribute of CALL (Davies et al., 2013; Schulze & Heift, 2013).

CALL "consolidated itself as an innovative field of research and practice" (M. Thomas, Reinders, & Warschauer, 2013a, p. 1) during the 1980s and 1990s, i.e. 'communicative' and 'open' phase. By this time, CALL advocates had been able to confidently proclaim that activities with computer programs can cover "the whole range from expository teaching to discovery learning" (Ahmad, Corbett, Rodgers, & Sussex, 1985, p. 57). This phase was a significant period for CALL as increasing technological and methodological developments generated a positive outlook. For example, teachers were encouraged to learn programming to better promote CALL in their daily work (M. Kenning & Kenning, 1983). Perhaps the most optimistic prediction came from Higgins (1988), who believed

that computers would "soon get taken for granted" (p. 103) in language education, and that after 10 years (namely in 1998), any debate regarding the introduction of computers in learning would be irrelevant as CALL would be the natural state of affairs.

Despite the optimism of the communicative phase, whether we have entered the third integrative/integrated phase is still in question. Although there has been a noticeable shift in education from a focus on whether technology should be used at all, to a focus on how to best utilise technology (Finger, Russell, Jamieson-Proctor, & Russell, 2007), the vision of 'taken for granted' computer use in language education (Higgins, 1988) has not been achieved, and is perhaps unlikely to be realised in the near future. As Warschauer (1998) notes, the continued existence of the popular term CALL, in contrast to the absence of terms such as 'BALL' (book-assisted language learning), 'PALL' (pencil-assisted language learning), or 'LALL' (library-assisted language learning), suggests that computers are not yet a fully integrated part of the language learning process.

To counter this lack of uptake, the full integration of technology into language learning, referred to as CALL normalisation (Chambers & Bax, 2006), has now become a central focus of CALL studies. The concept has been clearly defined as:

> A technology has reached its fullest possible effectiveness in language education when it has arrived at the stage of 'normalisation', namely when it is used without our being consciously aware of its role as a technology, as a valuable element in the language learning process. (Bax, 2011, p. 1)

Bax (2011) points out that CALL normalisation involves not only technology, but also "a host of social and cultural elements operating together in complex ways" (p. 13). This is presently taking place using a technology standard, which has been developed by the TESOL Association for both language learners and teachers (Healey et al., 2011). The technology standard involves goals for learners and teachers. Learners, for example, are required to have competent knowledge and skills in using various technological tools and devices in "socially and culturally appropriate, legal, and ethical ways" (Healey et al., 2011, p. 1). They are also expected to critically evaluate the technology they use in the

classroom. Teachers are required to understand how technology can enhance language teaching, improve learner assessment, and assist collaboration with peers, students, administrators and other stakeholders. This is a 'blueprint' for CALL normalisation in every aspect of language learning, and the goals set for teachers involve almost every role in language education. When the goals are fulfilled, CALL will be genuinely taken for granted.

In addition to the two 3-stage interpretations of CALL history mentioned above (Table 2.3), Walker and White (2013) proposed a fourth phase, naming it 'technology-enhanced language learning (TELL)'. In their opinion, TELL includes a wider range of devices beyond simply the computer, for example, mobile devices, tablets, multiplayer games and online virtual worlds, objects which are all now fully integrated into our everyday lives. However, I would argue that the TELL stage is a redundant categorisation, as it is very similar to CALL normalisation mentioned above.

2.4.2 CALL and autonomous learning

Definition of learner autonomy

Both theoretical discussions and empirical studies acknowledged that CALL produces "a lot of favourable learning outcomes" (Fotos & Browne, 2004, p. 9). One of the most significant of these benefits is enhanced learner autonomy. Learner autonomy, defined in a simplified way, means "taking control of one's own learning" (P. Benson, 2001, p. 47). It also involves control over management of the learning process, pace and mode of learning, control over material selection and control over learning content (P. Benson, 1996, 2001). For Little (2003), the major benefits of learner autonomy may lie in motivation and effectiveness. He believes that the essence of learner autonomy is willing, proactive and reflective involvement in one's own learning (Little, 2007). Therefore, the problem of motivation is automatically solved, and autonomous learners tend to learn more actively. Secondly, since "success in learning very much depends on learners having a responsible attitude" (Scharle & Szabo, 2000, p. 4), autonomous learners responsibly engaged with their learning are more likely to obtain concrete learning outcomes.

Affordance and constraints of learner autonomy

It is believed that there are opportunities for learner autonomy in the development and use of CALL technologies (P. Benson, 2007). A recent review of CALL benefits by Reinders and Hubbard (2013) indicates that technology can potentially support teachers and learners with new resources and methods, but it also poses a number of challenges, especially regarding self-directed learning skills as well as technological proficiency; they set out a range of affordances and constraints of CALL for learner autonomy, which are divided into two broad groups; those having mainly organisational or practical advantages (e.g. cost efficiency) and those that are more pedagogical (e.g. learner feedback). Table 2.4 provides a summary of the details.

Table 2.4 Affordances and Constraints of CALL for Learner Autonomy

Aspect	Affordances	Constraints
Organisational dimension		
Access	A level of access to resources that were impossible before; reliant less on scarce or unavailable teacher support	Being distracted or interrupted constantly, or swamped by data
Storage and retrieval	Easy storage and retrieval of materials and learning records for review and monitoring	Content indexing and locating
Sharing and recycling of materials	Pedagogical materials can be easily created, shared and updated	Legal issues during creating
Cost efficiency	Relying less on teachers, reducing the cost of language materials	Better materials which carries expenses that may not be favoured
Pedagogical dimension		
Authenticity	Using real-world materials that are relevant to their individual interests	Different discourse in the digital world; incomprehensible input far beyond the students' level
Interaction	Easy connectivity with others; corrective feedback readily given by software	Either a distorted view of target language use, or too difficult language input
Situated learning	Having support and tools in real-world settings	Selecting the right range of situations
Multimedia	More control on input	Possible distractions; inconsistent quality of online

		resources
Activities	New types of activities through new tools	Without a suitable pedagogical foundation
Non-linearity	Displaying content dynamically	Distraction
Feedback	Delivering immediate and personalized feedback	Very limited programmed feedback
Monitoring and recording	Access to learning behaviour and progress	A lack of reliable student models
Control	Accessing materials when and where they need to, and be provided with varying levels of support	Need an understanding of what control options there are and when to use
Empowerment	Making decisions or choices themselves	Not prepared to use the granted power effectively

Problems with learner autonomy

It can be seen from Table 2.4 that a number of problems impede CALL from enhancing learner autonomy. Two major problems include the reliance on the teacher's role, and the requirement of self-motivation for autonomous learning.

Concerning the first problem, CALL is largely dependent on teacher intervention and classroom instruction. According to Horton (2001) "it is not computers teaching people" (p. 5). Instead, the computer often serves as a supporting resource, which requires setting up by the teacher. It is pointed out that in CALL the teacher often takes charge of more communicative tasks like analysis, diagnosis and assessment, while the computer is involved in the less communicative jobs such as manipulation of learning materials (R. Lewis, 1986). Similarly, although Higgins and Johns (1984) have suggested that the computer should play an active and dominant role in the classroom, reducing the teacher to a routine manager, responder, facilitator, model and informant in CALL activities, the teacher is ultimately still required to show learners what to do and how.

Since the teacher still holds an indispensable role in CALL, it is unlikely that learners will become fully autonomous. This is true, even in the computer lab where each student is given a designated computer and typically has only restricted access to CALL in a fixed location at a fixed time. Klopfer (2008) notes that "the computer room paradigm is

problematic in practice" (p. 62) and illustrates in detail a scenario describing how a computer-assisted class can be ineffective because of trivial things like students forgetting their ID or password, and computer breakdowns.

In short, the reliance of CALL on the teacher-classroom paradigm is a major hindrance to its potential contribution to learner autonomy. If the teacher has to intervene at all times in a CALL class fixed in a classroom, taking control of what, when and how to do learning activities, there is little difference from formal learning in the classroom. In this framework, fully autonomous language learning cannot really be achieved, and the potential that CALL offers cannot be delivered.

The second problem exists because autonomy is both an outcome and a prerequisite of CALL. CALL and learner autonomy are in fact both part of a mutually supportive cycle, that is, autonomous learners are enhanced by CALL, while CALL is enabled by learners' self-motivation, self-discipline and self-direction. This point is supported by Blin (2004), who agrees that CALL applications can help promote the development and exercise of learner autonomy, "provided that learners are already significantly autonomous" (p. 381). Hence, due to the requirements of learning skills and technology literacy, CALL is often restricted to advanced learners at university-level institutions. Despite the enthusiastic proposals to integrate CALL into primary and elementary education (e.g. Hall, 2010; Siraj-Blatchford & Whitebread, 2003), it is noted that "schools are the only institutions that appear to be largely resistant" (Somekh, 2006, p. 176). Emerging technologies, such as the mobile platform, may provide some alternatives to less skillful learners.

2.4.3 Evaluation of efficacy and efficiency of learning in CALL

It is difficult to evaluate the efficiency and efficacy of learning in CALL. According to Hubbard (2003), this is because "the computer potentially interacts with all the key variables in language learning - teachers, learners, methods, materials, and environments", and as a result "CALL research may involve all dimensions of instructed second language learning" (pp. 141-142). Even enthusiastic advocates of CALL admit that the pedagogical

effects are difficult to monitor and measure (Chapelle, 2007; Chapelle & Jamieson, 1991; Golonka, Bowles, Frank, Richardson, & Freynik, 2014; Leakey, 2011). Despite the large number of CALL studies over the past decades as mentioned above, evaluative research among them is limited. Instead, "most CALL studies seem to focus on either describing the affordances offered by particular types of technology or measuring their effects on students' affective reactions, such as increased motivation or increased enjoyment of learning activities" (Golonka et al., 2014, p. 92).

Consequently, CALL has been under regular scrutiny about its pedagogical relevance, validity and effectiveness (Ahmad et al., 1985). During the past three decades there has been much discussion particularly on how to conduct research that evaluates CALL's effectiveness. Dunkel (1991), for example, reviewed and also proposed 20 research questions for evaluating CALL, including whether CALL is more effective for certain skills areas, whether it is more helpful for learners at certain levels of proficiency, and so on. Chapelle and Jamieson (1991) examined the factors required for internal validity (whether the research results can be attributed to the studied factors) and external validity (whether the results can be generalised) of CALL evaluation research; they suggested that, to be internally valid, the measure of language improvement needs to be free from the influence of unaccounted for variables, which are not easy to clearly identify and exclude, and that to ensure external validity, a sufficient amount of demographic and procedural information needs be provided in the report. In Chapelle's (2001) book on computer applications in applied linguistics, a separate chapter was used to explain and demonstrate in detail how to conduct judgmental and empirical evaluation of CALL, with a set of 12 broad research questions across six categories. In spite of the early awareness and continuous effort, to date there has been no single rubric or set of concrete guidelines available to provide CALL educators with a fair, complete, and consistent model of evaluation (Leakey, 2011). Evaluation of CALL effectiveness remains a major challenge even now (Levy, Hubbard, Stockwell, & Colpaert, 2015).

Meta-analyses of evaluative research fail to provide satisfactory results, and also reveal some problems. When CALL was initially on an upward trajectory at the beginning of

the 1980s, it was found that computer-based instruction made small but significant contributions to college teaching, since the time needed for instruction was substantially reduced (Kulik, Kulik, & Cohen, 1980). Zhao (2003) reviewed nine selected studies published in leading CALL journals from 1997 to 2000, to reach only a modest conclusion that CALL is, at least, not inferior to human teachers. Zhao's review also mentions a few other limitations of CALL research, for example, the lack of systematic studies and short observation periods; other problems can be seen in Huh and Hu (2005). Felix's (2005b) review of more than 150 papers after 1990 showed that there tended to be small gains related to L1 spelling, writing and reading, but the findings were mostly equivocal. Felix (2005a) reviewed another 150 papers published from 2000 to 2004, to find that related investigations increasingly combined quantitative and qualitative methods and focused primarily on learning processes. Another positive trend was that complex designs which compared different types of CALL were favoured more than simple comparison studies between CALL and traditional classroom learning.

Felix (2008) also carried out a large scale meta-analysis which included the 300 studies from the previous two reviews, as well as additional 192 papers (published between 1981 and 2005) from a third study. He found that the positive effects of CALL can be seen in the areas of spelling, reading and writing, and that students generally hold a positive attitude towards working with computers. He also found two overarching problems with many of the studies: a poor description of research design, and a poor choice of variables. Finally, a recent meta-analysis reviewed a selected collection of 37 CALL studies from 1970 to 2006 (Grgurović, Chapelle, & Shelley, 2013). The positive pedagogical gains from technology-supported teaching and learning remained so small, that the final conclusion of the meta-analysis was that "the overall results did not indicate that CALL was inferior to classroom conditions" (p. 192). This conclusion is hardly different from that of the first study carried out more than 30 years ago. This means, in spite of the rapid and widespread development of CALL, its effectiveness for language education is potentially still in doubt.

In short, it has been shown that CALL can help produce small learning outcomes, and is

accepted by learners in general. However, the results are not universal or widely recognised. In the light of the enormous amount of investment in technology equipment and facilities in the past decades, this answer is not particularly sufficient. More research evaluating the efficacy and efficiency of CALL is needed and perhaps new research perspectives beyond measuring effectiveness should be taken. As Blin (2004) notes, attention should be paid not only to evaluating the effectiveness of the individual features and functions that CALL incorporates, but to the extent that these functions can be used effectively in wider learning contexts and how they might contribute to building learner autonomy. The next section looks at technology-enhanced language learning on the mobile platform.

2.4.4 M-learning and MALL

Given that it is rapidly evolving, there is no accepted single definition of mobile learning (Hockly, 2013; Traxler, 2009b). Kukulska-Hulme and Shield (2008) provide a starting point by suggesting that mobile learning "refers to learning mediated via handheld devices and potentially available anytime, anywhere" (p. 273). In order to explain the nature of m-learning and its influence on the research carried out in this thesis, in the following sections, the researcher will provide a historical review of m-learning and mobile assisted language learning (MALL) and in doing so articulate the key attributes and issues.

Background

In an early article, Godwin-Jones (1999) explained how mobile technology could offer "exciting opportunities" (p. 7) for an enhanced learning experience. Since this time, the terms, *mobile learning* ('m-learning'[13]) and *mobile-assisted language learning* (MALL) have become common usage in the educational context. The practice of m-learning and MALL, however, dates back to the early 1990s (Burston, 2015). Mobile devices at this time were no better than a paper notebook in functionality, memory and convenience, and

[13] As with its precedent 'e-learning', m-learning does not have a standard spelling, and terms such as 'm-Learning' and 'mLearning' can be found in the literature.

hence the m-learning experience during this period was neither revolutionary, nor satisfactory. The remarkable proliferation of m-learning and MALL commenced at the beginning of this century. Crompton (2013), who cited the greatly increased number of Google searches for 'mobile learning' in 2005, notes that 2005 was the year when it became a recognised term. The acronym MALL was thought to have emerged in 2009 with the appearance of mobile 'apps' for English learning developed by the British Council (Hockly, 2013). However, Chinnery (2006) expressly proposed 'going to the MALL' at least three years before this date.

The lighter, faster and smarter specifications of the pioneering mobile devices, i.e. the first iPhone on iOS released in 2007 and the first Android mobile phone - HTC Dream G1, available in 2008, facilitated the increasing interest in m-learning (Godwin-Jones, 2008). These devices could execute complicated tasks and had multimedia capability, which were only previously possible on desktop computers, and therefore could employ resources and materials already used in e-learning and CALL (Godwin-Jones, 2011; Wang & Smith, 2013). They also had the added bonus of being highly portable and increasingly affordable compared to desktop computers.

Table 2.5 Technical configurations

Model	HTC Dream G1	HTC U11	ACER Aspire 4750G
Release date	September 2008	October 2017	February 2011
CPU[14]	528 MHz	64-bit octa-core, up to 2.45 GHz	Intel Core i5-2410M (2.3 GHz)
RAM	192 MB	4 GB	2 GB
ROM	256 MB, extendable to 16 GB by microSD	64 GB, extendable up to 2TB by microSD	320 GB
Screen size	3.2 inch	5.5 inch	14.0 inch
Display	480×320 pixels	920×1080 pixels	1366×768 pixel

[14] As for the technical terms in the table, CPU (central processing unit), which handles all human instructions to the machine, runs faster with a higher frequency (1 GHz = 1000 MHz); RAM (random-access memory) determines how many programs are running, while ROM (read-only memory) indicates how much data can be stored in the device permanently (1 GB = 1024 MB); graphic display from the screen becomes better with larger size and higher resolution.

It was the progression towards what would become defining devices for m-learning and MALL, i.e. smartphones and mobile tablets, that truly released the potential of mobile learning. Table 2.5 lists the configuration details of the first Android smartphone and the latest flagship model produced by the same manufacturer (as of October 2017), and also those of a laptop model at a roughly similar market price for comparison. To put it simply, compared to the ground-breaking model G1, U11 now has seven more processors (cores) working together, each of which is four times more powerful. Many more tasks can be implemented concurrently, and the storage space for all kinds of data (apps, texts, images, audios, videos, etc.) has been enlarged 256 times, not including the extendable space. The screen has become not only bigger, but also much clearer in display. Another point worth noting is that the latest model is no less powerful than an equally-priced computer in key configurations. It is only smaller in screen size and storage due to different usage.

The potential that developments in recent mobile technologies have created for learning are more evident when they are compared to those of the pre-smartphone period. For example, the small screen size of early mobile phones used to be a major hindrance which discouraged people from learning. Wang and Higgins (2006) noted the problem of display on mobile phones, among other limitations, stating that "as of September, 2005 most mobile phone screens are between 1.5-2.6 inches in size…The highest image resolution so far on mobile phones is just Q-VGA 240 x 320 pixels" (p. 6). It can be seen in Table 2.5 that even the first Android model had greatly improved the poor display quality. A few years later, Wang and Smith (2013) acknowledged that many of the problems mentioned in 2006 did not exist any longer due to advances in information technology, and they also stressed that the convenience and connectivity of mobile devices to internet networks were now just as capable and as fast as desktop computers.

With the rapid and continuous development of mobile technology m-learning has secured its foothold and "continues to gain identity and definition rather than lose them" (Traxler, 2009b, p. 2). However, in academia m-learning is often implicitly considered a derivative or a branch of e-learning. Correspondingly, MALL is often treated as an extension of CALL on the mobile platform. For example, in a book covering technologies for learning

from print to the mobile phone, the discussion of m-learning is affiliated with telephony for learning (M.-M. Kenning, 2007). In another book, learning via mobile telephones is thought to be one of the applications of CALL (Beatty, 2010). At the same time, there are a very limited number of journals and volumes specifically on m-learning or MALL. As a result, the growing number of articles in this field have to be published in leading CALL journals, such as *CALICO Journal*, *Computer Assisted Language Learning* and *ReCall*. Many edited books on CALL and e-learning contain a large proportion of papers on m-learning and MALL (e.g. Levy, Blin, Siskin, & Takeuchi, 2011; M. Thomas, Reinders, & Warschauer, 2013b).

There is little doubt that m-learning is a new phase of technology-enhanced learning. However, merging the discussion of m-learning with other technologies, which have already been well researched, will result in many of its unique features being overlooked. Similarly, it is potentially problematic if the principles and practices of e-learning and CALL are uncritically or directly transferred to m-learning and MALL. It is true that m-learning and e-learning share a lot in common (Traxler, 2005), but, in short, m-learning is not e-learning on mobile devices (Feser, 2015). It is obvious that m-learning has been developing in technological, social and conceptual contexts which are different from that of e-learning. Feser (2015) maintains that "[t]he differences between those two development paths are so significant that it requires a completely different approach to instructional design, graphic and user experience design, and information presentation" (p. 35). Similarly, MALL is not CALL on the mobile platform (Kukulska-Hulme, 2013). As a result, in the research community, m-learning and MALL are increasingly viewed as independent topics and new studies are emerging (Kukulska-Hulme, 2009b; Miller & Doering, 2014; Traxler, 2005, 2009a), shedding light on their unique features. These features are discussed in the next section.

2.4.5 Key attributes of m-learning and MALL

Mobility

Mobility is viewed as the essential attribute of m-learning, and as a result a crucial

discussion in these new studies is the meaning of 'mobile' in m-learning. Kukulska-Hulme, together with her colleagues, have employed 'context' as the overarching term to cover interrelated aspects of mobility; these include mobility in physical space, conceptual space and social space, mobility of technology, and dispersed learning over time (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Vavoula, 2009). The problem with this framework is the lack of clear layers. Kukulska-Hulme (2009b) also suggested another clear and concise approach to interpreting 'mobile' in m-learning from three dimensions: *the mobility of devices*, *mobility of content* and *mobility of learners*. Thus, while this is not the only way to interpret 'mobility', any comprehensive discussion of m-learning should take into account these three dimensions.

With regard to the *mobility of devices*, hand held, portable devices are central to the m-learning programme, that is, their sheer size and weight enables them to "fit in a pocket or in the palm of one's hand" (Kukulska-Hulme & Traxler, 2005, p. 1). Mobile devices, however, are not limited to mobile phones but cover a range of handheld electronic tools, including the iPad, the iPod, game consoles, eReaders, or even Netbook (Rogers, 2011). Nevertheless, smartphones and their extended form - tablets – are currently the most common mobile devices. They can serve almost all the functions of desktop computers with default apps, and more emerging features are currently being added. Woodill (2015) outlines as many as 25 unique affordances of mobile technology, including geolocation, cloud storage, touchscreens and Internet connectivity, all of which have been integrated in smartphones. Therefore, "it is perhaps the mobile phone that carries the most promise" (Stockwell, 2013, p. 212). This increasingly powerful and versatile handheld tool therefore provides much potential for m-learning. It perhaps should be pointed out that while recent models of laptops and netbooks, traditionally used in e-learning and CALL, have become increasingly portable due to their lighter weight and smaller size, they should still be excluded from the range of devices for m-learning because they "lack true portability and ubiquity as well as penetration of a wide range of social context" (Pachler, Bachmair, & Cook, 2010, p. 7). As Iversen and Eierman (2014) suggest, "very few people carry a laptop during their every waking hour to every location they visit (p. 1)". In sum, the enhanced mobility of devices such as smart phones and tablets which are constantly

carried and accessed by their users is crucial to m-learning.

With regard to the *mobility of content*, contemporary mobile devices' enormous storage capacity means that a large amount of multi-media learning materials can be kept on hand for use at any time or place required by the learner. These resources and the accompanying data can also be searched, retrieved and presented in an easy and user-friendly way. The mobility of content enables "instant, on-demand access to a personalized world filled with the tools and resources we prefer for creating our own knowledge, satisfying our curiosities, collaborating with others, and cultivating experiences otherwise unattainable" (McQuiggan, McQuiggan, Sabourin, & Kosturko, 2015, p. 8). The quick and on-demand access to materials and resources does not only apply to local data stored in the device itself, but also includes an increasingly vast reservoir of online resources which can be quickly accessed through the Internet using a wireless connection (Cochrane & Bateman, 2010, 2011; Sazalli, 2014). In short, m-learning enables easy and immediate accessibility of both personal and networked resources.

With regard to the *mobility of learners*, one effect of learning mobility is that it facilitates "new ways of dividing up one's time and crossing boundaries" (Kukulska-Hulme, 2009b, p. 160). In a traditional learning context, time and space are two major constraints, as students are required to stick to fixed class timetables, teaching plans and classrooms. Even in the CALL scenario, students often need to sit in front of fixed desktop computers in a special computer room away from their routine locations. However, in an m-learning setting, which "has the potential to transcend these spatial and temporal restrictions" (Kearneya, Schucka, Burdenb, & Aubusson, 2012, p. 4), students simply reach for their mobile. They can then search reference books, watch lecturing videos, or download, stream or access online learning materials before, during, and after class. Thus, mobile learners are provided with more flexibility and freedom and can enjoy the possibility of learning anytime and anywhere (Rogers, 2011). Recent research also shows that the flexible and ubiquitous m-learning environment can offer new study opportunities, and learners tend to be engaged and motivated when learning via mobile technology (Kim, Rueckert, Kim, & Seo, 2013; Sølvberg & Rismark, 2012; Zou & Yan, 2014).

In short, the mobile attribute of m-learning involves not only mobile devices but also mobile content and mobile learners. Other researchers have described this attribute of m-learning as 'untethered' (Masie, 2002), 'unplugged' (Gayeski, 2002) and 'wireless' (Roschelle, 2003), which generally refers to the absence of the cables traditionally associated with desktop computers, but also metaphorically to the lack of ties that the learner has to a specific educational space. M-learning has also been called 'ubiquitous', 'pervasive' and 'ambient' (Kukulska-Hulme, 2005), or 'here and now' learning (Martin & Ertzberger, 2013), which refer to m-learning's "continuity or spontaneity of access and interaction across different contexts of use" (Kukulska-Hulme & Shield, 2008, p. 273).

Personalisation

In contrast to the 'one-size-fits-all' approach to education, personalised learning aims to deliver customised learning experiences to individual learners, "taking into consideration their differences in skills level, perspectives, culture and other educational contexts" (D. Sampson & Karagiannidis, 2002, p. 24). Technology-enhanced learning can support personalisation with tailored content and resources so that learners have greater control over their own learning process (Conole, 2010).

M-learning seems to be particularly supportive of personalised learning. Kearneya et al. (2012) point out that *personalisation*, which they view as a major feature of m-learning, has strong implications for ownership and autonomous learning. Firstly, the new generation of digital natives often own a range of different technologies (Prensky, 2001a, 2001b), including mobile devices. With their personal devices as learning tools, mobile learners may enjoy a sense of intimacy and convenience, and the great control over the pace, time, space, content of learning may lead to a strong sense of ownership of one's learning (Traxler, 2007). Secondly, the timing, location and ways of learning can be customised in m-learning at the discretion of learners, since "mobile technology can assist learners at the point of need and in ways that fit in with their mobile lifestyles" (Kukulska-Hulme, 2009b, p. 162). They can have access to appropriate resources potentially anytime and anywhere to meet their individual learning needs, and they can initiate, structure and

direct their own learning in ways they feel comfortable. Personalised learning with one's own mobile device is thought to encourage learner motivation. Pachler (2009), for example, notes that "a sense of ownership and ability to personalize, and appropriate them according to individual needs can result in an increased willingness to utilize mobile devices for learning" (p. 4).

Connectability

While m-learning promotes personalised learning, it also facilitates connectability to people and resources, which tends to foster collaboration in learning (McQuiggan et al., 2015). Because mobile devices are usually connected to the Internet, social media and communicational technologies, learners can easily group with their peers or consult teachers and other experts, even when they are geographically distant. It is noted that "m-learners can enjoy a high degree of collaboration by making rich connections to other people and resources mediated by a mobile device" (Kearneya et al., 2012, p. 10). The current form of Internet technology, Web 2.0, further extends the reach of individuals to people and resources and hence enhances user interactivity and collaboration. According to Blessinger and Wankel (2013):

> Whereas Web 1.0 is considered a content-centric paradigm, Web 2.0 is considered a social-centric paradigm. In other words, at the heart of Web 2.0 is social networking, social media, and a vast array of participatory applications and tools. (p. 3)

Driven by these web-based developments, a learning theory called 'connectivism' has emerged in this digital age. This theory holds that learning is no longer an internal and individualistic activity, but a process of connecting networks of information resources (Siemens, 2005). The sources include experts, colleagues, databases, social networking sites and collaborative environments (Guder, 2010; Transue, 2013). The connectability of m-learning assists learners to link to these multiple networks of individuals and resources.

To sum up, mobility, personalisation and connectability can be seen as the three important attributes of m-learning. Researchers, however, often tend to describe m-learning with a

focus on one or two of these attributes. For example, Udell (2015b) notes that m-learning is "always on, always with you, always connected" (p. 191), which stresses the mobility and connectability of m-learning; Peter (2009) describes m-learning as "just in time, just enough, and just for me" (p. 114), which underlines the attribute of personalisation.

Based on the discussion above, m-learning could perhaps be more comprehensively defined as learning enabled and enhanced by mobile devices which provides convenient access to learning materials and offers learners a highly portable, truly personal and easily connected and networked learning experience. MALL, in the specific context of language learning, can be defined in a similar manner. Drawing upon ideas of previous literature, Palalas (2011) provides a useful definition of MALL (with references in the original text omitted):

> MALL can be defined as language learning enabled by the mobility of the learner and location, portability of handheld devices, human interaction across multiple situations mediated by mobile technology within a networked community of practice, embedded in contexts which are relevant and pedagogically sound and informed by the real-life context in which the learning takes place. (pp. 76-77)

2.4.6 Issues with m-learning

The use of m-learning is becoming increasingly common. According to a Pearson survey conducted in the U.S., over 50% of middle school students use smartphones and tablets for in-class and at-home study; for high school students, the percentage is above 60% (Harris Interactive, 2013). Another recent study, based on a large-scale survey of nearly 600 EFL learners across 10 different language groups in an Australian university, was conducted to chart the evolution of technology use by language students from 2006 to 2011 (Steel & Levy, 2013). It is worth noting that smartphones, m-learning and MALL experienced rapid development during this period. It was found that there was an obvious increase in the uptake and use of mobile technology for language learning, compared to two similar studies conducted in 2006. Nearly 55% of the students used mobile apps to support their language learning, and around 25% of them ranked mobile apps in their top

three beneficial technologies. It is likely that the increasing use and wide recognition of m-learning will keep growing, helping students take control of their own learning process.

Despite the positive trend and uptake of m-learning development, a number of issues are also raised in the literature. These are primarily related to the dichotomy between formal and informal learning. In general, formal learning is intentional learning "within formally constituted educational institutions" (Hager & Halliday, 2009, p. 2), often with explicit learning objectives, time or resources. By contrast, informal learning is not intentionally organised or structured in terms of aim, time or learning support (Werquin, 2010). It often takes place outside of the classroom context without teacher involvement (Santos & Ali, 2012).

Due to the mobility of devices, content and learners as mentioned in the last section, m-learning tends to be 'spontaneous', 'opportunistic' and 'bite-sized' (Traxler, 2009a). That is, m-learning is often an unplanned and unorganised activity across fragmented time. Therefore, m-learning resembles informal learning (Pachler, 2009). Although optimists forecast that m-learning is most likely to be integrated into the mainstream in the near future (Dudeney & Hockly, 2012), mobile technology massively incorporated in formal learning may not generate the best practice for m-learning.

Financial issues & standardisation

Burston (2014a) notes that we may encounter financial constraints and standardisation issues among other concerns when attempting to fully incorporate m-learning in formal learning. The cost of providing students with the required standard devices and Internet connections have been inhibiting factors. In addition, the types of digital resources that can be accessed is often dependent on the specific model of mobile device, especially with regards to the access of multi-media resources. As pointed out by Burston (2014a): "unless usage is restricted to the lowest common denominator of functionality, the general lack of hardware standardization (screen size, button functions and placement, basic functions) has made it impossible to provide access to all potential learners" (p. 351).

Acceptance of new technology

More importantly, not all teachers or students are well prepared to embrace m-learning in the formal system of teaching and learning. Firstly, teachers may not have enough confidence or motivation to change their teaching to include the use of mobile devices. Wishart (2008), for example, loaned handheld PDAs (personal digital assistants) to seven teacher trainees to support their teaching practicum. Although they were experienced users of technology, the devices were less used than anticipated. It was found that the future teachers did not feel comfortable exploring how PDAs could be employed in their work, and felt that it was not appropriate to disrupt their established teaching practices with mobile technology. Secondly, students may not be ready for 'formal' m-learning, i.e. learning structured and assigned content through their mobile devices. For example, in Stockwell's research (2008), only 26 out of 75 participants chose to complete assigned vocabulary activities via mobile phones. This implies that learners' acceptance of mobile technology may progress at different rates, that is, some may be enthusiastic, while others may be reluctant. In another example, Ciussi, Rosner, Augier, and Suder (2011) delivered course-related podcasts to French students studying business, to find that most of the participants did not want to see compulsory content on their mobile devices, and did not want their use of mobile devices to be assessed by teachers.

However, this does not deny the pedagogical potential of m-learning and its ability to provide a positive experience for future users. Rather, it stresses that issues of financial shortage, standardisation and acceptance by teachers and learners may emerge when m-learning is to be incorporated in a structured and organised framework of formal learning. Due to the above-mentioned reasons, m-learning may, therefore, not be suited to such formal learning contexts. In an informal setting, however, m-learning might provide learners with useful tailored resources and personalised experiences. Hence, although mobile devices can be used in formal learning to assist both teaching and learning (Kwan, McNaught, Tsang, Wang, & Li, 2011; Meddings & Thornbury, 2009), and there have been attempts to bridge the gap between informal and formal learning via mobile technology (Cook, Pachler, & Bradley, 2008; Trentin & Repetto, 2013), it may be best for m-learning to remain informal and at most serve as an optional choice in formal learning.

It is my argument that the future development of m-learning should focus on informal learning practices, which will better supplement and support formal learning. MALL will particularly benefit from this inherent informality. Since language learning is often increasingly seen more as developing communicative competence than gaining linguistic knowledge (Richards, 2006), ubiquitous, spontaneous and bite-sized MALL platforms and resources may better help learners become competent language users in authentic contexts. It is no wonder that Jarvis and Achilleos (2013) argue that mobile-assisted language use (MALU) is a more accurate term for the learning process. However, while MALL has much to offer informal and personalised learning, it can also be difficult to evaluate the nature and success of this learning.

Problems with evaluation

Evaluating student learning is viewed as problematic within CALL, and this issue is exacerbated in m-learning and MALL due to their essential informality, notably the distribution of the learning process across different times and space resulting in the variability and unpredictability of many vital factors, including context of use, learning process and mode of use (see Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009; Vavoula & Sharples, 2011). The problem of evaluation is illustrated in more detail by Sharples (2009):

> Mobile learning differs from learning in the classroom or on a desktop computer in its support for education across contexts and life transitions. This poses substantial problems for evaluation, if the context is not fixed, and if the activity can span formal and informal settings. There may be no fixed point to locate an observer, the learning may spread across locations and times, there may be no prescribed curriculum or lesson plan, the learning activity may involve a variety of personal, institutional and public technologies, it may be interleaved with other activities, and there may be ethical issues concerned with monitoring activity outside the classroom. (p.17)

Thus, m-learning research "exposes methodological complexities" (Pachler, 2009, p. 2), and many traditional methods of evaluating learning are no longer suitable. Traxler and

Kukulska-Hulme (2006) suggest that early m-learning research was characterised by trials, where questionnaires, interviews and focus groups were usually used to elicit participants' attitudes and achievements, but there was a lack of supporting observation of participant use or related statistics. Similarly, Burston (2015) noted that m-learning gains were often based on self-evaluation by students, or teachers' subjective assessment, and that statistically reliable measures of learning outcomes were rare; he also identified the problems of short duration of MALL research and the small number of participants involved. As a result, studies on m-learning have great difficulty in gaining recognition and acceptance in academia. In another meta-analysis of 345 MALL studies during the past two decades, Burston (2013) found that 60% of MALL publications were outside of mainstream professional journals.

Recently m-learning and MALL researchers have been endeavouring to overcome these challenges, and as a result have produced convincing results through the addition of quantitative data and large-scale longitudinal research. A recent meta-analysis (Sung, Chang, & Yang, 2015) selected 44 peer-reviewed journal articles and doctoral theses on MALL, involving a total number of 9154 participants. It was found that the overall mean effect size is around 0.55, which means that around 70% of participants learning with mobile devices outperformed their counterparts in the control group. In another analysis of a larger number of 110 experimental and quasi-experimental journal articles on general m-learning, the mean effect size was found to be 0.523 (Sung, Chang, & Liu, 2016). It is encouraging that mobile-enhanced learning can result in moderate yet meaningful outcomes. The evidence may contribute to a greater momentum for future development of m-learning research and practice.

More importantly, new concepts, techniques and approaches for m-learning evaluation are taking shape. For example, Parsons, Ryu, and Cranshaw (2007) have proposed a complex conceptual framework for m-learning with four perspectives; generic mobile environment issues, learning contexts, learning experiences and learning objectives. Sharples (2009) puts forward a simpler way to assess the effects of m-learning by checking three interrelated areas: "usability (will it work?), effectiveness (is it enhancing

learning?), and satisfaction (is it liked?)" (p. 22). Sharples et al. (2009) suggest that m-learning should be evaluated at the micro, meso and macro levels. Micro level evaluation "examines the individual activities of the technology users", meso level evaluation "examines the learning experience as a whole" (Vavoula & Sharples, 2011, p. 185), while the macro level "examines the impact of the new technology on established educational and learning practices and institutions" (p. 186). This three-level framework is clearly exemplified in Vavoula and Sharples (2011), using examples of a real project titled *Myartspace*. In *Myartspace,* classroom activities involved the use of multimedia materials collected via mobile devices from the students' museums visit. The micro level was concerned with isolated behaviour of the students, such as taking photos in the museum; the meso level checked the entire experience of connecting learning in the classroom and in the museum; and the macro level related to the organisation of technology-enhanced museum visits. It was seen that evaluation at all levels involved much personal experience and subjective feedback from the students using mobile technology. Only the macro level allowed some traditional evaluative measures from the institutional perspective, e.g. investigating the improvement in the students' performance after museum visits, or comparing the effects of taking photos with video recording on the students.

2.4.7 The prospect of m-learning

Although it has a number of disadvantages, the positive aspects of m-learning and MALL see it becoming an unstoppable trend (Kukulska-Hulme, 2009b). It is the learning style of the future and for the future. On the other hand, m-learning, and MALL in particular, can still be viewed as somewhat immature in terms of both technologies and pedagogies (Traxler, 2005). For example, it is far from clear which technologies integrated in mobile devices are conducive to learning and which are distractive. Even less is known about how m-learning can take an appropriate role in formal/informal learning or how it can fit well into a variety of learning strategies and teaching techniques. Hence, m-learning is still in its infancy, and requires further investigation as to how it might be developed in future (Traxler, 2009a; Traxler & Vosloo, 2014).

Many researchers around the globe who are interested in m-learning are endeavouring to implement innovation in m-learning practice and develop theory. They propose including students as co-researchers and co-designers in the design and execution of m-learning research (Kukulska-Hulme, 2009a; Vavoula, 2009). Teaching practitioners should also be involved, although m-learning will remain informal and supplementary to the student's curriculum. A widely quoted prediction states that "computers will not replace teachers. However, teachers who use computers will replace teachers who don't" (Clifford, as quoted in Healey et al., 2008, p. 2). It is likely to be the same with mobile technology. As Kukulska-Hulme (2009b) puts it: "[t]o a certain extent, by dint of their ubiquity, mobile devices are already influencing how people learn; on the other hand, educators need to do more than just watch it happen" (p. 158).

2.4.8 Mobile DDL

It is my belief that DDL can be conducted on the mobile platform, because both DDL and MALL can empower students to have an autonomous and self-directed experience of language education. Tim Johns (1988) ultimately envisaged DDL as a process free of classroom, in which "concordancers could be made available outside class on a self-access basis" (p. 24), so that users are "helped to become better language learners outside the classroom" (T. Johns, 1991, p. 31). Teachers are the role that DDL attempts to get rid of during the direct interaction between learners and corpus data: it was suggested that "[w]hat distinguishes the DDL approach is the attempt to cut out the middleman as far as possible and to give the learner direct access to the data" (T. Johns, 1994, p. 297).

Although Tim John was a programmer who developed and promoted programs for language learning (T. Johns, 1986, 1997; T. Johns & Wang, 1999), he conducted his DDL experiments on paper-based printouts (1991, 1994); he also planned publishing books of "ready-made DDL materials" (1994, p. 36), a compromised solution perhaps motivated by the difficulties in providing every DDL student with easy access to a computer and accessible concordancing software. The use of paper printouts was continued by other proponents of DDL. Boulton (2010b, 2010c), for example, continuously excluded the

computer and focused on the use of printouts in DDL practice; Jane Willis (2011) even handwrote concordance lines on the blackboard. Recent studies evaluating paper-based DDL produced positive outcomes (e.g. Huang, 2014; Smart, 2014), and an empirical study which compared the using paper-based, computer-based DDL and a combined approach concluded that the participants benefited in all modes with no significant difference in effectiveness (Chujo, Anthony, Oghigian, & Uchibori, 2012).

Nevertheless, I would argue that there are a few critical defects with paper-based DDL. Firstly, searching through concordance data and compiling concordance lines ready for student analysis takes an enormous amount of time. Tim Johns often spent long hours classifying, hand-sorting and rearranging concordance outputs into paper-based materials that could be handed out to students. In one example (T. Johns, 1991), he explained how 45 minutes of class work involved approximately over four hours' preparation time. This preparatory work was necessary as the corpus software used did not generate concordance lines in a manner that would enable learners to notice patterns in language use.

Secondly, on paper handouts, the length of concordance lines cannot be expanded or reduced as required, and furthermore the original text of the concordance line cannot be viewed so that the search term can be observed in its wider context. These are easy tasks with a computer concordancer, which provides more flexibility for learners' queries and investigations.

Thirdly, and in contrast to the underlying pedagogical aims of DDL, paper-based DDL cannot be carried out without a teacher. The teacher plays a vital role in paper-based DDL as the guide and activity organiser. The concordances on paper are unorganised and unfiltered compared to textbooks, and students may be confused on what to do without instruction and explanation from the teacher. Mobile devices, compared to stationary paper, can provide student with easier and friendlier access to experiencing the procedure of concordancing step by step via interactive interfaces.

More recent research on DDL has suggested the adoption of a classroom-free approach. Boulton and Pérez-Paredes (2014), in reviewing recent research on using corpora for language teaching and learning, observe that "rather than trying to bring corpus linguistics into the language classroom, the emphasis is increasingly placed on the L2 user and how he or she might benefit from corpus linguistic tools and techniques" (p. 122).

While such a radical vision of technology-enhanced and teacher-free learning has still not been achieved in DDL, mobile technology has now developed to a stage, where this possibility might now be provided. Furthermore, mobile devices are now more affordable and therefore ubiquitous, with almost all students owning and carrying a mobile device that has the technological capability to run concordancing software applications. When combined with PIC as explained in Section 2.3.4, mobile DDL may provide more flexible and targeted input, at the point of need, and automatically organise concordance lines into more easily observable search results. DDL, and its use of concordancing, may then become more accessible and pedagogically helpful for language learning students.

The next chapter outlines the methodology used in this study.

CHAPTER 3:

METHODOLOGY

3.1 Introduction

3.1.1 Research questions

This study was ~~in essence~~ an attempt to check whether new mobile technology could partly address the problems identified in the preceding Chapters 1 and 2 with regard to the lack of positive experience and uptake of DDL (Data-driven Learning). Compared to 'Keywords in Context (KWIC)', the conventional method of concordancing used in DDL, an alternative pattern-based concordancing approach, 'Patterns in Context (PIC)', might bring about a different experience and evaluation of the DDL approach. As such, this study also involved investigating whether PIC could contribute to solving these problems with DDL and get positive feedback from student users. Academic writing was the field that this adapted DDL approach was designed to help.

The research aimed to shed light on the following three questions:

1. To what extent can mobile-based concordancing software apps contribute to ESL students' positive experience and uptake of concordancing tools for their academic writing?
2. Could ESL students' positive experience and uptake of mobile concordancing software tools be enhanced by the implementation of an alternative pattern-oriented approach - Patterns in Context (PIC) - for searching and retrieving concordances?
3. What technical affordances can be utilised to develop such mobile-based concordancing tools?

In order to answer the three interrelated questions, this study, based on a methodology of action research, involved the continuous development and user evaluation of two mobile concordancing apps over a series of three phases. The mobile concordancers, representing the core searching techniques of KWIC and PIC respectively, were progressively and

iteratively developed by the researcher and assessed by six different cohorts of ESL (English as a second language) students. Following the cyclical and flexible nature of action research (Bloor & Wood, 2006), participant evaluation at the end of each phase contributed to the type of app developments conducted or rejected in the subsequent phase, as well as the way in which the testing and evaluative procedures in the subsequent phase were implemented. The process of app development and user evaluation shed light on the types of technical affordances that could be employed for mobile-based concordancing.

3.1.2 Mobile concordancing apps

In this research, two concordancing apps were developed based on the resources of corpus linguistics and the affordances of mobile technology. The apps were designed as reference tools to help student users quickly identify the meaning and behavior of certain words, by exposing the students to the target words in the context of authentic, appropriate and discipline-specific language.

With the two specially developed apps, this research aimed to establish the extent to which mobile-based concordancing apps might contribute to ESL students' positive experience and uptake of these tools for their academic writing. The study also attempted to shed light on whether students might be more inclined to use these concordancing-based apps as reference tools, if the search and retrieval processes involved a pattern-oriented focus, referred to as PIC, rather than the KWIC approach, traditionally employed by concordancing software. Hence, one of the apps contained the conventional concordancing search and retrieval method based on KWIC, while the other featured the proposed pattern-oriented concordancing method PIC (see Chapters 1 and 2). Since both of the apps used corpora containing academic texts, and the apps were designed to be reference tools to assist students with their academic writing, they were named 'AKWIC (Academic Keywords in Context)' and 'APIC (Academic Patterns in Context)' respectively. To evaluate whether the PIC approach could enhance students' positive experience and uptake of mobile concordancing software tools, AKWIC and APIC were compared based on how the participants actually used and evaluated the two apps.

Despite the web-based concordancers as mentioned in Chapter 1, it was decided to keep the concordancing function of the two apps offline, that is, the apps searched through only local texts in the mobile devices where the apps were installed[15]. The major reason is that pattern-oriented concordancing is less supported by the online interfaces, and it can be too challenging for student users to prepare regex strings before each search. Another reason is that most online interfaces do not provide access to discipline-specific texts. As discussed in Section 1.2 of Chapter 1, due to the discipline-specific features of language use, it is important for students to have access to the way English is used in their own academic fields. Therefore, disciplinary academic texts kept offline was one important concern in the development and user testing of the concordancing apps AKWIC and APIC.

COCA (Corpus of Contemporary American English) was chosen as the source of authentic texts of academic English. A few factors can account for the selection of COCA. Firstly, COCA, which is commercially available, contains a sub-corpus of academic English. Different from corpora of student-made writing, e.g. BAWE, the sub-corpus of COCA, mainly in the form of journal papers by researchers and scholars, features academic English used by professionals. Secondly, the texts in COCA are categorised into different disciplines, enabling the apps to provide results of searches which were discipline-specific. As a result, for this study the corpora in the two apps originated from the academic sub-corpus of COCA. This included one million words for each of the nine broad disciplines[16]. The texts were stored in ten entry-level tablets (model: Samsung T110), which were then borrowed by different groups of participants for a limited period during each phase. The mobile devices featured a 7-inch touchscreen, 600×1024 resolution and 1GB RAM. With a plastic cover, this model was light in weight and easy to hold. The specifications ensured that the costs of purchasing the tablets could be kept within the funding budget, while text concordancing through millions of words included in AKIWC and APIC could run smoothly without frequent crashes.

[15] It does not mean that the apps operated totally offline. In fact, an online dictionary was introduced prior to Phase 2 of this research.

[16] The disciplines are education, humanities, history, social science, philosophy and religion, law and political science, science and technology, medicine and health, and miscellaneous.

3.1.3 Participants

This research targeted pre-university ESL learners with competent English proficiency, a strong motivation to learn, and an ability to read academic English directly. According to the language assessment system of CEFR (the Common European Framework of Reference for Languages), the targeted participants could, at the time of the research, be placed at the B2 level, labelled as 'vantage/upper intermediate'. In addition, as the target participants were about to start study at the university level, it was assumed that they would be highly motivated to enhance their academic writing in preparation for their following years of university study.

The participants in this research were upper-intermediate level ESL students, who were recruited on a voluntary basis after the Ethics Approval from AUTEC was granted (AUTEC 14/174, granted on 28 January 2015; please see Appendix A for the approval and other related documents). The participants were recruited from a language school affiliated with the university where this research took place. Studying in a pathway programme to prepare them for university study, they were exactly the group that this research was designed to help in terms of language use and academic writing. Their performance in IELTS (International English Language Testing System) used by this university ranged from 5.5 to 6.5, with a minimum overall band of 5.5. When they obtained an overall band of 6.5, they could meet the threshold requirement of university admission.

After recruitment there was a short training session for each cohort of the participants. During this time, the two concordancing apps were introduced to the participants, described as 'a dictionary of examples'. This was to avoid using terminologies in corpus linguistics, such as DDL, concordancing and pattern; it also stressed one major benefit of DDL, i.e. extensive exposure to a number of usage examples in the original contexts. In the session, the participants were shown how to look up a word to get 'examples' of how it was used, i.e. concordance lines, with the concordancing apps. They were also trained

to focus on the highlighted words or patterns to observe word usage out of a large number of instances. It was explained that unlike a 'dictionary', each search provided ten initial examples identifying of how the specific word was used in real academic texts. If it was still not clear, students could then ask for another ten examples, and keep asking for more examples until they understood how the word was used. This is one of the benefits of mobile learning – that such examples were always accessible to them as the users needed them. The one-off training was further supported by uploaded YouTube video clips on how to use the apps. While terminologies were avoided, the participants were encouraged to make use of the unconventional approach of DDL: the aim was for students to understand word usage and be able to use what they had observed in real academic texts to include in their own assignments. Their feedback on how to improve the apps to better help them with their academic writing was also integral to this research.

In Phase 1, 18 students participated in two cohorts; in Phase 2, 20 students participated in two cohorts, and another 20 students participated in in Phase 3. In total, this research involved 58 participants. Due to the geographic location of New Zealand and its education policies for international students, the participants from the language school had a focused demographic coverage, with most of them from Asian countries, such as China, Vietnam and Korea; a few others came from Middle Eastern countries. The gender of the participants was approximately half male and half female.

It is important to note that the participants were treated as clients or co-researchers rather than passive subjects. Active user participation is not only a feature of action research (Greenwood & Levin, 2007), but is also desirable in software engineering (Pertti, 2007). The participants represented future potential users of the apps and the concordancing methods used in the apps, i.e. KWIC and PIC. Thus, their feedback was an important component of the research results.

3.1.4 Data collection

The data collected from each stage of the research was qualitative, involving both focus

groups, and semi-structured interviews with individual participant users of the apps. It was also quantitative, involving an online questionnaire completed by the participants. The research also involved experimental quantitative data, in that information about each participant's use of the apps was passively captured by means of automatic logging. The details of the data collection are set out in Section 3.6 of this chapter. All data was corroborated and triangulated at the end of each phase following a convergent parallel mixed methods approach (Creswell, 2014). The remainder of this chapter describes and explains this methodological approach in more detail, including the research paradigm that informs it.

3.2 Research worldview

The design of this research is based on the overarching worldview of pragmatism, which focuses on problem-solving. As described by Powell (2001), "[t]o a pragmatist, the mandate of science is not to find truth or reality, the existence of which are perpetually in dispute, but to facilitate human problem-solving" (p. 884). Since it is oriented to solving real problems, the pragmatist approach may lead to practical solutions. This research, as mentioned above, attempted to address the problems of uptake of DDL by introducing mobile technology and pattern-based concordancing.

Pragmatism underpinned two important and interrelated methodological components of this research: mixed-methods approach and action research (Ivankova, 2015). Firstly, pragmatism as a research paradigm supports the use of a mix of different research methods (Feilzer, 2010). In keeping with a pragmatist worldview, the spectrum of research philosophies ranges between two extremes: positivism and interpretivism. Positivism shows a preference for quantification, focusing on testing and verification through statistical analysis (Paley, 2008). Interpretivism, which is central to qualitative research, stresses meaning-making and knowledge mediation by the researcher, so as to understand "both reality and knowledge as constructed and reproduced through communication, interaction, and practice" (Tracy, 2013, p. 62). Pragmatism typically involves the integration of both positivist and interpretative paradigms. Therefore, a

pragmatist approach usually involves both quantitative and qualitative data, as well as appropriate mixed methods of data collection.

Secondly, pragmatism is intrinsically associated with action research (Hammond, 2013), in that action research also seeks to find practical solutions to problems. Similarly, according to Reason (2003), "[p]ragmatists share with action researchers a desire that our inquiry be 'useful'" (p. 114). As noted, action research commonly involves the use of mixed methods (Olson & Jason, 2015; C. Thomas, 2010), and "there are a number of common features between mixed methods and action research that make the integration of these two approaches possible within a given study" (Ivankova, 2015, p. xvi).

3.3 Mixed-methods research

The adaptation of mixed methods in this research was a direct consequence of the philosophical stance of pragmatism. A pragmatist approach encourages free choices of multiple research methods, procedures and techniques that meet real research needs (Tollefson, 2011). Mixed-methods research often involves a combination of multiple methods and the integration of both quantitative and qualitative data. As noted by Creswell (2009), the mixed-methods approach can utilise the combined strengths of qualitative and quantitative data and overcome their individual weaknesses. As a result, it is believed that the mixed-methods approach can enhance the triangulation and complementarity of data (Creswell, 1999; Johnson & Onwuegbuzie, 2004), and enable the investigation of complicated problems from more divergent views and perspectives (Gelo, Braakman, & Benetka, 2008; Schulenberg, 2007). Hence, the approach may lead to more insights and an extended understanding. M-learning theorists also encourage the use of mixed-methods research in m-learning research (Kukulska-Hulme, 2009a; Pachler, 2009). They argue that neither qualitative nor quantitative data alone can provide fully credible and reliable answers to the often complex research questions that occur in the field. As mentioned in Chapter 2, research on m-learning has been largely based on self-reporting and retrospection of learners, as well as subjective evaluation of teachers, but has rarely included statistics (Burston, 2015; Traxler & Kukulska-Hulme, 2006).

The mixed-method tools employed in this research are qualitative, involving **focus groups** and **semi-structured interviews**, as well as quantitative, involving **online questionnaires** and **passive data** about the participants' app use (e.g. the number of search queries, time of app use, and so on) which was automatically captured as they used the apps. The different methods are discussed in detail in Section 3.6 of this chapter. The qualitative and quantitative data was collected and analysed separately, and the information from the two sources was converged later to confirm or disconfirm each other and yield new results. This approach, as mentioned in Section 3.1, is a design called convergent parallel mixed methods (Creswell, 2014).

3.4 Action research

Action research as a research method has been widely used in a range of social sciences (Brydon-Miller, Greenwood, & Maguire, 2003; Greenwood & Levin, 2007). Education, particularly language education, has been an important field of its applications for many years (Burns, 1999; Carr & Kemmis, 2004; Elliot, 1991; McNiff, 1993; Tomal, 2003). Action research aims to address problems and make improvements, in that an 'action' is planned "to intervene in a deliberate way in the problematic situation in order to bring about changes and, even better, improvements in practice" (Burns, 2010b, p. 2). To achieve this, action research often involves "self-reflective, critical, and systematic" (p. 2) explorations. In addition to bringing changes, action research also pursues new knowledge or further understanding (Bloor & Wood, 2006). Taken together, action research is designed "to understand, evaluate and change" (Costello, 2003, p. 5) the investigated context or situation.

Cycles and participation can be deemed as two key features of action research. Firstly, action research "adopts a dynamic, cyclical process which moves through phases of planning, action, observation and reflection" (Bloor & Wood, 2006, p. 10). The cycles are recursive, repetitive and reflective, i.e. it may take a few progressive phases before achieving the optimal results. Therefore, action research tends to adopt a multi-phase

design, which is one of the common types of the mixed-methods approach (Creswell, 2012). This is a process in which taking actions and obtaining knowledge consistently support each other. In addition, action research is supposed to be inclusive and engaging: "everyone involved takes responsibility" (Greenwood & Levin, 2007, p. 7). In other words, action research participants are not passive subjects, but serve as co-researchers collectively and collaboratively, since they share the common goal with researcher(s) to improve the educational environment around them (Mcintyre, 2008). In this study, the participants made suggestions or requests in the interview and questionnaire for how the apps could be better for them based on their experience and expectation, and in light of participant suggestions, I made decisions on how to continuously modify the two apps.

Associated with its cyclical nature, action research tends to be flexible, because the next step of action is often influenced by what understanding and solutions are developed by the researcher during and after the previous phase(s) (Ivankova, 2015). In other words, action research often requires flexible adaptation to changing circumstances (McNiff, Lomax, & Whitehead, 2003). As a result, design components in action research usually change in response to ongoing findings and reflections, and it is common that the 'actions' over cycles need to be changed in the form of adjustments, improvements or refinements (Koshy, 2005). In this study, specific elements of the research methods were changed to better reflect how the participants used and evaluated the two apps.

Apart from education, action research has been increasingly accepted and employed in IT (Information Technology) industry in recent years (Baskerville & Myers, 2004; Kock, 2007; Willcocks, Sauer, & Lacity, 2016). This is partly because action research has an affinity with established practice in software engineering, e.g. the cyclical approach is in line with the common iterative process of software development. More importantly, the participation of users in the development process can address a problem common in software engineering, i.e. the development of software packages tends to be based on the personal expertise of programmers than the expectation of future users. It is noted that "the lack of cooperation between designers and the future users in the building process in many cases is found to cause failures" (Pertti, 2007, p. 50). To avoid this problem, the use

of action research can provide valuable user feedback leading to outcomes (dos Santos & Travassos, 2011). It is even argued that "a great deal of software engineering research is actually action research in disguise" (Easterbrook, Singer, Storey, & Damian, 2008, p. 302). Therefore, it is not surprising that an increasing number of IT development projects adopt action research as the methodological basis, aiming to generate or facilitate technical innovations (e.g. Abrahamse & Lotriet, 2012; Allen & Dovey, 2016).

In the field of technology-enhanced education, action research has been employed to update understanding and innovate practice (Somekh, 2006). Specific to m-learning, a number of recent studies have been conducted to improve mobile-enhanced pedagogy through rounds of actions (e.g. Nasongkhla & Sujiva, 2015; Unlu, Dokme, & Tufekci, 2015). In sum, action research was judged to be a suitable research method for this study.

3.5 Research procedure

The procedure of this mixed-methods action research (Creswell, 2009; Ivankova, 2015) involved an iterative progression of three phases, each of which involved two identical cycles. In each cycle, typically up to 10 voluntary participants were recruited. Each participant was provided with either AKWIC or APIC on a portable tablet that was purchased and configured by me beforehand. The participants' private mobile devices were not used due to potential specification and ethical issues of collecting data from their own devices. Prior to the commencement of each phase, participants were given a brief tutorial about the core principles and features of the apps. Two short video clips demonstrating how the apps worked were also uploaded to YouTube[17] so that they were easily accessible to the participants at the point of need.

Following the tutorials, the participants were asked to use the designated apps for a period of two or four weeks, depending on the specific phase (see the discussion of individual phases below), so as to assist them with their course writing assignments. At the end of each cycle, a process of evaluation was carried out involving focus groups, semi-

[17] The video clips can be watched online at https://www.youtube.com/channel/UC85o2jL8MkIgGIbU5DziVhg.

structured interviews and an online questionnaire. Information about how each participant used the apps was also captured passively through automatic logging, and the recorded information was collected when the tablets were returned.

The results of the evaluation and feedback by the participants contributed to the future changes and added features to the apps in preparation for the subsequent phase. Features which were seen as encouraging students' uptake and positive experience of the apps were included in subsequent versions of both apps for the ensuing phase (e.g. context extension; please refer to Section 4.3 of Chapter 4). In addition, other developments that the post-phase evaluation suggested would contribute to students' uptake and a positive experience were also included (e.g. access to an online dictionary; see Section 5.2.2 of Chapter 5). Features which were considered as reducing students' uptake and positive experience were removed from further versions of both apps (for example, a decorative gallery in the prototypes; see Section 4.3.2 of Chapter 4). Furthermore, differences between students' evaluation of AKWIC and APIC were also noted. Because the cyclic nature of action research requires responsiveness to the ongoing research process, the post-phase evaluation by the participants also contributed to a reflective evaluation which resulted in refinements of the research procedure and types of questions used in subsequent phases. The following provides an outline of the specific methods of the individual phases.

In Phase 1, nine participants[18] of each cycle were randomly assigned to use either the KWIC or the PIC app for four weeks. In this first phase, both apps limited the search terms to the most frequent 52 academic verbs as identified by Gardner and Davis (2014). This is because it was considered that students' recurring difficulty with verb phrases would encourage enough engagement with the apps to provide useful initial findings. The apps also enabled the participants to select discipline-specific academic texts before carrying out a concordancing search and extend the context of a certain search result. They could also have a passage of a text read aloud by the machine through the TTS (text-to-speech) function. The details of Phase 1 are listed in Table 3.1.

[18] Funding allowed the purchase of 10 tablets at first. However, one was lost by a participant during the pilot study, so nine tablets were available in Phase 1. An additional tablet was bought before Phase 2.

Table 3.1 Procedural Details of Phase 1

	APIC	AKWIC
Scope of search words	52 core academic verbs in the Academic Vocabulary List (Gardner & Davies, 2014)	52 core academic verbs in the Academic Vocabulary List (Gardner & Davies, 2014)
Number of users	10 (in two cohorts)	8 (in two cohorts)
Format	Participants used *either* APIC or AKWIC for four weeks	
Additional features	Ability to select discipline-specific texts and extend context of a searched example; TTS function	

As will be shown in Chapter 4, the findings and feedback from Phase 1 indicated that the participants felt that the focus on 52 core academic verbs limited their experience and the usability of the apps. They wanted to be able to search for any word. Therefore, the search scope was greatly extended through an updated algorithm in Phase 2. The patterns associated with approximately 20,000 verbs, nouns and adjectives could be searched in APIC, and users could theoretically look up any word in AKWIC. Despite the open-query extension, 500 core academic words from the Academic Vocabulary List (Gardner & Davies, 2014) were provided in both apps as optional search words. Access to an online Longman dictionary was also added as an additional feature based on the request for this by a number of participants in Phase 1.

It also became apparent through the interview data in Phase 1, that the ability of PIC to enhance students' positive experience and uptake of mobile concordancing software tools (Research Question 2) could be better evaluated if each participant experienced both of the apps. Therefore, the participants in Phase 2 experienced both apps. They were given one app to use for two weeks, and then changed to the other for the following two weeks. That is, five users started using APIC, while the other five began with AKWIC, and after two weeks they changed to the other app. The questionnaires and interviews were carried out every two weeks, so the participants would not confuse their experience and evaluation of the two apps at the end of four weeks. Because each participant gave feedback on both apps, the comparison of effectiveness, efficiency and user experience of the two apps was less influenced by individual difference. In addition, the number of

users of each app was in fact doubled, offering more data and increasing the validity of the results. The details of Phase 2 are set out in Table 3.2.

Table 3.2 Procedural details of Phase 2

Scope of search words	Approximately 20,000 verbs, nouns and adjectives (500 core academic words optional)	Any word class (500 core academic words optional)
Number of users	10 (in two cohorts)	10 (in two cohorts)
Format	Participants used either APIC or AKWIC for two weeks and then used the other app for two weeks	
Additional features	Ability to select discipline-specific texts and extend context of a searched example; gesture control of context extension; TTS function; online Longman dictionary	

Upon the completion of Phase 2, the open-query apps seemed to generally meet the needs of the participants' vocabulary check. Combined with the results of Phase 1, a conclusion could be drawn regarding whether PIC could enhance ESL students' positive experience and uptake of mobile concordancing apps for searching and retrieving concordances. Therefore, only APIC was provided to the two cohorts of participants in Phase 3. The period of each cycle was reduced to two weeks to align with Phase 2. Given that the emphasis was now on a single app, the third phase was able to address participants' comments in Phases 1 and 2 on the app design. Hence many of the changes at the end of Phase 2 involved the optimisation of aspects of graphic, procedural and operational design. This included adding an audio clip of instruction and gesture control of adjusting textual context. The aim was to enhance user experience with APIC and its underpinning method PIC. The details of Phase 3 are set out in Table 3.3.

Table 3.3 Procedural Details of Phase 3

Scope of search words	Approximately 20,000 verbs, nouns and adjectives (500 core academic words optional)
Number of users	20 (in two cohorts)
Format	Participants used APIC only for two weeks
Additional features	Ability to select discipline-specific texts and extend context of a searched example; TTS function; online Longman dictionary; audio instruction

3.6 Methods of data collection

This research employed elicitation techniques frequently used for mobile learning evaluation: interview, questionnaire and focus group, supplemented by system data (Traxler & Kukulska-Hulme, 2006). Data on the participants' app use was passively captured and recorded via automatic logging in real time as the apps were used by the participants. Data about the participants' experience of the apps was collected following each cycle of app use through online questionnaires, semi-structured interviews and focus groups. The participants' evaluation on the effectiveness and ease of use of the apps was a focus, because it has been long established that users' perception of usefulness and ease of use would be significantly correlated with current and future use (F. Davis, 1989). Before the study proper, a pilot study was carried out to test proposed methods of data collection. These methods were perceived to be effective to capture the participants' app use and evaluation.

Passive data capture

The procedure of the passive use data capture was conducted to provide details on how the participants used the apps. This involved automatic logging, a method where the devices recorded required information on the participants' use of the apps. This method is considered an effective means for collecting usage data of mobile devices (Trinder, Roy, & Magill, 2009). In this study, the task was completed by an automatic logging module embedded in the apps. The logs could provide rich information on how the participants used the apps, including sessions (the number of times the app was used), distinct or repetitive queries (what words were searched, and how often they were searched), the time and date of app use, and so on. The passively captured data was collected once the tablets were returned by each cohort of users. Statistical processing of the recorded logs helped reveal valuable information which reflected the users' behaviour and preference in a quantitative form. A limited amount of qualitative data, such as the words actually searched by the participants, was also collected through passive data capture. The passively captured data was triangulated with responses and answers to other means of

mainly qualtative data collection – online questionnaire, semi-structured interview and focus group.

Online questionnaires

While the above mentioned method of automatic logging was retained throughout the three phases of research, the online questionnaire was changed phase by phase in terms of size, type and wording of questions. Such changes were based on how well the responses in the prior phase could answer the research questions.

In Phase 1, the online questionnaire contained 13 questions, covering a range of topics around four major themes: perception of the apps, personal experience with the apps, attitude towards concordancing and towards mobile learning (see Table 3.4). Each question had four choices from negative to positive, with an additional option of 'I don't know'. In Phase 2, where each participant evaluated both apps, the changes focused more on the comparison of the two apps and the approaches they represented (PIC vs. KWIC). The questionnaire was changed to Likert-scale questions which asked for perceived effectiveness, efficiency, and ease of use for the apps AKWIC and APIC. The number of questions were reduced from 13 to 5, because the less relevant questions, e.g. on paper/electronic dictionary use, were removed before Phase 2. For each statement on the experience of app use, the participants could choose from nine scales ranging from 1 (representing 'completely disagree') to 9 (representing 'completely agree'). In other words, Scale 1 is the most negative, while Scale 9 is the most positive, and Scale 5 represents a 'neutral' view. Thus, the more often the scale was above 5, the more positive the users felt, while the more often the scale was below 5, the more negative they felt. The respondents also had a chance to leave open comments in an input box at the end of the questionnaire. Phase 3 used the same format and Likert questions as in Phase 2. All the questions in the three phases are included in Appendix B.

The changes to the interface elements in Phases 2 and 3, including the graphic attempts, were a response to the negative feedback in prior phases. The aim was to attract or amuse users to increase the positive experience and uptake of mobile DDL as a reference

resource for their acadmic writing.

Semi-structured interviews

The participants were invited to attend a semi-structured interview on a voluntary basis. More than a dozen indicative questions were formulated by the researcher upon discussion with the supervisors, with no reference to previous studies. These questions were prepared to further the investigation into aspects covered or not covered by the questionnaire. For example, regarding the perceived effectiveness and usefulness of apps, one indicative question was 'which feature of the app do you feel is most helpful'. As semi-structured, the interviews with the participants also provided the opportunity to ask further questions as appropriate, e.g. 'where and when did you often use the app' and 'did you use it with other reference tools'. Feedback from the interviews was supportive and complementary to the questionnaire results. All the indicative questions are set out in Appendix B.

Focus groups

The participants were also invited to join focus groups. A focus group is "a grouped interview with 3 to 12 participants and marked by guided group discussion, question and answer, interactive dialogue, and other activities" (Tracy, 2013, p. 167). It is believed that the focus group method can enhance interaction among repondents so as to solicit more infomration (Axinn & Pearce, 2006). The focus group method has also been employed in empirical studies in software engineering (Kontio, Bragge, & Lehtola, 2008). Throughout this three-phase research, five focus groups were organised, each involving three to four participants. During the interviews, the focus group members were asked the indicative questions in the semi-structured interview to guide their discussion. It turned out that the members of the focus groups shared opinions and ideas through dynamic interaction with their classmates. This allowed the collection of more information about app use.

The processing of the above mentioned types of data is explained in the next section. Following the convergent parallel mixed methods approach (Creswell, 2014), the quantitative and qualitative data obtained in the three research phases was combined and

triangulated (Olsen, 2004) to help produce practical solutions regarding students' uptake and positive experience of mobile concordancing tools, and the technical affordances required to develop such tools.

3.7 Data analysis

3.7.1 Analysing the passively captured data

The passively captured data, i.e. automatic logs of app use, needed some calculation before analysis and subsequent interpretation. How the data was processed is explained below. Firstly, a typical segment of the automatic logging is shown in Figure 3.1.

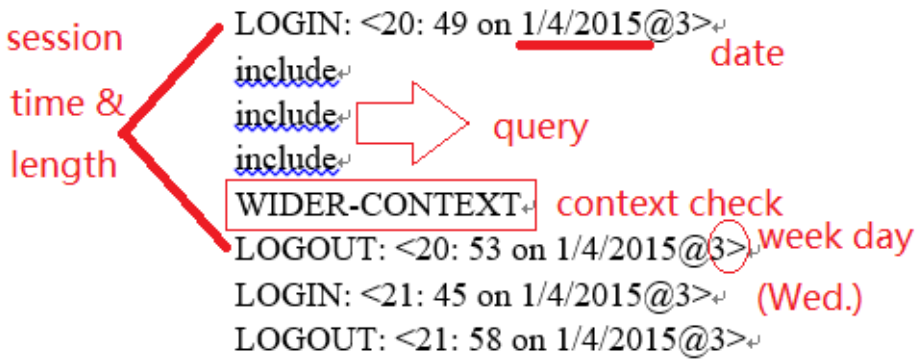


Figure 3.1 A typical segment of automatic logging

Based on the above logs, valuable statistics and information on app use could be obtained. Here are several indicators related to the analysis of the passive data capture:

Session: a 'session' refers to each period between a user's launch of the app to search for a word or a pattern and their later exit of the app. It is often indicated by a pair of 'LOGIN' and 'LOGOUT' symbols. Not all sessions, however, were valid ones to be included in statistical analysis. A 'LOGIN' mark was not counted as a 'session' under two circumstances: when no real search took place, and when there was a repetitive app launch. Regarding the first scenario, participants admitted in the interview that they might sometimes go straightforward to browse the word list. If there were no searching records along with this entry, it was not considered a valid session. In the second scenario, the apps might crash due to overloading of data, and then the participants launched the apps

again. In this case, the second or any subsequent launch was not counted as a new and separate session.

Query: each time the participants clicked the query button in the apps to retrieve a list of concordances for word usage information, it was counted as one query, whether it was a repeated search of the same word or not. A *distinct query* is a non-repetitive attempt to inquire about a different word, calculated by the total number of queries less repetitions of the same word search.

Time length: this is defined as the time spent on app use by a participant in a session. The figure was in general calculated by a LOGOUT time minus the corresponding LOGIN time. The time of an invalid session was not included.

Day of the week: in the logs, the time and date of app use are followed by a figure ranging from 0 to 6, which indicates the day of the week when the app was used (0 stands for Sunday, 1 for Monday, and 6 for Saturday).

Context check: the ability to view any concordance line in the textual context from which it originates is a feature of the apps, and the context scope is flexible from scores of words to hundreds of words at the user's request. Once a participant tapped the serial number link to look at the example in its original context, a label 'WIDER-CONTEXT' was recorded in the automatic logs. This indicator shows whether the user wanted to view a specific concordance line in a wider context.

Dictionary check: in Phases 2 and 3, an online Longman dictionary was made available to the participants. A 'DICT' mark was recorded in the automatic logs when a user referred to the online dictionary.

Based on the above definitions, the logging segment in Figure 3.1, can be used to show how the passively captured data was processed. Two sessions can be seen from this segment, but only the first one was considered valid, since no concordance search took

place between the second pair of 'LOGIN' and 'LOGOUT' marks. In the first valid session, three queries of the word *include* took place. Due to the two repeats, there was one distinct query. One context check was recorded after the queries, and the time logs show that the participant used the app on the night of 1 April 2015, which was a Wednesday. Use of the online dictionary is not found in this example.

The raw data underwent further statistical processing to generate six categories of data which reflect different aspects of app use: **distinct query**, **query per session**, **time per query**, **repetition ratio**, **context check per query**, and **dictionary check per query**. The number of distinct queries shows how many different words were looked up by a participant; query per session means the number of both distinct and repetitive queries in each session. These two indicators help measure the participants' engagement with the apps, based on the assumption that if a participant finds the method useful, he or she would try more queries in each session and in total. Time per query, i.e. the average time to compete a query by a participant, is used in an attempt to measure app efficiency, based on the assumption that a more efficient app requires less time for a participant to observe how a word or pattern is used. The repetition ratio is produced with the number of repeats divided by the total number of queries. The value helps check whether a participant needed more examples to understand the usage of a particular word or pattern. Context check per query is the average number of context checks done by a participant in a query. A participant might check the wider context of a concordance line to help understand the particular usage of the target pattern. The dictionary check per query appeared only in Phases 2 and 3 after the online dictionary was introduced. It indicates how often the dictionary definitions were referred to.

The median values of the above data from individual participants were generated for comparison of app use. Median is the middle value or score of a series of data. It is used here instead of mean (average), because "the median is less sensitive to extreme scores" (Tavakoli, 2012, p. 354). Thus, median values may better reflect how a participant who was neither too enthusiastic nor disinterested typically used the apps than mean scores. In addition, 'coefficient of variation' ('C.V' for short) was introduced for this research. It is

the standard deviation value of a column of figures divided by the mean score, representing intra-group variation. In this research, the C.V values show how differently the participants in a group used the same app, e.g. whether some of them used a particular function very often while others seldom used it. The higher the percentage, the more differently the designated app was used within the group user, and the less representative the median values are for app use. The major difference of C.V from standard deviation is that C.V can be used to compare groups of data with a different magnitude. For example, the number of distinct queries may range from 1 to 20, while the repetition ratio as a percentage is always much smaller below 1 (100%). To compare the variation of the two sets of data, C.V is better than standard deviation.

In addition, based on the data on the time of app use, two line graphs can be drawn to reflect how the participants used the apps in a day and on which day of the week. The lines drawn in Phases 2 and 3 were added to the ones in Phase 1 to see whether there would be 'peak time' or 'off-peak time' of app use shared by most participants.

3.7.2 Analysing the questionnaire, interview and focus group data

Online questionnaire

The online questionnaire was conducted through the website QuestionPro. After each cycle, the link to the online questionnaire was sent to each participant (except those who generated no valid data of app use). The website collected their responses and produced basic statistical results. In Phase 1, there were 13 questions for the participants who used the two apps separately, covering four major themes as explained later in this section. The results, i.e. how many of them selected a specific option, were presented in percentages to allow the drawing of pie charts for comparison of the two concordancing apps. In the next two phases, the questionnaire took the form of nine-scale Likert questions, and the number of questions was reduced to five. For each question, the mean value out of the selected scales is calculated. The greater the value is, the more positive the responses are in general.

Interviews and focus groups

The semi-structured interviews and focus groups took place in each phase as follows:

Phase 1: 3 individual interviews and 2 focus groups (each with 3 participants);
Phase 2: 6 individual interviews and 2 focus groups (each with 3 participants);
Phase 3: 3 individual interviews and 1 focus group (with 4 participants).

The interviews and the focus groups were digitally recorded and later transcribed. After member checking, the transcripts were prepared for coding, a process which involved "highlighting extracts of the transcribed data and labelling these in a way that they can be easily identified, retrieved, or grouped" (Dornyei, 2007, p. 250). The coding process was conducted electronically with NVivo, a popular software package for qualitative analysis (Bazeley & Jackson, 2013). In the coding system, what the participants said and discussed on certain topics or aspects was marked and grouped by a number of 'nodes', which formed tree-like layered structures. For example, under the node 'app features', there were a subordinate level, consisting of nodes such as 'TTS reading', 'context extension', 'online dictionary' and 'disciplinary division'. Through systematic coding, the content of the transcripts could be easily retrieved on specific aspects around a few major topics, e.g. m-learning, DDL and concordancing, app design and so on.

Relationship between questionnaire and interview questions

Data triangulation, which combines data from different sources, is aimed to maximise research validity (Flick, 2004). The interview questions were designed to confirm, supplement and further explore the questionnaire responses. The data from the two sources was triangulated to generate more valid results. How the questions in the questionnaire and interview correspond to each other is illustrated in Table 3.4 under four interrelated themes. For example, the learning strategies of the participants would obviously influence the perceived effectiveness of KWIC and PIC, and their personal experience with the apps would be closely related to their attitudes towards mobile learning. Following the change to Likert scale questions in Phases 2 and 3, the online questionnaire became more focused on the experience and evaluation of the two apps (Theme 2 in Table 3.4; other themes were no longer covered but might be included in the

interview answers). All the interview questions used in Phase 1 were maintained in the ensuing two phases. It should be noted that the interviews were semi-structured, i.e. the aspects actually discussed were not necessarily limited to the prepared questions. In fact, the participants raised a number of interesting topics in the interviews, especially in the focus groups.

Table 3.4 Correspondence of Questions in Questionnaires and Interviews (Phase 1)

Online questionnaire questions	Semi-structured interview questions
Theme 1: perceived effectiveness of the apps	
Q9 – The way the search results are displayed helped you find the correct verb structure	Is the part highlighted helpful to keep you focused on the target?
Q10 – You were usually able to find the verb structure you were looking for	Is it difficult to find a verb structure? At a glance or with many attempts? Which part of language use did you find the app most helpful for, if any (vocabulary, grammar, sentence structure, terminology, hand used to identify)?
Theme 2: personal experience with the apps	
Q4 – I liked the app that I was given to try.	Which feature of the app do you feel is most helpful? Which is the least helpful? How did you use the app? Alone, or with any other resources? Where did you use the app most frequently? What did you use the app for? Only to deal with writing assignments? Any other problems, any suggestions?
Q5 – How did you find learning to use the app?	
Q12 – Overall do you think the app is helpful for your academic writing in English?	
Q13 – I would use this app in the future to help me with my academic writing.	
Theme 3: views towards concordancing search	
Q6 – Are the 10 random examples displayed clearly after you do a search?	Are you happy with the incomplete sentences? Is it helpful to extend the context on demand? How did you read the lines of examples? One by one, left to right or skimming?
Q7 – Is the level of the academic texts used in the app okay?	
Q8 – This selection of verbs provided by the app was	Do you often meet and use the verbs provided? Are you happy with the number provided? Did you browse the verbs or texts?

Q11 – Do you think it's helpful to have the texts divided into different disciplines?	Do you like the texts to be further divided/tailored to your needs?
Theme 4: views towards mobile learning	
Q1 – I use a paper dictionary when I am doing academic writing.	Are you currently using any apps for learning on your mobile devices?
Q2 – I use an electronic dictionary when I am doing academic writing.	
Q3 – Do you think mobile devices can help you with your learning?	

The next chapter provides the results of Phase 1 of the research.

CHAPTER 4:

PHASE 1

This chapter discusses the details and findings of Phase 1 of the research. It involves:

(i) A profile description of the two mobile concordancing app prototypes used in Phase 1 of the research;

(ii) The process of technical research involved in the development of the two mobile concordancing app prototypes used in Phase 1;

(iii) The results of the quantitative and qualitative research used to evaluate the users experience and uptake of the two mobile concordancing apps;

(iv) A reflection on the results of the quantitative and qualitative research. This will inform the subsequent processes of technical and evaluative research to be carried out in Phase 2 of the study.

4.1 App profiles

This description of the app profiles refers to the prototypes used in Phase 1. It aims to provide an understanding of the app design principles and core functionality. Further developments in the subsequent phases will be detailed in the following chapters.

The two apps designed for this research are in essence mobile concordancers with additional features. They are named APIC (Academic Patterns in Context) and AKWIC (Academic Key Words in Context), which represent the two concordancing approaches to be tested by the participants using the mobile platform. Hardie (2012) points out that various software tools for corpus linguistics are shaped to meet two very different demands: the need for power (capable of sophisticated queries through large corpora), and the need for usability (easy to use for non-technical-specialists). As mobile tools designed to produce and present concordancing results directly to learners, it is apparent that APIC and AKWIC place more emphasis on usability than power. Compared with conventional concordancers, most of which are accessed on desktop computers, either

through websites or through dedicated software, the two concordancing apps provide a more convenient and user-friendly access to a large number of authentic language examples with the target form aligned and highlighted. Concordancing functionality is the only focus, while more sophisticated text manipulation, e.g. sorting of results, and further statistical analysis, are excluded from the apps. With the least awareness of terms and techniques, student users can still follow the simple procedure of 'set/select query and get examples' to use the apps as a dictionary-like reference. At the same time, the two apps are open to incorporate technological affordances and changes of design elements for enhanced user experience and uptake. It turned out that during the action research, most of the attempts to improve the apps focused on usability enhancement based on user feedback, while the core functionality of concordancing remained largely unchanged over the three phases.

Although usability took priority in the iterative cycles of app improvement, this is not to say that the need for tool power was reduced to nothing. Two features were pursued and maintained throughout the research, so that the mobile apps were not simplified concordancers only for ease of use by non-experts. The one was PIC, i.e. pattern-oriented concordancing, and the other was access to disciplinary texts. All AKWIC and APIC versions of the app had the same pre-loaded discipline-specific corpora. All the texts contained in the corpora are authentic academic English writing, taken from the academic sub-corpus of the Corpus of Contemporary American English (M. Davis, 2009). There are nine disciplinary areas in the sub-corpus: i) education, ii) humanities, iii) history, iv) social science, v) philosophy and religion, vi) law and political science, vii) science and technology, viii) medicine and health, and ix) others. The number of words for each discipline amounted to one million. Before proceeding to the concordancing function, users of both app versions were asked to select the particular discipline they were interested in, hence all search results were discipline-specific. The underlying principle here is that different disciplinary areas have specific structural and lexical conventions, and discipline-focused texts are more likely to return search results relevant to the users specific disciplinary needs (Christie & Maton, 2011; Hyland, 2006a). The AKWIC app are described first, followed by an outline of the differences in the APIC app.

4.1.1 AKWIC in Phase 1

In the AKWIC prototype, after the user selects a target discipline, 52 core academic verbs, taken from the most recent frequency-based Academic Vocabulary List (Gardner & Davies, 2014), are listed as set search terms. It was intially determined that this list of frequently occuring academic verbs would motivate the required amount of student interest to effectively compare the participants' usage of the two concordancing apps. Once a target verb is selected, the app presents 10 random concordance results, with the target verb highlighted in yellow between a pair of square brackets. Figure 4.1 illustrates the interface of concordancing the word *provide* in AKWIC. On the upper left part, there is a figure of search results in red indicating whether the word is used frequently or not. If necessary, users can press the search button (a detective icon) to see another 10 random concordance lines of the same verb. This can be carried out an infinite number of times. If, at this stage, the user wants to carry out a different search, the verbs are retrievable from a drop-down list in the upper right corner.

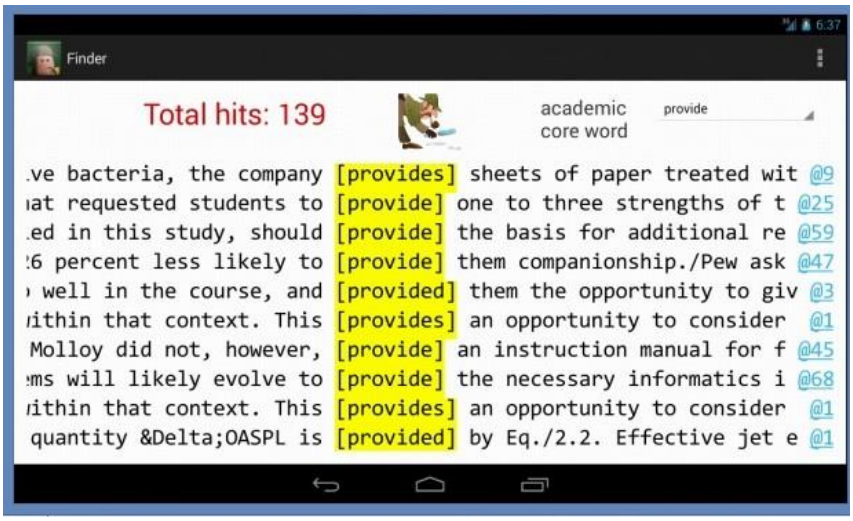


Figure 4.1 Concordances of the word *provide* in AKWIC

The user can access the wider textual context of any concordance line by clicking on the serial number at the end of each line. By doing this, they bring up another interface showing a larger extract of the original text containing the selected concordance line (see

Figure 4.2). In this interface, the target word is still highlighted in the middle of a wider context. There is a default length of context range, and the user can also use the 'Set Context' line on the middle right part of this interface between two iconic buttons to adjust the range of the textual context. Additionally, to take advantage of the multi-media affordances of mobile technology, the feature of TTS (text-to-speech) was added on the same interface to allow the displayed text to be read aloud by machine. This feature can be initiated by clicking the 'speaker' button in the lower right corner of the screen. The two features are also shown in Figure 4.2 (AKWIC and APIC shared the same layout and functionality of this interface).

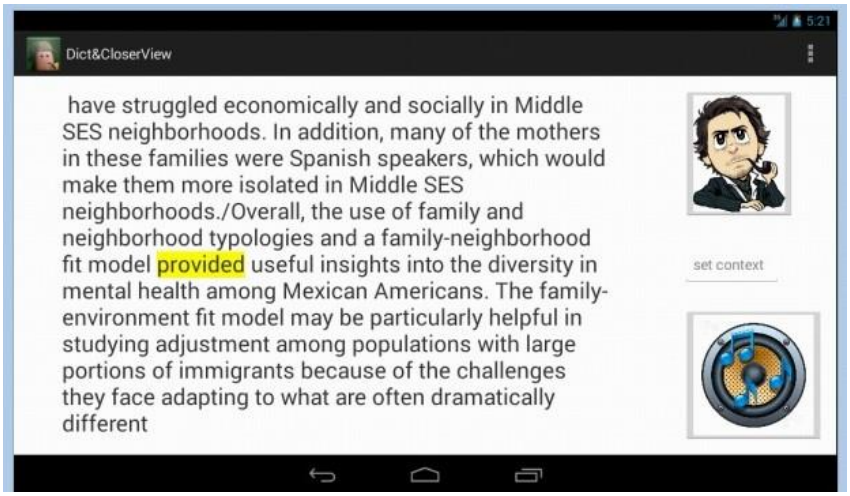


Figure 4.2 The interface for context extension in AKWIC

4.1.2 APIC in Phase 1

The major difference in Phase 1 between the AKWIC and APIC versions is that in APIC, each of the 52 core academic verbs has a drop-down menu which provides the user with the most commonly used patterns of the selected verb. For example, Figure 4.3 shows the two patterns associated with the verb *provide* as *provide* somebody *with* something, and *provide* something *for* somebody. In total, approximately 100 patterns are set out for the 52 core verbs. The user may also switch to another discipline via the upper left drop-down list in this interface.

Figure 4.3 The interface for discipline and pattern selection in APIC (Phase 1)

Once the the relevant verb pattern is selected, 10 concordance lines will be presented, which all show the selected pattern highlighted in yellow between square brackets (see Figure 4.4). The 'Look Up More' icon in the bottom right-hand corner of the interface provides the access to another 10 random search results. To the left of the button is the figure in red indicating frequency of the searched pattern. The figures in blue to the left of each concordance line provide access to a wider textual context for the specific concordance line as in the AKWIC version. A TTS reader identical to the one in AKWIC is also provided in the subsequent interface.

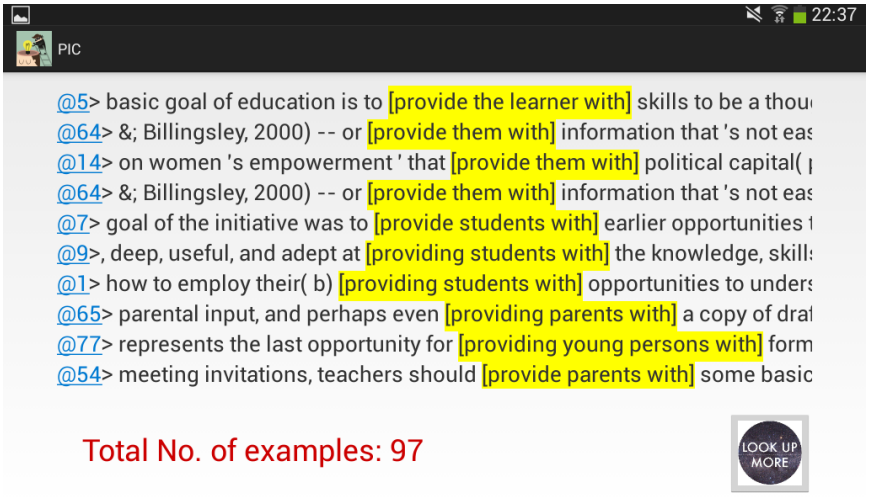


Figure 4.4 Concordances of the pattern *provide… with* in APIC

As part of the research process, these AWIC and APIC prototypes underwent a series of developments following the evaluation of feedback from the voluntary participants in Phases 1 and 2. The next section discusses the process of technical research involved in the development of the two mobile concordancing apps used in Phase 1.

4.2 Initial app development

This section demonstrates the technical steps of initial app development to produce the above-mentioned features. It was determined that Android would be the platform of development due to the wide availability of development tools and help from the developers' community. Since the source codes became increasingly complex as the project developed, they are not posted in full in this chapter. Instead, the concepts and algorithms used in each step are explained, with a particular focus on the complicated and tricky points. The description of the technical steps in the next two chapters for Phases 2 and 3 follows the same mode. The purpose is to ensure that this technology-enhanced study can be repeated by other Java-literate researchers and the apps may be improved iteratively as technology advances.

Java is a common programming language and is elementary in Android development. Basic knowledge of Java and Android programming is required to understand many of the technical descriptions in this and the subsequent two chapters. Unless otherwise noted, all specifications of the mentioned methods discussed hereafter can be found in Java or Android API (Application Programming Interface) documentation online[19]. A number of programming techniques were learned from a few special websites for programmers, such as GitHub, Stack Overflow and CSDN.

4.2.1 Java concordancers

Firstly, two Java concordancers were needed for the execution of KWIC and PIC, i.e.

[19] Available at http://docs.oracle.com/javase/7/docs/api/ and http://developer.android.com/intl/zh-cn/reference/packages.html .

concordancing of individual words and multi-word patterns. Concordancing is a process to find the search term (i.e. a string of letters) in a text and to retrieve the matched parts together with a certain length of characters to the left and to the right (i.e. the textual context). Mason (2000) and Hammond (2002) developed two Java programs for KWIC searches in their books, aiming to teach programmers how to use Java for text processing and manipulating in language research. However, in comparison to recent developments, these concordancers now appear to be overly complicated, since the two books were published at the turn of this century, and the authors were not able to benefit from the more recent development of Java technology. As there are very few similar books on this topic, it is necessary to refer to some works on general programming. In the fourth edition of their algorithm textbook, Sedgewick and Wayne (2011) provide a new solution, where a text is divided up into a list of numbered words by means of the `split()` method, which uses a space or punctuation as the criteria for splitting. This is similar to putting the words away one by one into an array of boxes. During KWIC searching, if a word in a box is found to be identical to the search term, this word is retrieved and placed in the middle, and it is easy to extract a few words around it from neighboring boxes through serial numbers, say, 5 to the left and 5 to the right. After restoring spaces and punctuation, a concordance line is assembled as it is in the original text. As long as more occurrences of the target word are found, other concordance lines are produced in the same way and aligned top-down. This approach is simpler, and is probably the one that is now used in many online KWIC search engines. Although it works well with individual words, this KWIC concordancer is not suitable for searching patterns which go across multiple words, as they have been dissembled and put into separate 'word boxes' before concordancing.

Therefore, a new Java concordancing program capable of both KWIC and PIC searching was required for this research. A new approach, similar to Sedgewick and Wayne's (2011) method, was adopted for the development. The principle of this new approach is to locate the positions of all the occurrences of the target form (a word or a pattern) found in a text, retrieve a certain number of characters (not words) on both sides, and then assemble the three parts to make a concordance line. In this way, concordancing can run smoothly even if the search term varies in form and length as in the case of PIC, since the searched string

is not divided into individual words, and there are no ‘box’ boundaries between words.

In the first step, `compile()` under the `Pattern` class and `matcher()` under the `Matcher` class were used in tandem to find the target form in the text. In the brackets of `compile()`, there must be a regular expression (‘regex’ for short) representing the search term, and an optional flag `CASE_INSENSITIVE` can follow it to include matched results in capital letters; the loaded text to search is put into `matcher()`. The `group()` method can retrieve the matched item(s), and `start()` and `end()` can identify the position (serial numbers) in the text. With the position data, a string of characters (irrespective of words, punctuation and spaces) to both sides of the matched form can be extracted from the text using `substring()`. One thing to note here is that neither end of the truncated part can go beyond the boundaries of the original text, i.e. less than 0 or larger than the text length, otherwise an exception will occur. To avoid this possible error, earlier in the text a period (‘.’) was added to both ends with repeated loops to the set amount of context span. This method was later abandoned, as it took a long time to process long texts. As an alternative, the start position and end position of a cut string was made equal to 0 and the text length respectively under the above two circumstances. Finally, each search term occurrence was identified and located in the text, and then was assembled with a certain length of characters on both sides as in its original context. A pair of square brackets were put onto each matched occurrence for highlighting purposes. The combining of strings can be done using `StringBuilder` or `StringBuffer`. The loops of finding and joining results kept running while `find()` remained true.

The PIC concordancer was largely the same as the KWIC one except for two differences. One is that a PIC search term must be a regex containing POS (part-of-speech) tags, and the texts to search must be POS-tagged accordingly. In this research, the tagged texts were adopted from the academic sub-corpus of COCA (Corpus of Contemporary American English). The other difference is that there was one more additional step of removing the tags attached to each word before the PIC results were presented on the screen. The removal can be done using the `replaceAll()` method. In fact, tags may be hidden on request without removal, but the hiding of tags conflicted with text highlighting which is

explained in the next section. As a result, the tags were deleted in this algorithm before the concordance lines were presented to the user.

4.2.2 Adaptation to mobile use by learners

Upon creation, the two concordancing programs had to be adapted to suit the two purposes of this research: to be used on mobile devices rather than desktop computers with large screens, and to be used by language learners rather than specialised linguists. In a typical concordancer, all results are displayed in full upon task completion. Given the huge size of most corpora, there are often scores of or even hundreds of generated concordance lines, which is probably overwhelming to most student users. A decision was made that the upper-intermediate learners involved in this research probably did not have the need, adequate experience and necessary skills to process all the results. In addition, it would be messy for the large amount of data to be forced into a smaller mobile screen, which is likely to have a negative impact on user experience with the mobile apps. Therefore, it was decided to present only a limited number of random concordances in a search (set as 10 to fit in the small screen of tablets). Instead, users could start another search for another 10 random examples. Frequent usages could still be observable from repeated concordances, despite the reduced number of results.

The concordancers were adjusted for the designed random searching. An `ArrayList` of strings was set up first, and each produced concordance was put into the list one by one using the `add()` method. When it was about to send examples to the screen, 10 results were retrieved from the list with 10 `Random` numbers using `get()`. Then the random results went through the final step of keyword highlighting, which was done using `SpannableString`. The key words to highlight could be identified by the brackets around them in the `setSpan()` method, where the highlighting colour was determined; it was possible to paint the letters or the background by choosing from the flaps of `ForegroundColorSpan` or `BackgroundColorSpan`. Figure 4.5 shows the results of random concordancing of *provide* in an earlier version of the KWIC concordancer, with the search word highlighted in the middle against a yellow background. Users can

press the detective icon at the top middle of the interface to retrieve another 10 results.

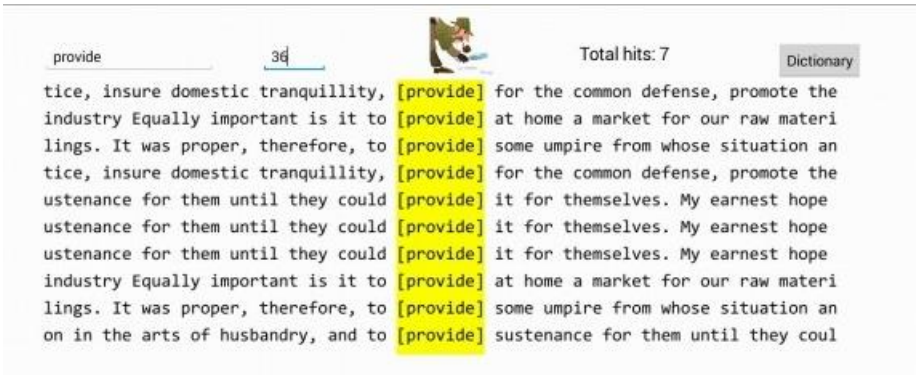


Figure 4.5 Highlighted KWIC results in an earlier version of AKWIC

There are a few points to note about this first version of the AKWIC app. Firstly, here the users had to set the context span themselves. The figure referred to the number of characters on each side rather than the number of context words, which was thought to be confusing to users. Secondly, to ensure that the target word could be placed right in the middle of the concordance lines, it was required to use a mono-space font, such as 'consola'. This was a disadvantage of AKWIC due to the limited range of available mono-space typefaces. For APIC, since both tags and matched patterns were not equally long, there was no point in making all the letters mono-spaced. Thirdly, the search shown in Figure 4.5 was a trial using a short text, so there were only seven results. Because of this, some concordances had to be repeated to make 10 examples. Fourthly, the searching was sensitive to inflections, so only the base form of *provide* could be processed here. The shortcoming of inflection-sensitiveness was addressed by introducing an appropriate SQLite database of inflections. One minor item to mention is the 'dictionary' button on the upper right of the screen gave access to a small English-English dictionary.

4.2.3 Additional features

As concordance-lines tend to be truncated sentences, users may need to look at a broader context for better understanding. In conventional concordancers, this can be done by setting a wider context span. That is why users were supposed to set the range of context in the earlier AKWIC version shown above in Figure 4.5. However, this might have been

confusing and unfamiliar to students, and furthermore, they may not have wanted to check the larger contexts of all examples. Thus, it was redesigned to provide each concordance with a clickable link to another interface where users could see the extended context of the specific result. This access on request could be done by using the `ClickableSpan()` method under `SpanableString`. The mechanism of the context extension feature was that the entire concordancing was repeated with a new parameter of context span (the default was set as 300, although it could be changed by the user as appropriate), and the results were again numbered and sorted in a list. Then the longer concordance with the same serial number as that of the clicked example could be retrieved and presented. The searched word was still highlighted in the middle of a longer passage, so it seemed like the context of the specific concordance was extended.

In addition, to take advantage of the multi-media affordances of mobile technology, the feature of TTS (text-to-speech) was added on the same interface to offer audio input of the displayed text. By clicking a 'speaker' button, users could listen to machine-reading of the passage on the screen, whether it was further extended by the user or not. For this feature, the TTS module within mobile devices was employed. The interface with context extension and TTS can be seen in prior Figure 4.2. Users could set a larger context range in the input box, and an attribute `setMovementMethod` had to be added, so that the text box was able to be scrolled vertically to accommodate more words to read on request.

There was one minor change in the initial design of the clickable links for viewing the extended context of the concordance line. In the original design, the clickable component of the link was also the matched pattern of the search result in the middle of the concordance line, as shown in Figure 4.6 below. It was decided that firstly, this overlap might make it difficult for the user to easily identify the existence of the link, and secondly that fingers might mistakenly click these links in the middle of the touchscreen. As an alternative, serial numbers were added to either side of the concordances to function as clickable links to extended textual contexts.

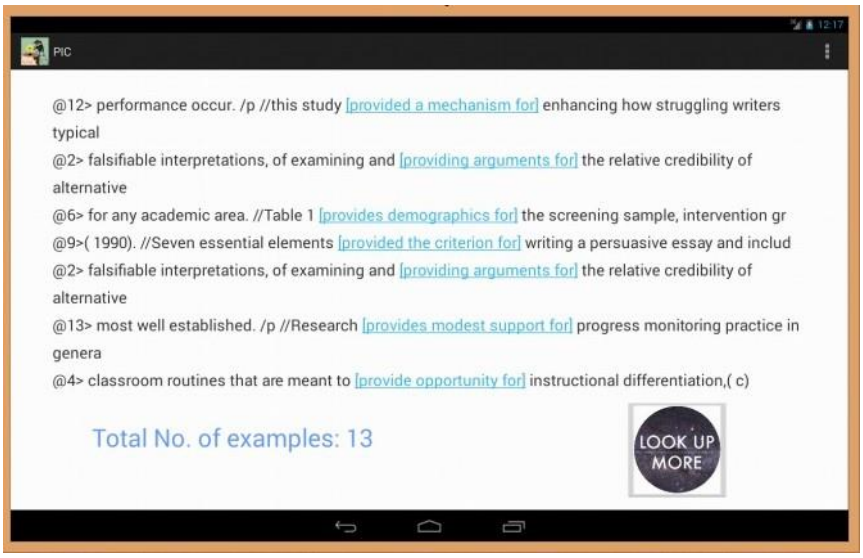


Figure 4.6 Earlier APIC version with the target patterns in clickable links

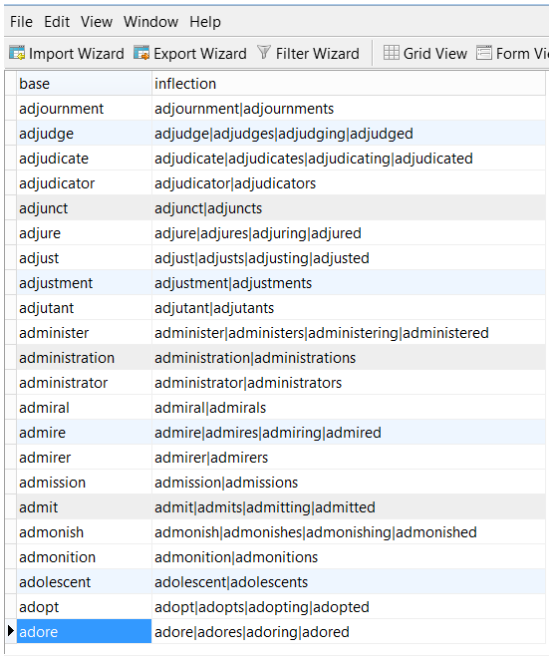
4.2.4 Integration of SQLite databases

The integration of SQLite databases was a milestone in the app development. It enabled inflection-insensitive concordancing, a prerequisite for PIC searches and the overall upgrading to open-query concordancing prior to Phase 2. SQLite is a relational database management system which runs faster than others. A visualised tool called Navicat was used to establish and maintain the SQLite databases in this research. The underlying principle of a SQLite query is that a `cursor` searches through a database, and once the target item is found in the key-value column, data in corresponding columns is retrieved using `getText()`. As the `SQLiteOpenHelper` class in Android is very complex, another SQLite helper class programmed by Jeff Gilfelt was adopted[20].

The first trial application of SQLite in this research was a small local dictionary. A database which contained 16,000 entries was established to provide concise definitions for searched words along with concordance lines. However, some definitions were too simple to be helpful, such as *act n. thing done; deed*. Hence, the SQLite dictionary was removed before Phase 1. However, at the request of the participants, an online dictionary was introduced in Phase 2, and became a popular and highly rated feature of both apps.

[20] The source codes can be downloaded from https://github.com/jgilfelt/android-sqlite-asset-helper .

The second SQLite database was set up to associate base forms of a word with various inflections. The data was taken from the lemmatisation list in the corpus-analysing software package WordSmith 4. Lemmatisation refers to treating different inflectional forms of a word as the same one, so that in text analysis they are not counted as different words. According to the help documentation, the list was compiled by Yasumasa Someya on September 1, 1998; the list at that time contained 40,569 words (tokens) in 14,762 lemma groups. Figure 4.7 shows part of the inflection mapping database.



base	inflection
adjournment	adjournment|adjournments
adjudge	adjudge|adjudges|adjudging|adjudged
adjudicate	adjudicate|adjudicates|adjudicating|adjudicated
adjudicator	adjudicator|adjudicators
adjunct	adjunct|adjuncts
adjure	adjure|adjures|adjuring|adjured
adjust	adjust|adjusts|adjusting|adjusted
adjustment	adjustment|adjustments
adjutant	adjutant|adjutants
administer	administer|administers|administering|administered
administration	administration|administrations
administrator	administrator|administrators
admiral	admiral|admirals
admire	admire|admires|admiring|admired
admirer	admirer|admirers
admission	admission|admissions
admit	admit|admits|admitting|admitted
admonish	admonish|admonishes|admonishing|admonished
admonition	admonition|admonitions
adolescent	adolescent|adolescents
adopt	adopt|adopts|adopting|adopted
adore	adore|adores|adoring|adored

Figure 4.7 SQLite database for inflection mapping

Unlike in WordSmith, the inflection mapping list was used to ‘de-lemmatise’ input words in the two apps, i.e. when a user entered the base form of a verb or noun, all the different inflections, including third-person singular, past tense, past participle, present participle and plural, would also be searched. Figure 4.1 above shows how all inflective forms of *provide* are included in the results of a single query with AKWIC. The case of APIC is shown in Figure 4.4. It should be noted that the apps demonstrated here are the ones used in Phase 1, with a set group of 52 academic core verbs. Larger SQLite databases were established for APIC in the reflection period before Phase 2.

4.2.5 Tailored for research use

As the two apps were designed to assist with academic writing, they needed to be adapted to academic contexts with appropriate materials. Firstly, the apps provided disciplinary-specific texts for users, who were exposed to language use specific to their domains of interest. Users were required to choose a certain discipline out of nine on the initial interface. The nine options are presented in `ListView` under `SimpleAdapter`. With `setOnItemSelectedListener`, appropriate texts can be loaded for searching once a discipline is selected. The discipline selection feature has a separate interface in AKWIC, and the list can be seen in Figure 4.8.

Figure 4.8 The AKWIC interface for discipline selection in Phase 1

On the left part of the interface, there was a gallery of finger icons presented through `GalleryView`. Users could scroll down the row of icons and see the enlarged picture below. This feature was designed to convey the idea of 'click to find', i.e. the user could easily carry out the search procedure using only their fingers. However, this feature was later removed due to negative comments from the users in Phase 1. It was generally considered useless or confusing by a number of participants (see Section 5.3.2.2). In addition, a total of 52 core academic verbs, taken from the Academic Vocabulary List (AVL), were provided in a drop-down list. It was not difficult to load the group of verbs as set search terms using `setDropDownViewResource`.

In the APIC app, there was an additional pattern selection step before concordancing could take place, and this feature was combined alongside discipline selection within the same interface. The selection of disciplines had to be put in a drop-down list accordingly to make room for the gallery. The pattern selection was more complex, as there was a similar list of 52 academic core verbs, while the associated patterns needed to be attached to a word in a subordinate list. The interface of pattern selection in APIC is shown in Figure 4.9, where the pattern list of the word *provide* has been expanded. Here the method `ExpandableListView` was introduced to present the patterns in an organised and clickable manner.

Figure 4.9 The APIC interface for discipline and pattern selection in Phase 1

For the purpose of this research, automatic logging was initiated to collect app use data. The logs included time of login and logout, date, day of the week, searched words/patterns, and the number of context and dictionary checks. The information of time and date could be retrieved by calling `Calendar.getInstance()`; the input words and patterns were recorded through `AutoCompleteTextView`. Once a user chose to use the feature of context extension, or the online dictionary introduced in Phase 2, a string of upper-case letters 'WIDER-CONTEXT' or 'DICT' were recorded in a plain .txt file by using `FileOutputStream()`. The files of the automatic logs were collected by the researcher for statistics once the devices were returned by the participants. Please refer to Section 3.6.1 in the preceding chapter for a typical example of automatic logs.

4.3 Results of Phase 1

Phase 1 of the study proper contained two cycles of app use and involved 18 participants in total. Eight participants used AKWIC and the other 10 used APIC. A participant in Phase 1 was anonymously identified by the letter P (standing for 'APIC') or K (standing for 'AKWIC') followed by a string of "cohort number - serial number". For example, P1-5 represents the fifth APIC user of Cohort 1.

It was found that three APIC participants in Phase 1 produced no passive capture data in valid sessions, which means that they did not use the app. Consequently, the app use data of the other 15 participants was collected, with eight AKWIC users versus seven APIC ones. Approximately 60% of the participants, 9 out of 15, accepted the request for a final interview (including in focus groups), excluding those who produced no app use data or declined the interview request. The data collected from automatic logs, questionnaires and interviews for Phase 1 is presented below.

4.3.1 Data from automatic logs

4.3.1.1 Comparison of app use in Phase 1

The raw calculations of sessions, queries and so on about how the participants used the two apps are presented in Appendix C. The data from statistical processing is shown in Tables 4.1 and 4.2. For definitions of these indicators, please refer to Section 3.7.1 of Chapter 3. In both tables, the median value, rather than the mean, is calculated based on app use data from individual users, to show typically how a user engaged with the designated app.

The percentage in the bottom row is called 'coefficient of variation' ('C.V' for short). It is the standard deviation of the column divided by the mean score, representing intra-group variation. In this research, C.V value shows how differently the participants in a group used the app, e.g. whether some of them used a particular function often, while

others seldom used it. The higher the percentage, the more differently the designated app was used within the group, and the less representative the median values can be of the app use by individual participants. The major difference of C.V from standard deviation is that C.V can be used to compare groups of data at different orders of magnitude. For example, as shown in Table 4.1, the number of distinct queries ranged from 1 to 20, while the context check per query was mostly under 0.5. The calculation of C.V is introduced here to compare the variance of the two sets of significantly different data.

Table 4.1 Processed Data of AKWIC Use (Phase 1)

User code	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query
K1-1	7	2.40	1.92	41.67%	0.25
K1-2	12	1.67	2.10	40.00%	0.45
K1-3	4	1.67	2.20	20.00%	1.20
K1-4	11	6.25	1.76	56.00%	0.32
K2-1	20	7.57	1.89	62.26%	0.75
K2-2	5	4.00	4.13	37.50%	0.38
K2-3	3	3.50	1.57	57.14%	0.43
K2-4	1	3.00	0.33	66.67%	0.00
Median	6	3.25	1.90	48.84%	0.41
C.V	78.70%	56.91%	52.55%	32.67%	76.44%

As shown in Table 4.1, a typical AKWIC user looked up six different verbs over the four weeks. The difference in the number of distinct queries is the highest within this group. In addition, in each session over three queries were made. It also usually took slightly less than two minutes to complete a query. The repetition ratio of nearly 50% indicates that typically there was a repeated query out of every two queries. With the smallest intra-group variation, it appears that the AKWIC users needed repeated queries to get more examples. Finally, a typical user wanted to see a wider context about every 2.5 queries.

As shown in the row of C.V percentage, the highest two values were for distinct query and context check per query, which means the app use was the most varied in these two aspects. For example, K2-4 searched only one distinct verb, while K2-1 looked up as many as 20 from the list of set verbs; it was the same case in their use of the context check function, as the frequency is 0 versus 0.75 per query.

For the APIC users, Table 4.2 shows that typically three different verbs were searched during the period, and each APIC query took about 1.5 minutes. It should be noted that APIC users did not have much difference in the time spent on each query. There was a repeat query out of about every five queries, as indicated by the repetition ratio of slightly over 20%. Compared to the AKWIC group, the APIC users generally used fewer repeated queries. Finally, an APIC user typically checked a wider context once every two queries.

Table 4.2 Processed Data of APIC Use (Phase 1)

User code	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query
P1-1	3	3.00	1.50	50.00%	0.50
P1-3	3	1.00	2.00	0.00%	0.33
P1-4	7	1.29	1.56	22.22%	0.22
P1-5	3	2.33	1.29	57.14%	0.86
P2-1	1	2.00	1.00	50.00%	0.00
P2-2	1	1.00	3.00	0.00%	1.00
P2-3	4	4.00	2.00	0.00%	0.75
Median	3	2.00	1.56	22.22%	0.50
C.V	64.76%	53.74%	37.01%	102.80%	69.65%

As shown in the row of C.V data, the intra-group variance remained high in the number of distinct query and context check per query, but the highest was for repetition ratio. This is where the major intra-group variance lies: some APIC users (e.g. P1-5) often needed to use the repeat concordancing, while the other three participants (P1-3, P2-2 and P2-3) did not use the function at all.

With the mentioned indicators, the engagement and efficiency of using the two apps can be compared. The medians of AKWIC and APIC use are listed in Table 4.3 below.

Table 4.3 Median Data of App Use (Phase 1)

App	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query
AKWIC	6	3.25	1.90	48.84%	0.41
APIC	3	2.00	1.56	22.22%	0.50

On the one hand, the AKWIC users looked up a greater number of different words, twice the amount searched by the APIC users. It is similar in queries per session (3.25 vs. 2.00). Therefore, by comparison, the AKWIC group seemed to be more interested in using the designated app than the APIC group. Considering that three APIC users did not produce any use data, that is, they did not use it at all, it is clearer that APIC was less attractive to use than AKWIC. On the other hand, the AKWIC group tended to spend more time on each query than the APIC group. Specifically, the time of 1.56 minutes for the APIC group is considerably shorter than 1.90 minute for the AKWIC group. In other words, APIC saved 20% of the time for each query, amounting to approximately 20 seconds. In addition, the AKWIC users repeated searches for the same word notably more often than their APIC counterparts, with about one repeat every two queries, versus one repeat every five queries. Although the APIC users behaved very differently in this aspect within the group, i.e. some APIC users often used repetition, on the whole the AKWIC group tended to need more examples through repetition to find out about a word than their counterparts using APIC. Therefore, the two indicators – time per query and repetition ratio – show higher efficiency of APIC over AKWIC. The medians of 0.41 and 0.50 in the last column indicate that the participants tended to have a context check out of every 2 to 2.5 queries, where they might read through 20 to 25 concordances and focus on one example.

In short, it seems that the AKWIC users had more interest in working with the provided app than the other group using APIC. However, the AKWIC users had to spend more time on finding out the answer to their query than their APIC counterparts. In addition, it would appear that the on-request context extension may help this process. One reason might be that the concordance lines are usually difficult to read, since they are incomplete sentences densely aligned together. This is particularly true for academic texts which often feature long sentences and complex grammar. The comparison of engagement and efficiency, as well as the significance of context extension, needs further discussion in combination with qualitative data from the questionnaires and interviews, which is presented in Section 4.3.2 of this chapter.

4.3.1.2 Time of mobile use

With the automatic logs, it is possible to investigate the time of mobile use, i.e. which week days and what time of a day the apps were used. Such data can shed light on whether the participants could obtain the reference resource anytime they wanted, which indicates that they could overcome the restrictions of time. The use data of AKWIC and APIC is combined in this aspect, and the processed data of logging is presented in Figures 4.10 and 4.11 with two line charts.

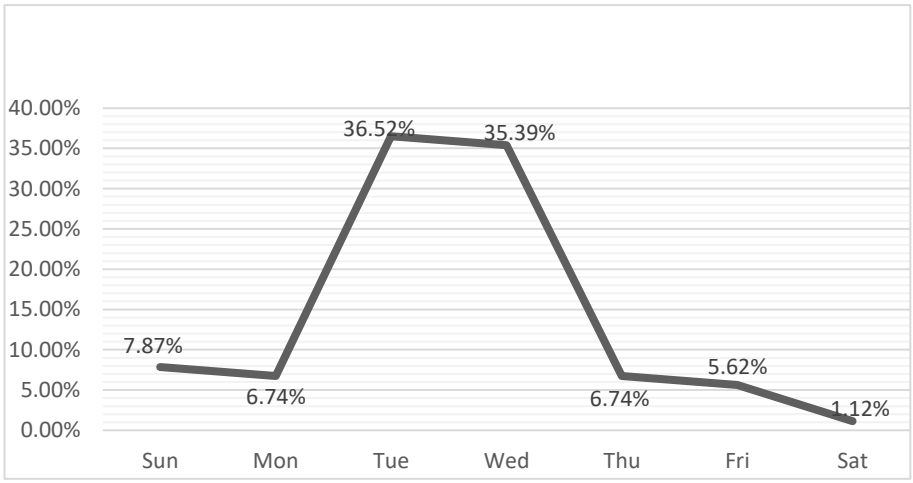


Figure 4.10 Daily app use through the week

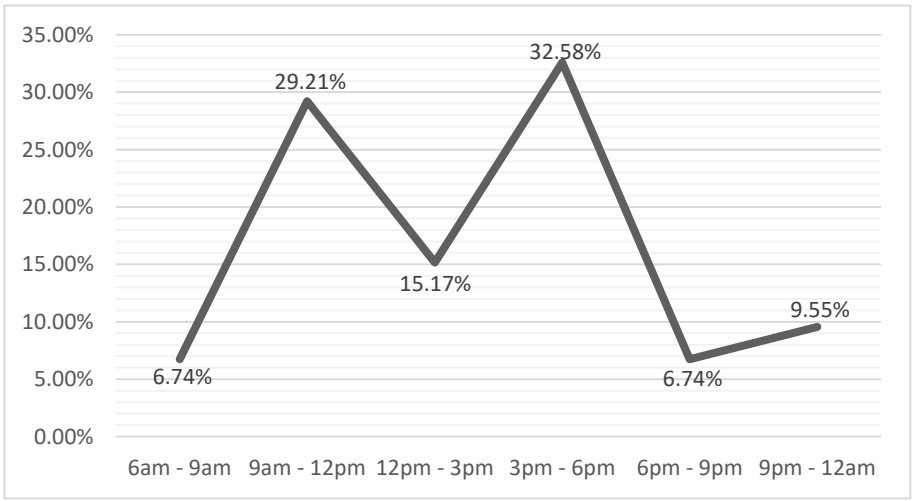


Figure 4.11 Time of app use in a day

It can be seen from the figures above that the participants used the apps most frequently during the middle of a week on Tuesday and Wednesday. While the frequency of use declined to the lowest point on Saturday when students might have been enjoying their

weekend rest, it rose back sharply on Sunday, maybe because the users needed to prepare for their study for the upcoming week.

For the specific time of a day, the time from 6 am to 12 am is considered the possible work time of the students, and is divided evenly into six periods with three hours for each. Again it is reasonable that they made most queries, over 60%, in the morning and afternoon. In addition, a considerable number of queries were made early in the morning and late at night. In fact, the earliest captured time of login was 6:10 am, and the latest time of use was only a few minutes prior to midnight. It should be noted that these time statistics represent the behaviour of only a few users. However, the data could at least indicate that the mobile apps did support the learners out of school time, e.g. on weekends and at night, when they probably had to work alone with no teacher to consult. The convenient access was enabled by the development of mobile technology.

4.3.2 Questionnaire and interview responses

This section sets out the participants' responses to the questionnaire and interviews in detail. Links to the questionnaire were given via email to the 15 participants who made valid queries. They completed the questionnaire online when they were available. Eight of them accepted the request for an interview and answered questions individually or in small groups. Such qualitative data from the two sources is presented in an integrated way around four topics: perceived effectiveness of the apps, personal experience with the apps, views about concordancing searches and views about m-learning.

4.3.2.1 Perceived effectiveness of the apps

All the 13 questions for Phase 1 questionnaire can be seen in Appendix B. Among them, Q9 and Q10 are about direct evaluation of how effective APIC and AKWIC were. The responses to the two questions are shown in Figures 4.12 and 4.13.

For at least half of the users in both groups, the display method 'sometimes' helped them

find the correct verb structure; on average around 40% of users said they could 'often' get the help. In addition, 13% out of AKWIC members (actually one) felt he or she 'always' benefited from the method. With the apps, a very small number of users could find the target structure 'easily', while most of them still had to make some effort to find it. One AKWIC member even reported having some difficulty. By comparison, AKWIC showed no inferiority to APIC in terms of perceived effectiveness. To some extent, it seems that AKWIC was even thought by some AKWIC users to be slightly more helpful and effective than APIC.

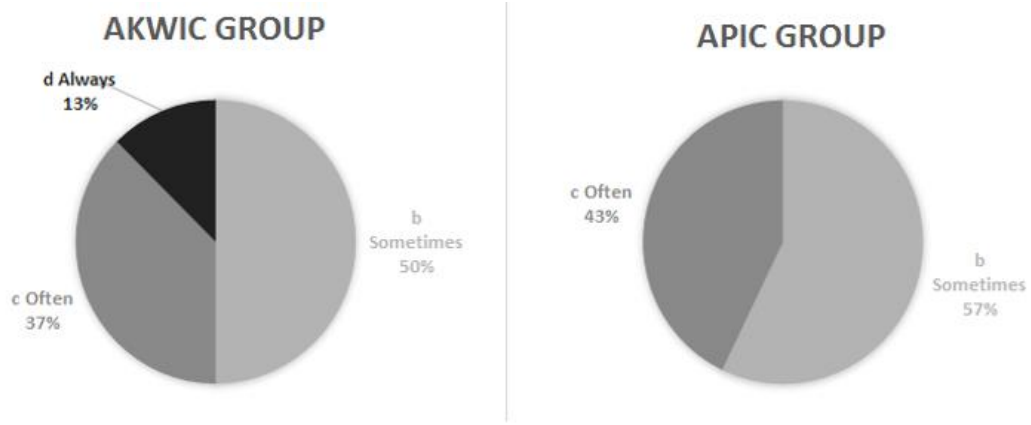


Figure 4.12 Responses to Q9: The way the search results are displayed helped you find the correct verb structure (N=8; N=7)

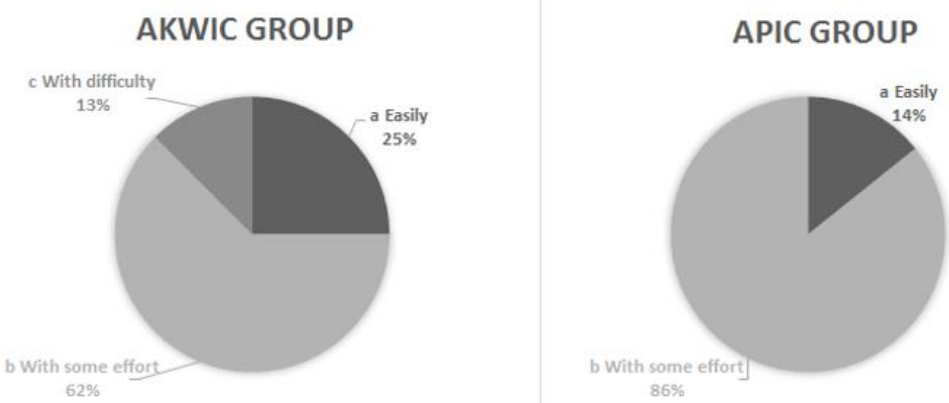


Figure 4.13 Responses to Q10: You were usually able to find the verb structure you were looking for (N=8; N=7)

It was found from the interview that yellow highlighting of the search word or phrase in the concordance lines effectively improved the positive experience of the users of both concordancing apps. All interviewees commented that this function helped them focus on

the target form (the selected word or pattern) in the textual context. The comment from K1-2, an AKWIC user, may be representative of this view:

> I think it's the best way, if you highlight the word. Because we look for a word, and how it is used in context. And you provide all text, and you highlight it in the middle. I think the highlight[ing] is a good idea.

The APIC users were also quite positive about highlighting, e.g. P1-5 reported that the highlighting helped him "notice the common usages". However, the AKWIC users often needed repeated queries to notice the target form, while fewer APIC users had this experience. This is consistent with the higher ratio of query repetition in AKWIC.

In the interview, some participants discussed how the apps assisted their language use. AKWIC and APIC's different approaches to producing concordance results (individual words vs. structured patterns) appeared to affect the participants' experiences at this level. Many AKWIC respondents, for example, considered that the designated app was most helpful for their vocabulary building, e.g. K1-4 and K2-3. By comparison, APIC users tended to focus on linguistic information at the grammatical or sentence level. P1-5, for example, thought that APIC was helpful on "more grammar than vocabulary" and offered more comprehensive linguistic information, so that her writing became more "fluent, and smooth, or coherent". Some other APIC users (P1-1 and P1-3) felt that their general language proficiency was enhanced, but on further questioning stated that it was hard to identify exactly in which specific areas.

Interestingly, some AKWIC users requested a further sorting of the concordancing results of individual words. For example, K1-2 suggested providing "collocations and phrases" of the target word, which is exactly what APIC aimed to deliver. This implies that APIC might be more effective for users aware of multi-word units.

4.3.2.2 Personal experience with the apps

The personal experience of the two groups can be indicated by Q4, Q5, Q12 and Q13,

and the answers to the four questions can be found in Figures 4.14 to 4.17.

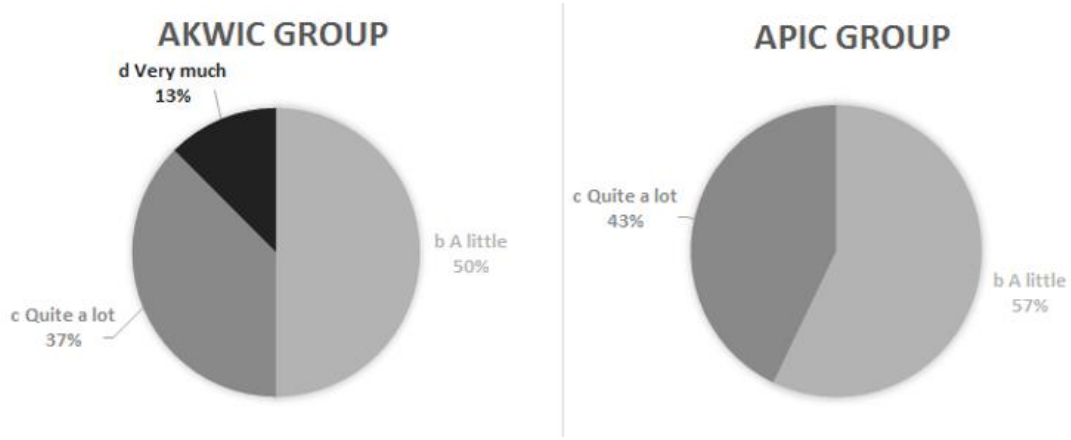


Figure 4.14 Responses to Q4: I liked the app that I was given to try (N=8; N=7)

From Figure 4.14, it can be seen that over half of the participants only liked the apps 'a little', which means there is substantial room for comprehensive improvement. By comparison, slightly more APIC users reported to like the app 'quite a lot', while one (13% out of 8) AKWIC user selected 'very much'. In the interview, APIC received more positive comments. A few APIC users in the study said that they "never met with this method" (P1-1 and P1-4) and one was positive about its prospect as a "promising commercial product" (P1-3).

As for the features, context extension and TTS (text-to-speech) were very popular with the participants. At least 3 interviewees expressly listed 'context extension' as the most helpful function (K2-1, P1-3 and P1-4); one of them further demanded meta-information of the texts, such as author, year of publication, journal or book title, and so on (P1-3). The TTS function was also highly praised. The audio reading by machine was thought to be able to add one more modality to the language input, and enrich the presentation of text-only corpora to learners. The benefit was recognised and described by P1-4 as:

> Yes, students can match the sound and the word; they can match what they hear and what they see. This is really good… If you only read, it's a single type of stimulus. When audio is added, the brain can receive another type of signal.

At the same time, a few participants complained about the quality of this broadcasting functionality, saying that the machine reading was unnatural and not human-like (e.g. P1-1 and P1-4). Because of this feedback, the researcher made a decision to maintain these two features with some improvement. Contrary to this, the gallery of finger icons was considered the least helpful. After the failure to find any concrete function it could serve, the participants could not understand its symbolic meaning of 'fingers-on': "I tried to play around, but I don't know what I'll get from it. I was actually confused" (K1-1). P2-2 gave similar feedback. Thus, it was decided that this confusing design should be abandoned.

More complaints were about the interface design as a whole. A few AKWIC users felt that the app should be made "more fun, more colourful" (e.g. K1-2). Compared to AKWIC, APIC required the additional step of "pattern selection" in a typical procedure. It was decided that this extra step should be condensed within the same interface as discipline selection, so that APIC would contain the same number of interfaces as AKWIC. As there were more items on the initial interface, it appeared to look "messy" or "rough" (P1-3 and P1-4). This inevitably impacts on the efficiency and experience of using the app: "I just feel there is so much stuff. I have to look around, so I feel tired. You have to spend a lot time on getting to details" (P1-1). Also, more APIC users reported having annoying crashes: "it may crash a number of times before I could see a word" (P1-4). Therefore, interface and procedure redesign were put on the agenda for improving the users' experience of app use.

It seems that both apps were easy enough to use. Figure 4.15 below shows that no participants felt it difficult to learn to use the apps. The result can be confirmed by the feedback from the interview, where the interviewees reported to have no difficulty in working with the apps. However, a few users (e.g. P1-1) suggested that on-request instructions or tutorials should help better understand the apps in a short time. Considering the time that the adaptation to m-learning may take varies across people, built-in instructions on how to use the app should be made available.

The potential advantage of APIC over AKWIC emerged from the perceived effectiveness

for academic writing and the students' willingness to use this app in future. As can be seen in Figure 4.16, the participants in the AKWIC group who felt the app was 'very helpful' and 'helpful' for their academic writing accounted for 25% respectively, and the other half of participants said it was only 'a little' helpful. By contrast, the APIC members who felt the app was 'helpful' more than doubled to 57%, and the proportion of 'very helpful' and 'a little' respondents on the continuum declined correspondingly. It seems that most APIC members agreed that the app could help them with their academic writing, while the AKWIC users were less positive and less coherent in their answers.

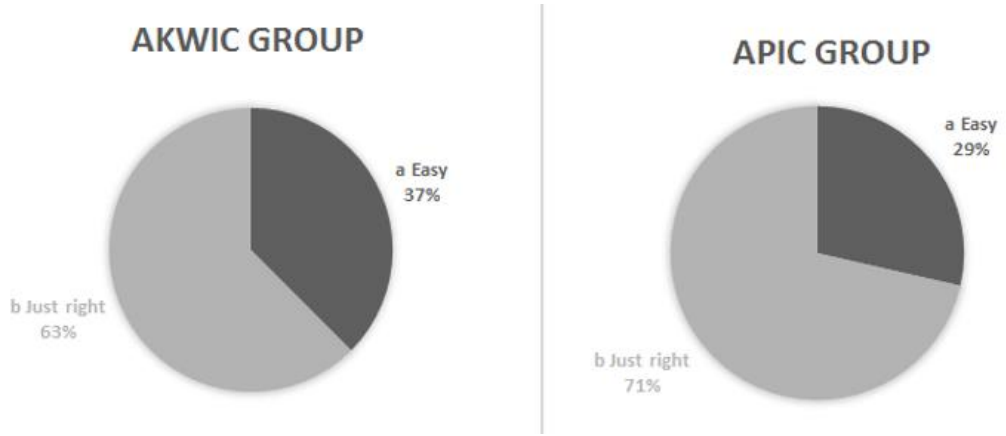


Figure 4.15 Responses to Q5: How did you find learning to use the app (N=8; N=7)

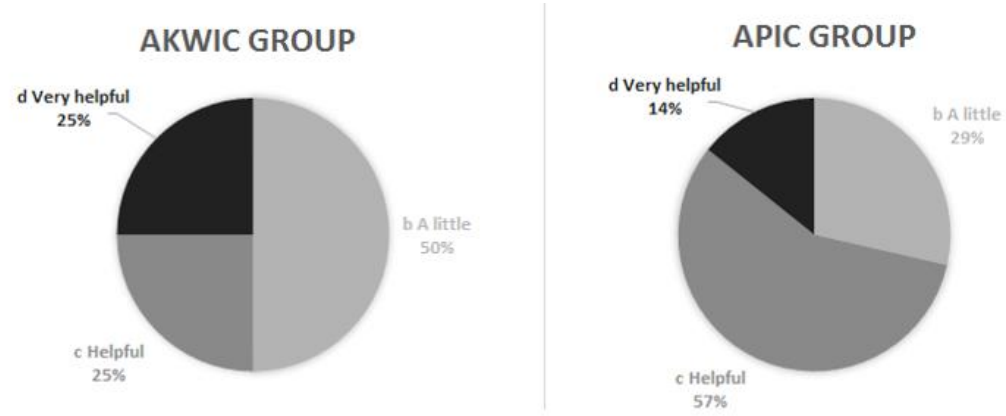


Figure 4.16 Responses to Q12: Overall do you think the app is helpful for your academic writing in English? (N=8; N=7)

The different ideas about helpfulness of the two apps are clearly shown in Figure 4.17. Although in answer to the question about future use, in the AKWIC group 13% (in fact one user) reported 'definitely' and another chose 'probably', three-quarters of them were quite uncertain, as they answered 'maybe' or even 'don't know'. By contrast, the majority

of participants in the APIC group would ‘probably’ use it in future, and those who chose ‘maybe’ accounted for less than 30%. The better results of APIC in perceived helpfulness and willingness to use it in future to some extent imply that the users thought APIC is better. However, this was contradictory with the data of actual use, and no reason was revealed from the interview answers.

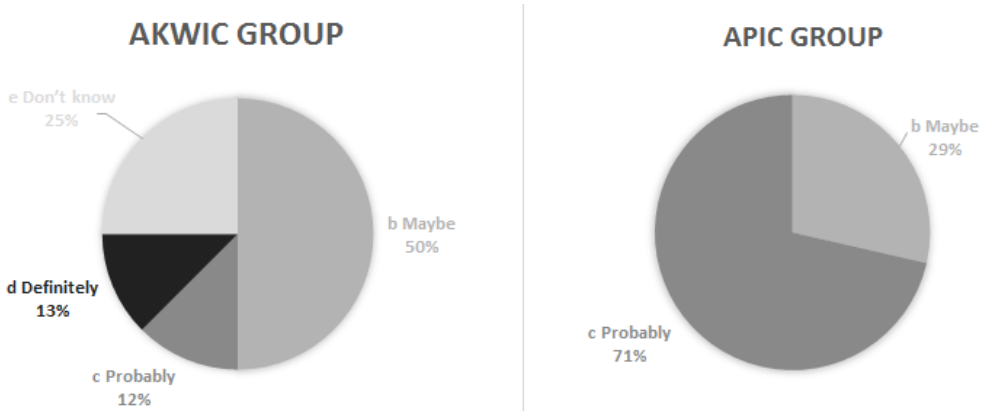


Figure 4.17 Responses to Q13: I would use this app in the future to help me with my academic writing (N=8; N=7)

4.4.2.3 Views about concordancing search

This section focuses on the participants’ views about the concordancing functionality. Figure 4.18 shows whether facing 10 results in a single query posed a challenge to them.

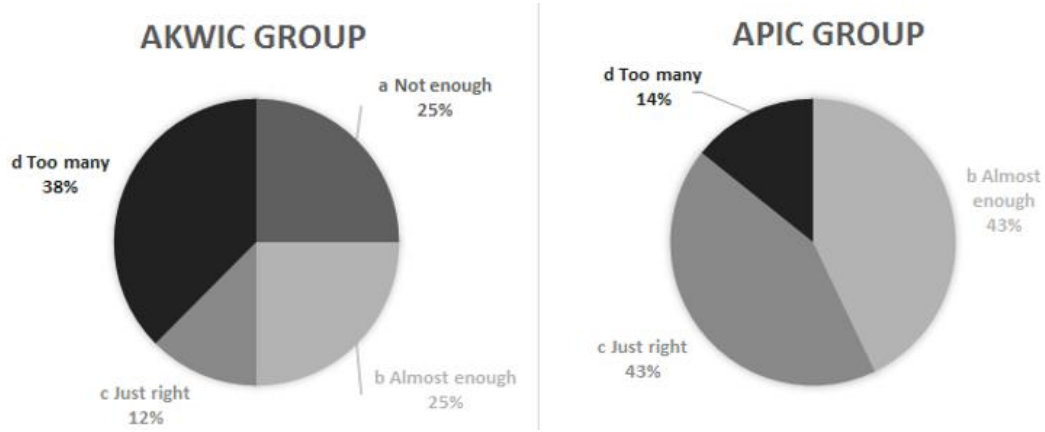


Figure 4.18 Responses to Q6: Are the 10 random examples displayed after you do a search (N=8; N=7)

In the AKWIC group, only one participant (12%) felt that the number of examples was ‘just right’, and nearly 40% of them reported ‘too many’. It was found in the later

interviews that most of the participants followed the usual practice of reading words one by one from left to right. In a single query there were more than 100 words displayed on the screen, and reading incomplete sentences across 10 different contexts would be more difficult. Since no training on skimming techniques was given to the participants, reading concordance lines was unsurprisingly challenging to them. For instance, an AKIWC user K1-4 complained: “I feel the examples of the words are a bit too many. If I read them without a purpose, I will feel bored after reading 3 or 4 sentences”.

By comparison, over 40% of their counterparts using APIC felt the number of examples was ‘just right’, and only one APIC user (14%) thought that the amount was ‘too many’. Although APIC users faced the same challenge of reading 10 concordance lines in a short time, it seemed to be easier for them to read the results of PIC than KWIC concordancing. Although there was no explicit comparison in the interview, the sorting of results and focusing on one usage in APIC were thought to be helpful by the APIC users (e.g. P1-4 and P1-5).

Interestingly, a large number of participants thought that the 10 results were ‘almost enough’ or even ‘not enough’ (half of the AKWIC users and more than 40% of the APIC users). There might be a problem in the wording of Q6. Some participants might take the question of “are the 10 examples displayed at a time too many to process” for “are the 10 examples enough for you to pick up the usage”. In fact, both qualitative and quantitative data indicated that although highlighting was helpful, it could not enable the participants to find the target form at a glance out of many concordance lines. Most participants said in the interview that they had to press “more than once” to find the target form; the data of ‘repetition ratio’ indicates that the users of both concordancing apps often needed repeated queries (see Section 4.3.1.1 of this chapter).

In general, the authentic academic texts were not thought to be difficult by the majority of participants, as shown in Figure 4.19. Half of the AKWIC users and over half of the APIC users felt the level of difficulty was ‘just right’. Only a few of them felt that the texts were ‘slightly difficult’, and a couple of them even answered the texts were ‘easy’.

Although in this research there were no tests designed to check their comprehension of the texts, the participants' confidence in processing the authentic language indicated that the selected corpus data can remain as the databank of queries.

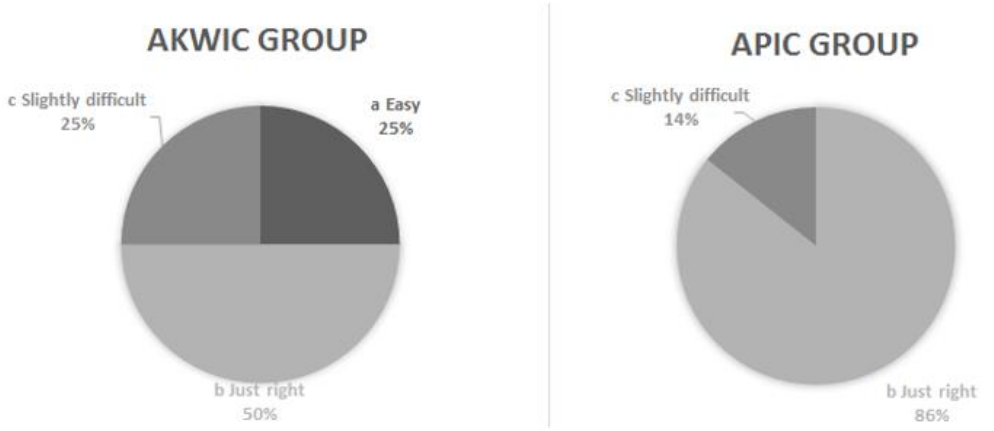


Figure 4.19 Responses to Q7: Is the level of the academic texts used in the app (N=8; N=7)

The potential benefits of using authentic academic texts may be another factor that makes the original texts more appealing and acceptable to learners. The gains may even go beyond the linguistic level, based on a comment from an APIC member, "If this is for academic purposes, large-scale input is not a problem. Long examples are also fine, and they may sometimes inspire some ideas" (P1-1). One of her AKWIC counterparts, K1-2, confirmed this statement with his own example, reporting that he "borrowed an idea" from the texts he searched and used it in one of his assignments.

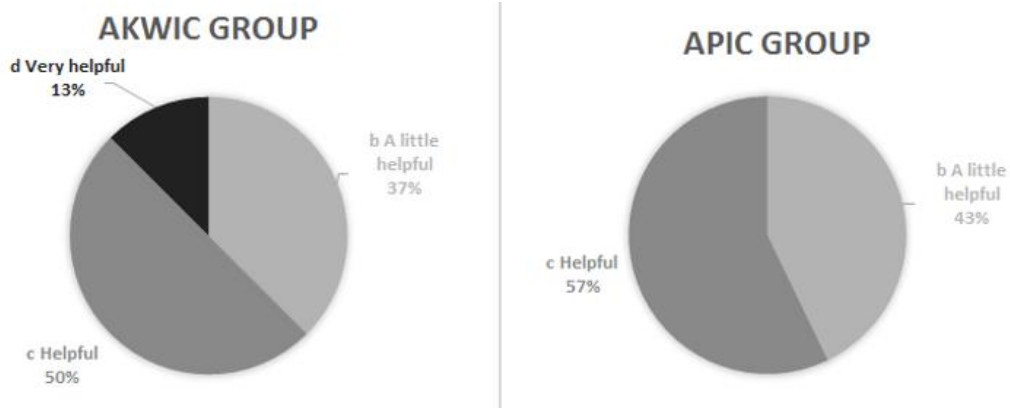


Figure 4.20 Responses to Q8: This selection of verbs provided by the app was: (N=8; N=7)

Figure 4.20 demonstrates how helpful the participants thought the two apps to be. It is encouraging that around 60% of the participants were very positive about the selection of core verbs to search by responding 'helpful' or 'very helpful'. Nevertheless, the other 40% were not as satisfied.

Two specific shortcomings were identified in the interview: one is the frequency-based listing of the verbs, and the other is the limited number of verbs provided. A problem with the frequency-based approach to listing the verbs is that it was not easy to find a specific word from the list. Instead, the participants preferred an alphabetical sequence. Among others, P1-4 commented:

> Alphabetical order will probably be better than frequency of usage. Because as the users, we don't know [where] the frequency usage is from, we don't know the numbers. So I need to search bottom-up to get it. If the words can be sorted out in an alphabetical order, it would be easier for me to search.

Secondly, it was found that very few interviewees were content with the number of 52 verbs. For example, K1-2 asked for an academic wordlist of at least 200-300; other participants often responded "the more the better" (e.g. P1-1 and P1-4). In addition, many frequent words in the list can serve different word classes, and verb usages were not enough for the users, as P1-5 said: "my hope is the words can be divided by word class, like verbs, nouns, and adjectives". It is possible that the participants did not fully understand the importance of the AVL (Academic Vocabulary List) verbs, or that use of these verbs might improve their academic writing. Instead they preferred to have more verbs to choose from, perhaps so that they could choose verbs they already knew.

It is also possible that the two problems identified by the users partly accounted for the relatively low utilisation of both apps, as it was inconvenient for them to find a word that they wanted to know. When they scrolled up and down the list and did not find the word they were familiar with, it was thought to be "a waste of time" (P1-1). This was especially true for APIC: the participants had to go through a more complex wordlist and an

additional step of pattern selection. P1-4 complained about his experience in class: “when the teacher is explaining a word, the process may be very fast, but it is a long time before I find it”. Therefore, finding solutions to overcome the two reported problems needed to be taken into serious consideration.

As for disciplinary text division, Figure 4.21 shows the participants’ views about the division of discipline-specific texts. About 60% of participants considered the discipline-specific texts were ‘helpful’ or ‘very helpful’, while the other 40% were not so positive. Answers from the interview were largely consistent with the limited recognition of academic disciplinarity. Quite a few interviewees did not understand the value of searching texts about a specific subject. P1-1 and P1-4 were not happy with the ‘discipline selection’ step, as they often wanted to “look at how the same word is used in different contexts, in different areas”; they would like to see examples across many subjects at the same time. P1-5 was more negative:

> So the division of disciplines, I don’t understand it. At least at present, this is not useful for me. … At least now, for general study, when disciplinary division is not so significant, this is of little use for me.

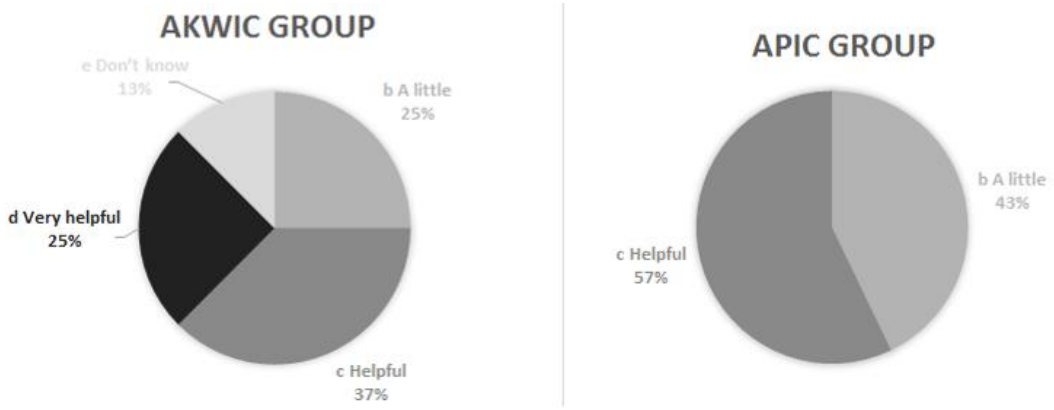


Figure 4.21 Responses to Q11: Do you think it’s helpful to have the texts divided into different disciplines? (N=8; N=7)

As the users were about to enter university, they did not fully understood the importance of discipline-specific vocabulary. Despite the negative comments, discipline-specific texts were maintained in the ensuing phases to convey the core concept of ‘disciplinarity’.

Apart from disciplinary texts, there were other recommendations on what materials could be included the apps. One participant suggested adding a new dimension of texts divided by topic or theme associated with current issues, like climate change or emerging technology (K1-1); P1-5 mentioned that it would be helpful to add pop-up vocabulary exercises before and after word inquiries. Quite a few of them requested a dictionary for quick reference to word meaning. These ideas may reflect that learners wanted the apps to be a multi-functional tool or a comprehensive platform where more resources are available at their fingertips.

4.3.2.4 Views about m-learning

The first three questions in the questionnaire asked about the participants' views towards learning with traditional and digital resources. Q1 and Q2 aimed to investigate what kind of dictionary was used by students to aid their academic writing. The responses are illustrated in Figures 4.22 to 4.23.

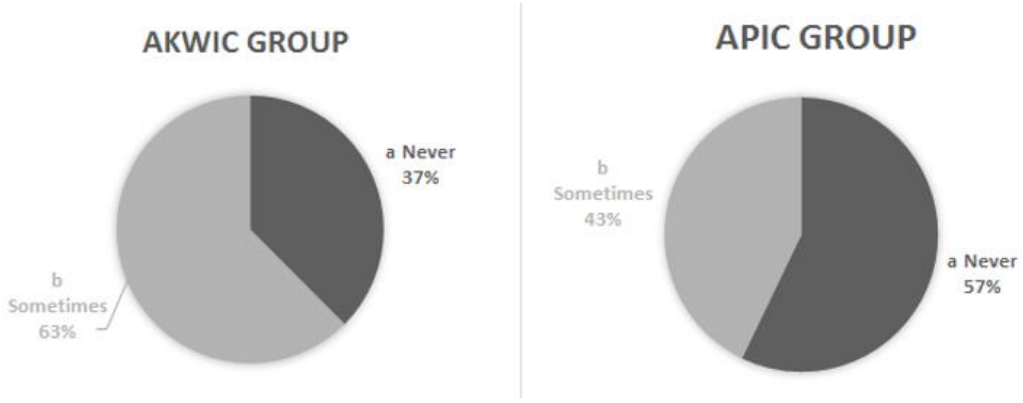


Figure 4.22 Responses to Q1: I use a paper dictionary when I am doing academic writing (N=8; N=7)

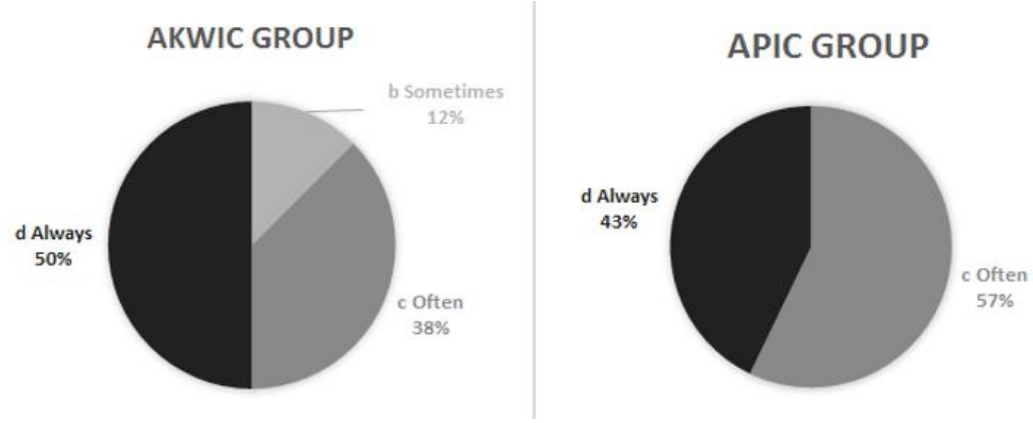


Figure 4.23 Responses to Q2: I use an electronic dictionary when I am doing academic writing (N=8; N=7)

As shown in Figures 4.22 and 4.23, no participant reported frequently using a paper dictionary when doing academic writing; on average, slightly more than half of them only 'sometimes' referred to a paper-dictionary, while the other half chose 'never'. In contrast, above 90% of the participants 'often' or 'always' used an electronic dictionary. The results are consistent with research on the students' use of dictionaries. It has been reported that the utilisation of dictionaries in different forms by the new-generation learners has changed dramatically, as the use of electronic dictionaries is increasing rapidly with the decline of paper dictionaries in learning (Dziemianko, 2010, 2012).

Q3 aimed to investigate the participants' attitude towards m-learning, and the results are illustrated in Figure 4.24. The overwhelming majority of the respondents held a strongly positive view towards the potential of mobile devices as an aid to their learning, with only one respondent (14%) not so certain.

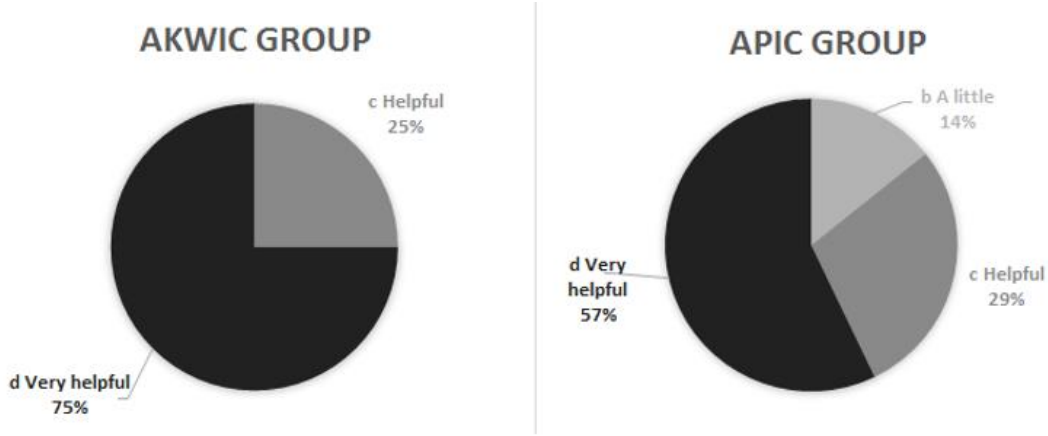


Figure 4.24 Responses to Q3: Do you think mobile devices can help you with your learning? (N=8; N=7)

On the whole, the majority of the participants were very positive about using mobile devices for learning purposes. They had already been using digital learning tools or traditional resources in the digital form, such as electronic dictionaries. Some learners may have relied on the new technology for their academic study. Most participants could name a couple of mobile apps for their learning: web-based ones (e.g. dictionary.com, Fastcite, Youdao dictionary), or a few that could be accessed in their mobile devices even without Internet access (e.g. downloaded app of Oxford Advanced Learner's Dictionary).

4.4 Summary and reflections

In summary, some tentative findings on AKWIC/APIC comparison were generated from Phase 1. The AKWIC users appeared to be more engaged with the designated app than their APIC counterparts, since they tended to use the designated app to look up more words. However, the APIC app seemed to be more efficient in helping users find the target form. In a typical query, APIC could save around 20% of search time for each query. From questionnaire responses, it can be seen that APIC was thought to be more helpful for academic writing and this was supported by an apparently higher willingness to use it in future. Therefore, while the comparison between AKWIC and APIC turned out to be inconclusive in many aspects, and in some extent even paradoxical, APIC did achieve greater recognition and higher efficiency, even though it was employed less by the participants in actual use. This phenomenon needed further investigation which took place in the next phase of research.

A number of problems in the research design were identified, which contributed to the inconclusive result of the AKWIC/APIC comparison. Firstly, the participants were divided into two groups with each group only experiencing the use of one app. They were unlikely to be aware of, or experience, the other app. As a result, there was no question that asked participants which app they preferred in the questionnaire or interview. Furthermore, even if there was evidence showing some advantage of APIC over AKWIC, it could not be supported or challenged by subjective feedback. Secondly, due to the group

division, the number of participants using each specific app was very small. For this reason, it is understandable that one person's choice in the questionnaire accounted for a large percentage. This means that individual differences and preferences had a great impact on the results. Therefore, it was clear that it was necessary to expose more participants to both approaches and apps, i.e. shifting the focus to enable the participants to try both apps. In this way, a clear and explicit comparison could be made by the same users. Thirdly, there were too many questions (13), which covered a range of topics, but could not accurately reflect whether and how app features could help enhance the participants' experience and uptake of using mobile concordancing for their academic writing. Hence, the questions needed to be more focused for the second phase.

Drawbacks in the app design were also revealed according to user feedback. Firstly, a mono-functional mobile concordancer did not seem satisfactory, although concordancing as the core function was thought to be helpful by the participants. In fact, they expected a mobile platform which could integrate other learning resources, such as dictionaries and reference books. Secondly, the participants were unhappy with the limited number of search words (52 core academic verbs from the AVL) and the complexity of finding a certain word from the provided word list. It seemed to desire a large databank at hand, and at the same time, the data needed to be easily retrievable. Thirdly, some design features were criticised as being confusing or not helpful.

To improve the uptake of mobile concordancing, changes needed to be made to the apps based on the feedback from the participants in Phase 1. The changes were also expected to facilitate the comparison of AKWIC/APIC. On the one hand, some requested that improvements needed to be made, including a massive extension of the vocabulary range (i.e. more words to be made available for searching) and the inclusion of a supportive dictionary. On the other hand, redesign of the functionality and layout of the apps was necessary. The poorly functional features needed to be removed, such as the finger icon gallery. At the same time, it was decided that the highly rated functions should be maintained and improved, such as context extension and TTS.

Finding and implementing solutions to address the problems identified in Phase 1 was the priority during the reflection period before the start of Phase 2. How the apps were further developed and how the research was adjusted is elaborated on in the next chapter with the details of Phase 2.

CHAPTER 5:

PHASE 2

This chapter discusses the details and findings of Phase 2 of the research, involving:

(i) A description of the developments made to the two mobile concordancing apps and the research design according to the results of Phase 1;

(ii) The process of technical research involved in the development of the two mobile concordancing apps used in Phase 2;

(iii) The results of the quantitative and qualitative research used to evaluate the users experience and uptake of the two mobile concordancing apps in Phase 2;

(iv) A reflection on the results of the quantitative and qualitative research. This will inform the subsequent processes of technical and evaluative research to be implemented in Phase 3 of the research.

5.1 Changes in Phase 2

Based on the results and reflections from Phase 1, the two concordancing apps (i.e. AKWIC and APIC) underwent some major developments in an attempt to increase the participants' positive experience and uptake of mobile concordancing. The first major development involved expanding the range of search words, which was requested by a number of participants in Phase 1. As mentioned in Section 4.3 of Chapter 4, the 52 core words and associated patterns were considered insufficient for the reference need of the participants, who asked for a list of 200-300 words, stating 'the more the better'. As a result, the search function of the two apps was upgraded to open-query, so that almost any word could be used for a search. In the APIC app, this means that the patterns associated with most verbs, nouns and adjectives could be retrieved (patterns of adverbs and so on are not provided due to the simple structures). At the same time, 500 recommended academic core words were provided as optional search words in a hidden list behind the input box for queries.

Another important development was the introduction of an online dictionary in both versions of the apps. The TTS function was enhanced with an updated voice bank. In the interface of context extension, the participants used to set the range of context by inputting a certain number, and after the improvement, finger movement on the touch screen could be detected, so that the participants could use their fingers to control scaling of context. It was expected to make the query more fun and convenient. At the same time, the gallery of finger icons in the prototype apps was removed due to negative comments. The researcher's programming effort to improve the apps, mainly open-query upgrade and enhancement of app features, are set out in detail in the next section of this chapter.

Apart from improvements to the apps, adjustments to the research design were also implemented to address the problems identified in Phase 1. As an attempt to address the issue that feedback was not able to clearly identify whether APIC might contribute to ESL students' positive experience and uptake of concordancing software, participants in Phase 2 were given the chance to experience both apps. In each cycle, five participants were given AKWIC, while the other five started with APIC. After two weeks, the two groups changed to use the other app for the next two weeks. With this strategy, app use data and evaluative feedback from the same users could be collected. Secondly, the data collection methods were adjusted to facilitate the comparative evaluation of the two apps, which became the central task of Phase 2. Likert scales were introduced in the questionnaire to reflect the participants' views more accurately. The number of questions was reduced from 13 to 5 to provide a stronger focus on app evaluation. In addition, an explicit question asking the participants about their app preference was added to the interviews.

5.2 Programming details of the Phase 2 developments

As mentioned at the end of Chapter 4, it was hoped that expanding the range of search words, as requested by a number of the participants in Phase 1, might help improve the uptake of the two mobile apps. Additionally, according to the feedback from the participants, an online dictionary was to be added, and the highly rated features of context extension and TTS were to be maintained in Phase 2. Firstly, the researcher decided to

upgrade the two apps to open-query, which meant that in APIC, the patterns associated with most verbs, nouns and adjectives could be retrieved, and in AKWIC, any word could be searched in theory. Secondly, context extension and TTS needed some improvement to make them easier and more user-friendly. Two tutorial video clips showing the typical procedures of using the apps were made and uploaded onto YouTube[21] so that the participants could refer to the tutorials when necessary.

5.2.1 Open-query expansion

The mapping of inflected words mentioned in Chapter 4 enabled an inflection-insensitive KWIC search of an individual word. Open-query PIC concordancing, however, entailed establishing new databases for patterns. It was designed so that when a user wanted to inquire about a word, the associated patterns would be shown on request. Since many words may be used as either a verb, a noun, or even an adjective, the patterns had to be displayed by word class separately. According to the requirements, three SQLite databases for verbs, nouns and adjectives respectively were built (see Section 4.2.2 of Chapter 4 for information of SQLite). All together 6,000 verbs, 10,900 nouns and 5,800 adjectives were included in the three databases. After reduction of repeated words in more than one database, there are more than 20,000 words with associated patterns available for searches in APIC. Patterns were selected referring to the two volumes of grammar patterns (Francis et al., 1996, 1998), *Oxford Collocations Dictionary for Students of English* (Thurnbull, 2009) and *Oxford Learner's Dictionary of Academic English* (Lea, 2014).

Verb patterns are both complicated and diverse. Figure 5.1 shows part of the database of verb patterns. It can be seen that verbs were listed in rows, and a dozen structural verb patterns were spread over columns. If a verb could be used in a pattern, the corresponding cell was marked with a letter[22], otherwise the cell was kept null. For example, most verbs can be used in the passive voice (except for a few, such as *occur)*, so the 'passive' column

[21] The video clips are available at: https://www.youtube.com/watch?v=hBujc1ZI_6I (AKWIC) and https://www.youtube.com/watch?v=kVcwMKnYPA8 (APIC).
[22] In fact it can be any character; it only needs to make sure that the box is not empty.

is almost always full in the screenshot; some verbs can be followed by a *that* clause, like *know*, *find*, *think*, so the cells for these verbs were not null under the 'v that' column. Two other databases with the same design and structure were established for nouns and adjectives respectively. The difference was that nouns and adjectives have a smaller number of structured patterns, so the databases were simpler and smaller.

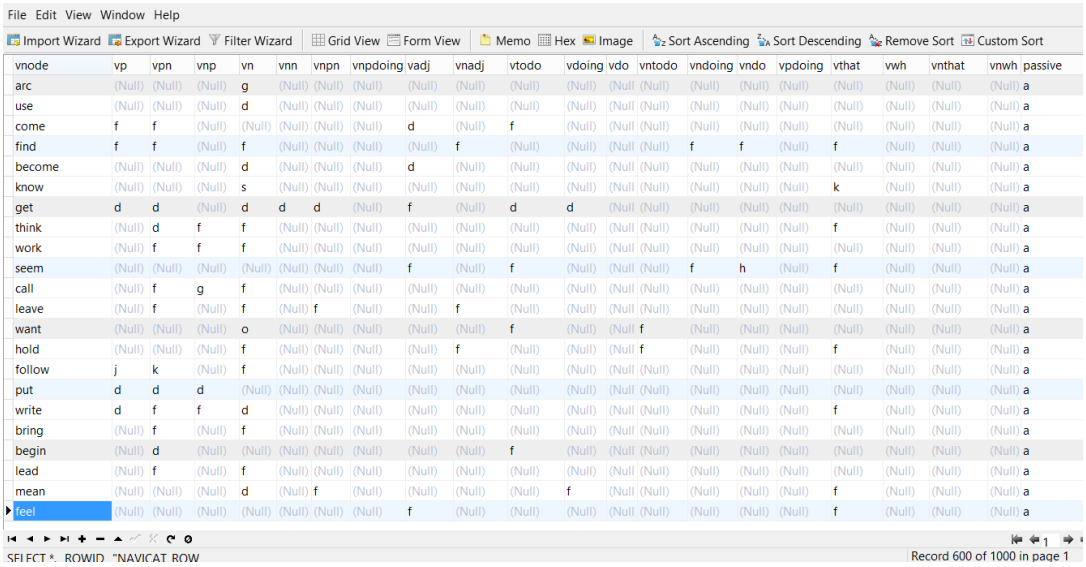


Figure 5.1 Part of the SQL database of verb patterns in visualised software

These databases were easy to maintain. If necessary, new words could be introduced, and existing pattern associations could be reviewed and altered at any time. When a word was identified in the databases, the cursor would go through all the columns, and collect the column titles with full cells. To check whether a cell was null required a complex script line as follows:

```
if (verbCursor.getString(i) != null
   && !verbCursor.getString(i).equals(""))
```

Each volume title was linked to a regex string that was used for pattern searching (see Appendix E for the regex strings). When a word was input in APIC, the cursor would search the three pattern databases to retrieve matched structures and present them by word class.

Figure 5.2 shows what would happen when *system* was entered. Only noun patterns would be retrievable, while the lists of verb and adjective patterns could not be opened. As

displayed in the list, the noun *system* may collocate with an adjective (e.g. *political system*) or a verb (e.g. *establish a system*). By clicking the corresponding patterns, the user could see how *system* may pattern with other words in the next interface of PIC concordancing. The online dictionary on the left part are discussed later (see Section 5.2.2).

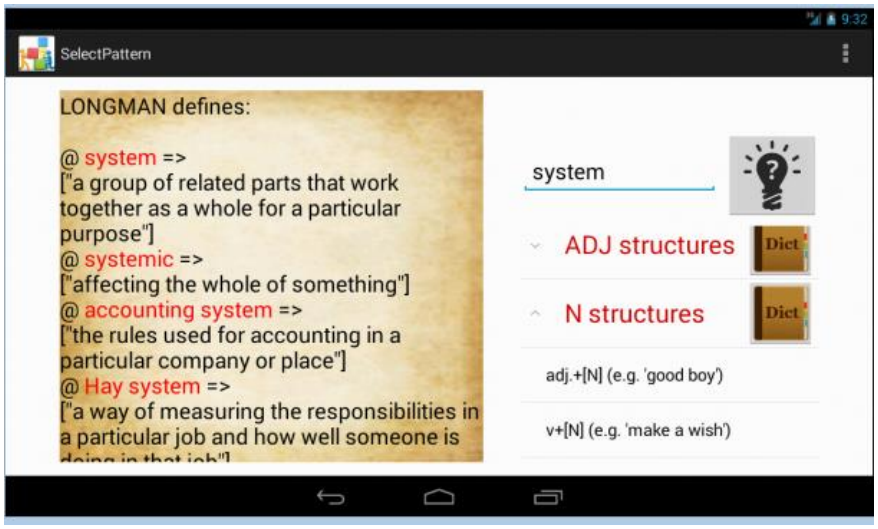


Figure 5.2 The interface of pattern check and online dictionary in APIC (Phase 2)

Although the apps were open to any query, i.e. in theory the users could look up any word, there still needed to be some guidance to help them look up academic vocabulary. At this stage, 500 academic core words (verbs, nouns and adjectives) from the Academic Vocabulary List were recommended as auto-completion search terms hiding behind the input box by setting `ArrayAdapter<String>`. Once the first few letters of a word were entered, partially matched words from the front in the list would turn up automatically. If no letter was entered, tapping the input box could trigger the dropdown list of 500 words in the sequence of frequency in academic texts, as shown in Figure 5.3.

The same list could be initiated in the APIC input box. Once a word was entered or a pattern was selected, the corresponding regex would be prepared for KWIC or PIC concordancing. In this way, users could easily choose a core word, or enter the word they wanted to search with less effort. Despite the list of 500 recommended words, concordancing any other word beyond the range was still available by entering all the letters of the word.

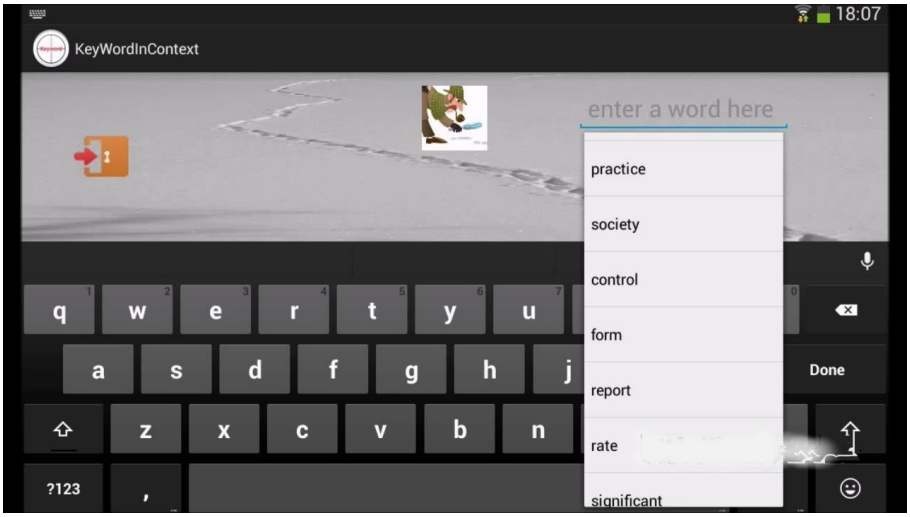


Figure 5.3 The hidden list of recommended search words

5.2.2 Enhancement of additional features

A significant feature of both apps was the addition of an online dictionary, as the need for this dictionary was recognised in Phase 1. The introduced dictionary was the 5th edition of the Longman Dictionary of Contemporary English[23]. To utilise the online resource, the method `HttpGet` was used, which must operate in a separate thread in recent versions of Android. After receiving a query, the dictionary API searches its own database, and then sends back multiple aspects of word information in JSON format. The following lines are part of the retrieved information for the search word *provide*:

> "results": [{ "datasets": ["ldoce5", "dictionary"], "headword": "provide", "id": "cqAFjq2WJb", "part_of_speech": "verb", "pronunciations": [{ "audio": [{ "lang": "British English"

The information to display is the content in multiple levels of brackets. To extract and present the data, the methods of `JSONObject` and `JSONArray` had to be repeatedly used through the layers. In APIC and AKWIC, only word definitions from the online dictionary were retrieved to supplement concordance examples. The interface in APIC has been shown above in Figure 5.2. The interface in AKWIC was a drawable box which

[23] The API can be found at http://developer.pearson.com/apis/dictionaries ; some other Longman dictionaries are also available from online access.

could be restored after use, as shown in Figure 5.4 below. Integrating this feature could be achieved by adding `SlidingDrawer` in the XML layout.

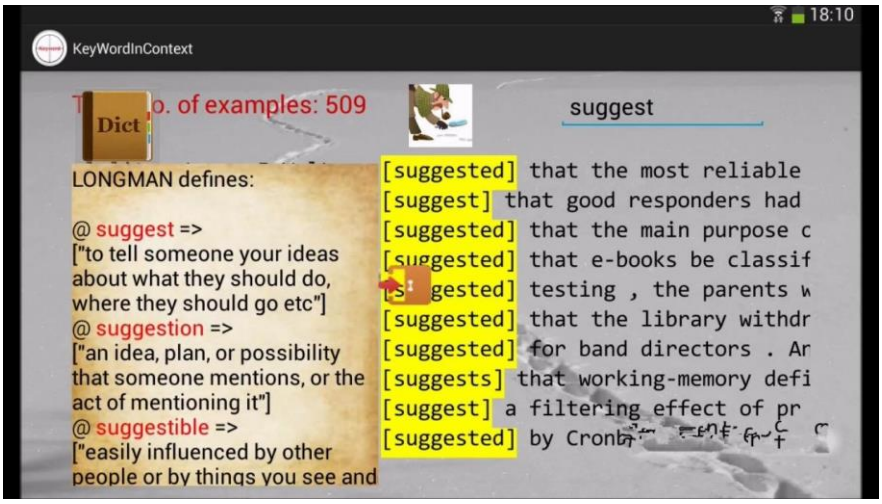


Figure 5.4 The interface for concordancing with the sliding online dictionary in AKWIC (Phase 2)

Another enhancement was on the feature of context extension. The context range setting was removed since it was evidently confusing to learners. The method `ScaleGesture`, capable of detecting finger gestures on the touchscreen, was adopted instead. Users could simply use fingers to make 'zoom-in' or 'zoom-out' gestures in order to have a wider or shorter context, as shown in Figure 5.5 below.

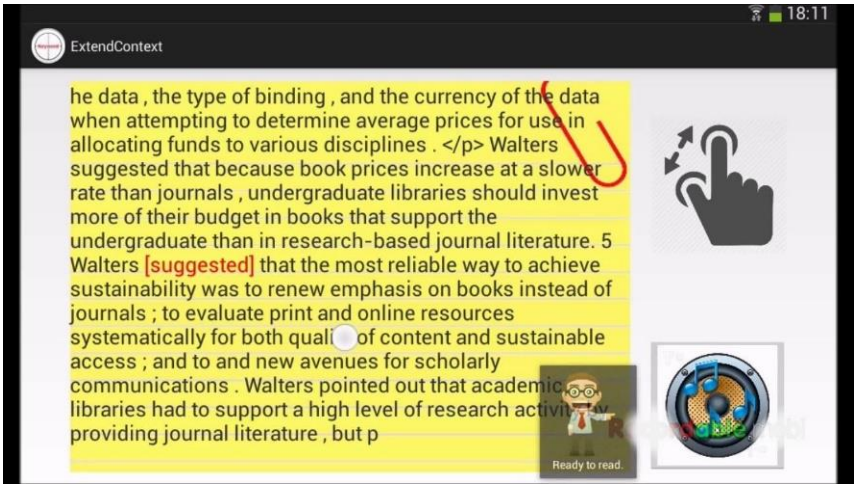


Figure 5.5 The interface for context extension with finger gesture control and TTS (Phase 2)

Each movement could add or reduce around 10 words to the existing passage. At this

stage, learners only needed to enter the word they wanted to know, and use their fingers to handle all the rest of the process of app use. On the same interface, the other maintained feature of TTS was also improved with the most up-to-date Google TTS voice bank (released in May 2015) introduced so as to generate more human-like audio output of displayed texts.

5.3 Results from Phase 2

5.3.1 Data from automatic logs

5.3.1.1 Comparison of app use

Similar to the presentation of Phase 1 data, the raw calculations are set out in Appendix C. It is encouraging that all the participants in Phase 2 produced valid data of app use. This means that there was use data from 20 participants for both AKWIC and APIC. In addition, as each participant used both apps, how the same persons used the two apps was captured by the automatic logs for later analysis. Therefore, the data could be considered more reliable for app comparison in terms of size and accuracy.

Tables 5.1 and 5.2 below show the processed data of app use in Phase 2. In the tables and also in the interview responses, the participants switching from AKWIC to APIC were coded with “K-P” plus the cohort number and serial number, and those switching from APIC to AKWIC were identified with “P-K” plus the cohort number and serial number.

From Table 5.1, it can been seen that a typical AKWIC user looked up four distinct words over the two weeks, and in each session more than three queries were made. As for efficiency, typically an AKWIC query took 1.83 minutes. The repetition ratio remained over 40%, which means there was a repeated query out of every 2.5 queries. In addition, the function of context extension was typically used once every three queries. Finally, the online dictionary check was an additional feature in Phase 2, and a typical AKWIC user referred to the feature approximately once for each query. As indicated by the C.V values, the intra-group difference was generally large in AKWIC use by different participants, and the most significant was in the use of context check and the online dictionary. For

example, P-K2-2 and P-K2-4 never extended context in AKWIC, while K-P1-2 and K-P1-3 used the function more than 1.5 times in each query. Similarly, P-K1-5 and P-K2-4 never referred to the online dictionary from AKWIC, while P-K1-4 used the feature 4.57 times per query.

Table 5.1 Processed Data of AKWIC Use (Phase 2)

User code	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query	Dictionary check per query
K-P1-1	10	3.40	1.88	41.18%	0.12	0.10
K-P1-2	3	1.00	5.33	0.00%	1.67	1.00
K-P1-3	4	3.50	2.14	42.86%	0.57	0.75
K-P1-4	4	6.00	2.50	33.33%	1.50	2.00
K-P1-5	14	1.42	1.65	17.65%	1.00	0.36
P-K1-1	9	5.50	2.50	59.09%	0.23	1.56
P-K1-2	4	2.67	1.63	50.00%	0.25	1.25
P-K1-3	2	4.00	1.63	75.00%	0.13	1.00
P-K1-4	14	4.86	1.76	58.82%	0.06	4.57
P-K1-5	2	2.00	0.50	50.00%	0.25	0.00
K-P2-1	12	14.00	2.14	14.29%	0.64	0.42
K-P2-2	14	3.33	2.30	30.00%	0.45	0.86
K-P2-3	3	3.00	1.33	0.00%	0.67	0.00
K-P2-4	5	5.33	0.81	68.75%	0.19	0.80
K-P2-5	2	2.00	2.00	0.00%	0.50	2.00
P-K2-1	3	3.50	0.86	57.14%	0.14	0.33
P-K2-2	12	12.00	3.17	0.00%	0.00	0.08
P-K2-3	6	2.80	0.79	57.14%	0.43	0.83
P-K2-4	1	1.00	2.00	0.00%	1.00	0.00
P-K2-5	1	2.00	0.50	50.00%	0.00	3.00
Median	4	3.37	1.82	42.02%	0.34	0.82
C.V	75.74%	80.65%	58.01%	72.81%	97.52%	109.91%

Table 5.2 shows that a typical APIC user searched five different words during the period, and two queries were made in each session. The largest difference for both apps is the number of dictionary checks per query. It seems that some enthusiastic participants used this feature much more frequently than others[24]. In those cases, the number of dictionary checks tended to be far greater than the number of the distinct or repeated words they sought for examples. Automatic logs showed that in many sessions, the participants used

[24] Dictionary check behaviour might vary even for the same person, that is, a participant might not always use the feature in the same way for both apps.

only the dictionary check function without initiating the concordancer (AKWIC or APIC) at all. Although this phenomenon was not in line with the design principles of the apps, it highlighted the popularity of the online dictionary function. Such a technical affordance should be retained.

Table 5.2 Processed Data of APIC Use (Phase 2)

User code	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query	Dictionary check per query
K-P1-1	2	1.00	1.50	0.00%	1.00	15.00
K-P1-2	1	1.00	1.00	0.00%	0.00	1.00
K-P1-3	2	2.00	3.50	50.00%	0.50	1.00
K-P1-4	4	3.00	1.00	33.33%	0.50	5.00
K-P1-5	6	1.50	1.67	33.33%	0.89	1.17
P-K1-1	4	1.33	1.25	0.00%	0.25	4.50
P-K1-2	6	1.50	0.83	0.00%	0.67	0.33
P-K1-3	5	1.50	2.50	16.67%	0.17	1.00
P-K1-4	7	1.60	0.88	12.50%	0.13	0.14
P-K1-5	2	2.00	1.00	0.00%	0.00	0.00
K-P2-1	5	1.13	1.00	44.44%	0.67	1.60
K-P2-2	6	3.00	2.33	0.00%	1.17	0.50
K-P2-3	5	2.33	2.43	28.57%	0.29	0.20
K-P2-4	1	3.00	1.00	66.67%	0.33	1.00
K-P2-5	2	2.00	7.75	50.00%	0.75	10.00
P-K2-1	6	3.00	1.44	33.33%	0.22	0.33
P-K2-2	11	1.38	2.18	0.00%	0.36	2.00
P-K2-3	23	3.00	2.26	45.24%	0.62	0.17
P-K2-4	6	2.25	1.33	33.33%	0.67	5.67
P-K2-5	2	2.00	1.00	0.00%	0.00	0.00
Median	5	2.00	1.39	22.62%	0.43	1.00
C.V	91.43%	36.11%	82.23%	98.10%	74.29%	153.50%

To clearly compare AKWIC and APIC, the medians of app use data over the first two phases are put together in Table 5.3 below. It can be seen that a typical APIC user in Phase 2 made more distinct queries than a typical AKWIC counterpart, which may indicate that APIC users became more active and engaged when working with the designated app. As for efficiency, each APIC query was completed in a shorter time of 1.38 minutes than an AKWIC query, saving about 24%. There was a repetition out of nearly every five queries, and a context check done more than every two queries. The median number of dictionary

checks per query was 1, which means the dictionary was referred to once in each query. According to the data in the C.V. row, the intra-group variance remained large in APIC, with the exception of query per session. The most significant variance lies in the use of the online dictionary. For instance, two participants never used the function, while K-P1-1 made 15 dictionary checks per query in APIC.

Table 5.3 Medians of App Use Data in Phases 1 and 2

Phase	App	Distinct query per week	Query per session	Time per query (min)	Repetition ratio	Context check per query	Dictionary check per query
1st	AKWIC	1.5	3.25	1.90	48.84%	0.41	N/A
	APIC	0.75	2.00	1.56	22.22%	0.50	N/A
2nd	AKWIC	2	3.37	1.82	42.02%	0.34	0.82
	APIC	2.5	2.00	1.39	22.62%	0.43	1.00

Since a cycle in Phase 1 was four weeks but was reduced to two weeks in Phase 2, a new indicator 'distinct query per week' was calculated. On the assumption that the participants would make the same number of distinct queries each week, the value helped investigate whether the open query change, i.e. massive extension of search words, could enhance participants' engagement in Phase 2. It can be seen that there was an increase in AKWIC use with the number of distinct queries per week, rising slightly from 1.5 to 2. By comparison, the same indicator of APIC more than tripled from 0.75 per week to 2.5. One of the major reasons for the improved engagement may be that the open-query feature. In other words, the participants could make their own queries, free from the limitation of pre-set search words as was the case in Phase 1. The automatic logging collected all the entered queries. It was found that the 20 users looked up as many as 98 different words in total. It did not only double the number of pre-set search words in Phase 1, but also exceeded the range of vocabulary. A large share of the search words, 20, were the words that users may not have encountered previously, e.g. *cardiovascular*, *chronology*, *memento* and *misogyny*. Thus, the open-query concordancing was shown to enhance the engagement of the participants, especially APIC users, who became much more active in looking for pattern-focused examples.

As for efficiency, APIC again saved considerable time, over 20%, similarly to Phase 1. The number of queries per session and repetition ratio remained almost unchanged for the two apps. Over the two phases, APIC users always made fewer queries in each session and needed less repetition. This may support the claim that APIC was more efficient than AKWIC. The above analysis contributed to the finding that APIC appeared to be better than AKWIC in terms of user engagement and efficiency. This tentative conclusion will be further discussed with interview responses in Section 5.3.2 of this chapter.

Context check remained a helpful function for the users of both apps. However, no significant difference could be seen in the use of context check, since in general participants extended context of a certain example once out of every two to three queries. The additional feature of the online dictionary also proved to be very popular. The medians of dictionary check per query are also close, around once for every query.

5.3.1.2 Time of app use

The time of app use is illustrated in two line charts, Figures 5.6 and 5.7, which show how the two apps were used throughout the week and in a day. The two lines for Phase 2 are superimposed on those for Phase 1. Figure 5.6 shows that the middle of a week, from Tuesday and Thursday, remained the major week days of app use; Monday and Friday, as the days immediately before and after weekends, were used less often for study using the apps. It appears that, in the situation of autonomous learning with mobile apps, students often chose the middle of the week for study. They seldom worked with the apps on Monday and Friday, and were sometimes even less active than on weekends.

Figure 5.7 shows a one-peak line to represent the time spent on app use in a day. It can be seen that in Phase 2, the morning remained the most preferred time slot, while more time was spent on working with the apps at night. The traditional class time, in the morning and afternoon, was still preferred for study, while night was the other popular time.

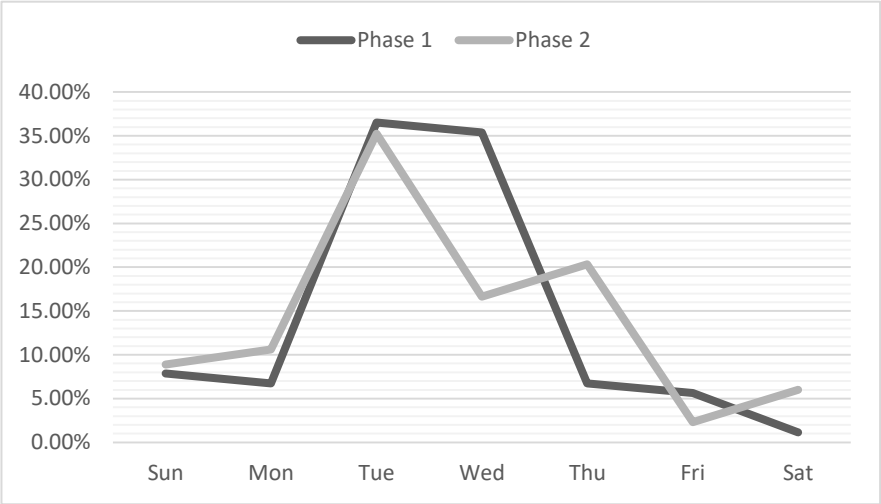


Figure 5.6 Daily app use through the week

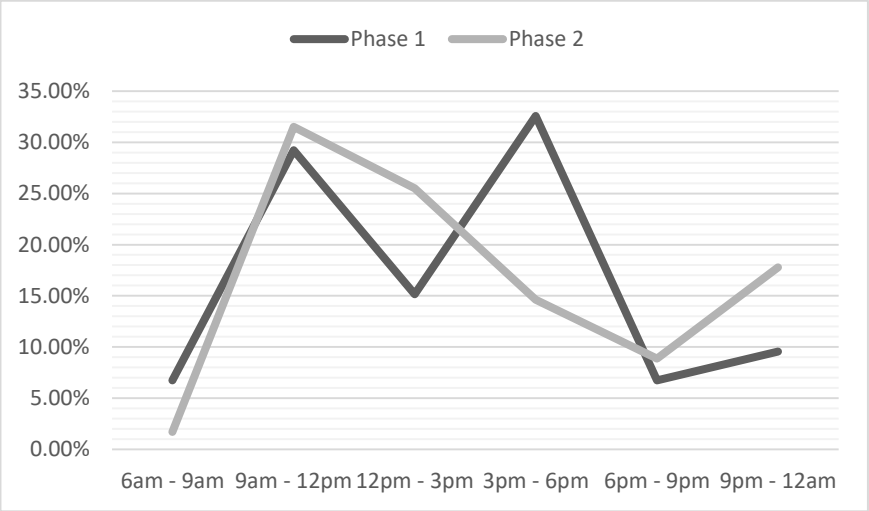


Figure 5.7 Time of app use in a day

5.3.2 Questionnaire and interview responses

The data from the automatic logging needs to be supported with the questionnaire and interview results. All 20 participants completed the questionnaire for both apps, and 12 of them volunteered to be interviewed. The participants' responses to the questionnaire and interview were collected for the APIC/AKWIC comparison and other related topics.

5.3.2.1 Comparison through Likert scale questionnaire responses

A nine-point Likert scale was used in the questionnaire in Phase 2, and as noted the

number of questions was reduced from 12 to 5 with the focus on comparative evaluation of the two apps. The questions were formulated as positive statements on the apps, and the participants were requested to choose a point ranging from 1 to 9. Point 9 stands for 'completely agree', 1 for 'completely disagree', and 5 for 'neutral'. The higher the point is, the more positive the attitude was; the lower, the more negative. The questionnaire responses are presented from Figure 5.8 to Figure 5.12. AKWIC is represented by darker columns, and APIC is represented by lighter-coloured ones. Observing the columns can give an indication of how the participants evaluated the apps respectively. Figure 5.8 shows the results for Q1 on the perceived helpfulness of the two apps. Many participants (40% of the AKWIC users and 25% of the APIC users) were only neutral in the overall evaluation. APIC seemed to gain slightly higher points, since the columns of APIC above the 'neutral' level were longer than those of AKWIC.

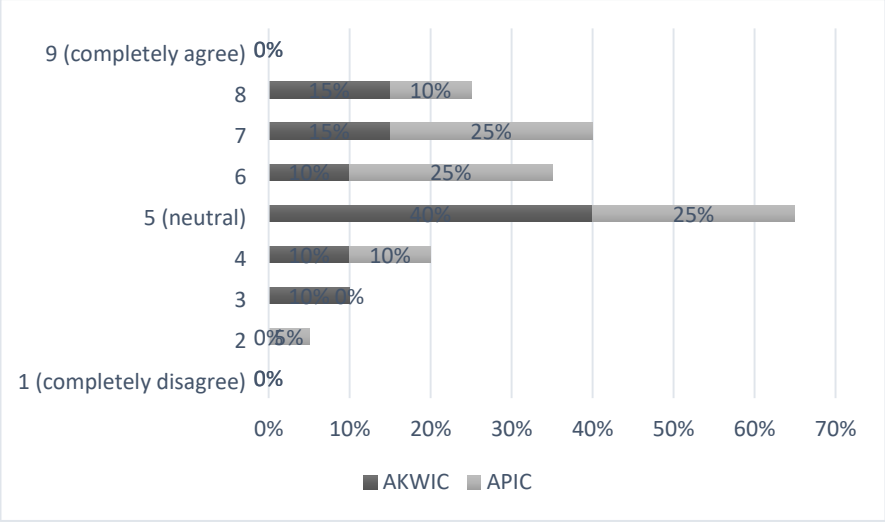


Figure 5.8 Responses to Q1: Overall the app is helpful for your academic writing in English (N=20; N=20)

Figure 5.9 shows the results for Q2, which was designed to check the perceived effectiveness of the DDL method, i.e. alignment of a number of examples with the target language usage highlighted in the middle. It seems that the majority of the participants thought that the method helped them notice and observe the word usage. The APIC users appear to be slightly more positive, since all the columns of APIC are above the neutral level. By comparison, 30% of the AKWIC users were only neutral, and one of them (5%) selected the slightly negative scale 4.

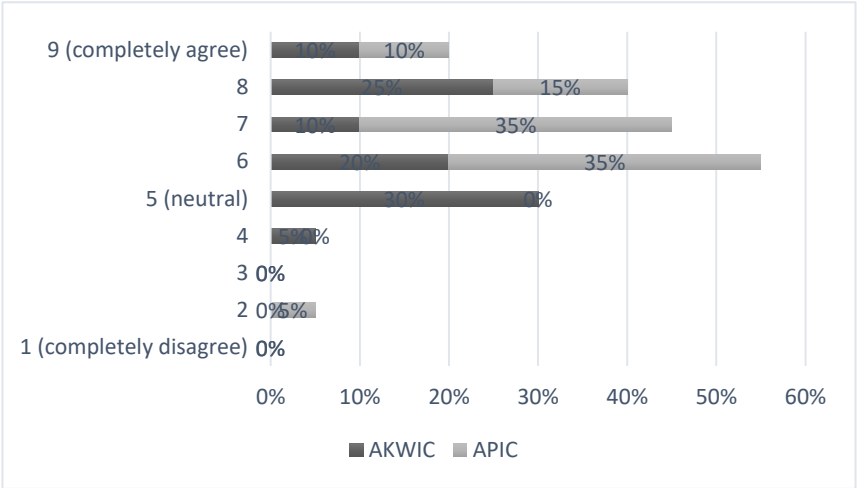


Figure 5.9 Responses to Q2: The highlighted yellow part of the search results helped you notice and observe the word usage (N=20; N=20)

Q3 was to check the perceived efficiency of the two apps, and the results are presented in Figure 5.10. There seems a significant difference between the perceived efficiency of the two apps. As many as 40% of the participants rated the efficiency of AKWIC as 4, while the same proportion of them gave a high rating of 8 to APIC. As a result, all together 60% of the points for AKWIC were negative, and 75% of the points for APIC were positive.

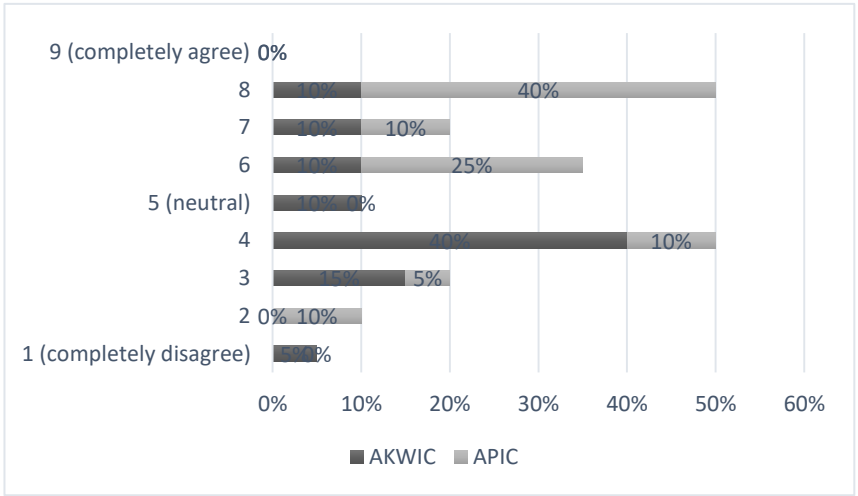


Figure 5.10 Responses to Q3: It was usually quick and easy for you to find the word usage you were looking for (N=20; N=20)

The responses to Q4 are illustrated in Figure 5.11. On the ease of APIC use, 30% of the participants were neutral, and only half of them gave positive points to this question. By comparison, AKWIC gained positive points from 80% of the participants. Therefore,

AKWIC was considered easier to use.

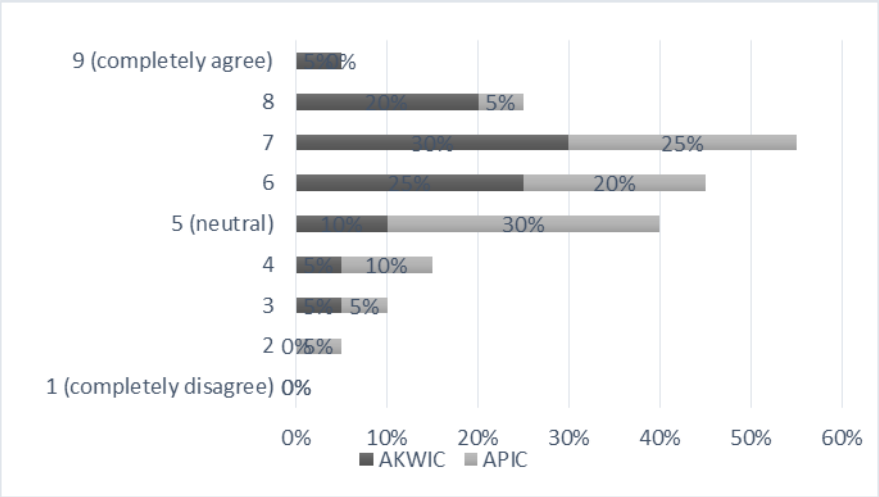


Figure 5.11 Responses to Q4: The app was easy to use (N=20; N=20)

However, it seems the perceived greater ease of use did not lead to the participants' greater willingness to use AKWIC in future. In other words, although AKWIC was easier to use, many participants would not like to use it in future. As shown in Figure 5.12, half of the participants were only neutral in their willingness to continue using AKWIC. Out of the remaining half, the majority of them (30%) appeared to be reluctant, as indicated by a 4 or 3 point choice. Contrary to this, 70% of the evaluative responses for APIC were above the neutral level. It seems that more participants were willing to choose APIC to help them based on its effectiveness rather than its perceived ease of use.

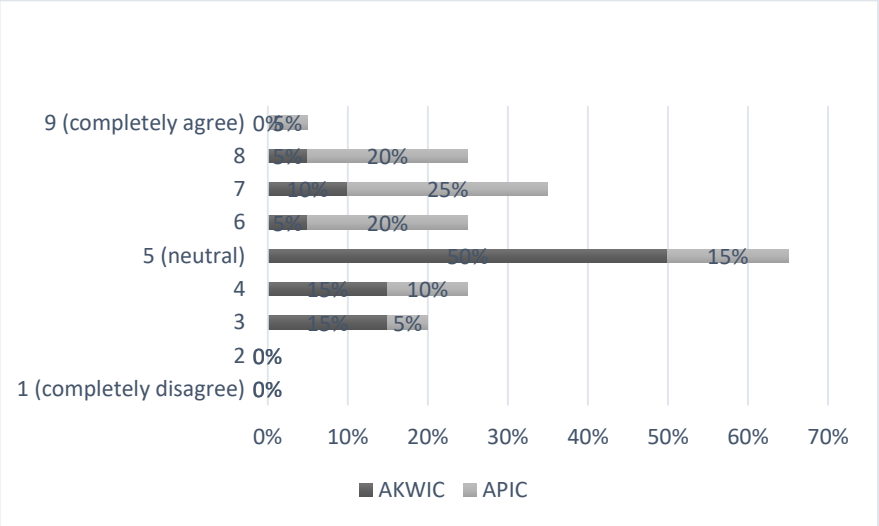


Figure 5.12 Responses to Q5: I would use this app in the future to help me with my

academic writing (N=20; N=20)

In addition to observing the above figures, it may also be helpful to compare the mean points for the two apps, which are listed below in Table 5.4.

Table 5.4 Mean Scores of the Questionnaire Questions

Question	AKWIC mean score	APIC mean score
Q1. Overall the app is helpful for your academic writing in English.	5.55	5.8
Q2. The highlighted yellow part of the search results helped you notice and observe the word usage.	6.5	6.75
Q3. It was usually quick and easy for you to find the word usage you were looking for.	4.7	6.15
Q4. The app was easy to use.	6.5	5.5
Q5. I would use this app in the future to help me with my academic writing.	4.95	6.3

It can be seen from the table that there was little difference in the mean points of the apps for the first two questions, while a significant difference emerged in the next three questions. From Q1, it seems that both apps were considered to be moderately helpful, since the mean points were over 5.5. The use of highlighting search results seems to be very helpful, since the mean points were over 6.5. APIC gained much higher points than AKWIC in Q3 with 6.15 vs. 4.7. This means that APIC was thought to be more effective in helping participants find the target language use. At the same time, APIC was considered more difficult to use than AKWIC, as shown in the results for Q4 on ease of use. Lastly, APIC again was awarded higher points of 6.3 compared to AKWIC at less than 5. The difference indicates again that users were more willing to use APIC in future.

The questionnaire results are helpful and more reliable, because the same 20 participants experienced and evaluated both apps. The participants' evaluation was consistent with the tentative findings from automatic logging and interview responses in Phase 1. More importantly, it was confirmed that APIC was more efficient; although APIC seemed more difficult to use than AKWIC, the participants were more willing to use it in future.

5.3.2.2 Comparison through interview answers

As illustrated above, the automatic logging and Likert scale questionnaire in Phase 2 have mutually shown that APIC was more efficient in helping the users notice the target word usage. The effectiveness of APIC was generally acknowledged and favoured by the participants, although APIC tended to be more complex to use. The results can be further supported by the evaluative comments from the interviews.

Most of the interviewees explicitly said that APIC was better. When the participants wanted to know about a word using APIC, the patterns associated with the word would be presented. Although the pedagogical benefits of 'patterns' (see Chapter 2) was not introduced to the participants, they embraced the concept, and they thought that they were benefiting from the categorised information on "collocations" (K-P2-2) or "word phrases" (P-K1-4). This function seems well accepted, as described by one participant:

> When you enter a word, you can have a list of items [word usage], and I'll read them one by one… I always go through all the listed categories [patterns] if they are provided upon a click. (K-P2-2)

The sort feature of APIC, i.e. pattern-specific concordancing, was highly rated. The user K-P1-3, who swapped from AKWIC to APIC, was happy to see that in the latter app "the results are sorted out and focused on one structure". Another participant P-K1-4 made a very similar comment: "the results are more focused, specific to a certain structure". This feature seemed to be the major reason that APIC was preferred by most of the participants. The participant P-K2-1 put it as:

> Yes, the 2nd one [APIC] is better, because it is easier for me to find out the family words, how they link to verb, to adjective, and to noun. So it is the way I learn a new word, and maybe that's the reason I think the 2nd one is better.

In a focus group, K-P2-4 said: "certainly the 2nd [APIC] is better than the 1st [AKWIC]. The 2nd offers searching specific to word class, and the other does not". This was echoed by another member K-P2-3.

At the same time, the complexity and difficulty in using APIC remains a problem. After all, PIC is a new concept, and there has to be an extra step of pattern selection in APIC. It is understandable, therefore, that there were also a few participants who argued that AKWIC was better. For example, P-K2-9 thought that it was "faster and more convenient" to look up a word with AKWIC, and P-K1-1 emphasised that AKWIC was "easier to use". In fact, they did not deny the value of patterning, the difference is that they attached more importance to the ease of use than sorted search results.

The quantitative and qualitative data from automatic logging, questionnaire and interview responses triangulate to confirm the tentative findings in Phases 1 and 2. It can be concluded that APIC featuring sorted word usages has some advantages over AKWIC, although the former tends to be more complex and difficult to use than the latter.

5.3.2.3 Other findings from the interviews

Apart from the AKWIC/APIC comparison, the interviewees also evaluated other aspects of the apps. The features of context extension and TTS maintained from Phase 1 remained popular with the participants in Phase 2. K-P1-4 acknowledged the importance of learning a word in the context:

> I certainly want to understand a word in the context, so I know better about the environment where the word is used. Definitely it helps, and it's a good method… I may learn other words surrounding, it's possible.

TTS also gained positive comments for the audio input offered. For example, K-P2-2 put it as: "This is helpful to me as I need such training. The materials can be read aloud, and this is good".

The added feature of the online dictionary in Phase 2 produced positive results. On the one hand, this function was highly rated. The participants were satisfied that "the words you provided have very good definitions" (P-K1-2), and the definitions were "very clear

and concise" (K-P2-2). Therefore, the introduction of the online Longman dictionary turned out to be helpful, which was also reflected in the frequent use by the participants (the median amounting to once per query). On the other hand, the idea of concordances and DDL was not highly rated. The inefficiency of the bottom-up approach represented by concordancing was compared to the easy access to meaning understanding provided by a dictionary. When talking about the DDL method, P-K1-1 commented:

> It's fine to have this inductive method, but you have to adopt other methods to display the results… I cannot tolerate the method of display. So I turn to familiar dictionaries for help.

P-K2-5 made a similar comment:

> Compared to dictionaries, it lacks some orderliness. You may refer to traditional dictionaries. People are so used to that way for thousands of years. When suddenly faced this change, although maybe it's better, we're just not used to it.

Considering there were a few cases where the user only referred to the online dictionary without looking for AKWIC or APIC examples, the added online dictionary, which was designed to be a supplementary tool, sometimes appeared to be more popular than the primary concordancing function of the two apps. Nevertheless, since it provided only concise definitions, it did not have a direct and negative impact on PIC or KWIC concordancing. The online dictionary feature is an example of how students in m-learning expect easy and direct access to a range of required information.

It also became clear that app design of the two mobile concordancers was unsatisfactory for the users. One participant K-P1-2 complained that the layout of the app was "not clear", and he requested to "make the user interface easier to understand and use". Another participant (P-K1-1) suggested to find an interface designer:

> In my view, you could make this app more simple and friendly [simpler and friendlier] to users. Sometimes I cannot recognize the button for the specific function ... so I think you might need an interface designer.

With the open-query upgrade and the functionality enhancement, the app users increased their number of queries and used more functions. However, based on feedback from the users, it also became evident that appealing and instructive interfaces were necessary to enhance the users experience and uptake of the mobile concordancing apps.

5.4 Summary and reflections

Phase 2 focused on comparison between AKWIC and APIC, which involved upgraded apps and an adjusted research design. Findings suggest that APIC was shown to be more efficient and required less search time. It also resulted in more active use of the apps from the participants, perhaps due to the open-query expansion of search words. Responses to the focused questionnaire confirmed not only the above two findings, but also that the participants were more willing to use APIC in future although considering it more difficult to use. In the final interview, the majority of the participants who experienced both apps explicitly claimed that APIC was better. In conclusion, APIC was shown to be better in helping students search for and find the usage of core academic words than AKWIC. Based on the results of the comparison in Phase 2, the third phase of this research shifted its focus to investigate how to enhance the uptake of the APIC app.

Two changes to the apps, namely, open-query expansion and the introduction of an online dictionary, turned out to be both helpful and popular. The open-query feature, which enabled the users to look up almost any word, might have improved the users' engagement with the apps, in particular APIC. The online dictionary was not only highly rated, but also used more frequently than the core concordancing function of the apps. The two features may represent a seemingly paradoxical desire of m-learning students; they require a comprehensive platform of resources where they can make their own queries, and at the same time they want direct, easy and quick access to the information they need. The requirement may guide the future design of m-learning tools. The next chapter discusses the third phase of the research.

CHAPTER 6:

PHASE 3

This chapter sets out the findings and details of Phase 3 of the research, involving:

(i) A brief description of the changes made to the app APIC and research design according to the results of Phase 2;

(ii) The technical research involved in the development of APIC used in Phase3;

(iii) The results of the quantitative and qualitative research used to evaluate the users experience and uptake of APIC;

(iv) A reflection on the results of the quantitative and qualitative research.

6.1 Changes to Phase 3

Through the use of two mobile concordancers and related research in Phases 1 and 2, it has been shown that PIC could enhance users' positive experience and uptake of mobile concordancing more than KWIC. Because of this, a decision was made to focus on APIC only in Phase 3 of this research. In other words, all the participants in Phase 3 were given the tablets with only APIC loaded. Two weeks were allocated to each cohort of Phase 3 participants to use the app, the same as the period allocated for users to experience either AKWIC or APIC in Phase 2. Correspondingly, the interview questions did not involve a comparison of user experience and evaluation between AKWIC and APIC. Instead the focus was on eliciting personal experience and advice for improvement of the APIC app.

According the results in the preceding chapter, the participants in Phase 2 were generally satisfied with the functions of the apps, and the complaints focused on the interface design. Therefore, to increase positive experience and uptake in Phase 3 of APIC, it seemed necessary to improve the graphic and procedural design of the app APIC. In the separate interface for discipline selection, a representative icon was added to each discipline in the list followed by discipline names, and an image of a female teacher was introduced to function as a button which would activate a short audio instruction on request. In the

interface of PIC concordancing results, the bare background was changed to an image of a ‘white board’ to match the teacher on the first step of discipline selection. To reduce the lag time of text loading and concordancing, the multi-threads technique was used. The technical details of the graphic and procedural changes are set out in the next section.

6.2 Graphic and procedural changes to APIC

Minor changes were made to the graphic design of APIC, with the aim of developing more user-friendly interfaces and a smoother operation. As an example, the redesigned discipline selection interface is shown in Figure 6.1. Here customised `ListView` was created to combine pictures and words in the list of discipline options. To the right of the list there was a graphic button of a female teacher, as seen in the Harry Potter movies. It functioned to provide audio instruction, that is, an audio clip introducing the app would be played once the button was pressed. The audio guide was recorded with a female voice of high-quality TTS. For PIC concordancing interface, an icon of a ‘whiteboard’ generally used in classrooms was added as the background in APIC, as shown in Figure 6.2. Another development in the interface design included adding a pop-up instruction, which would vanish automatically after three seconds, in each step of search process to help guide the user (also see Figure 6.1). This development involved the custom `Toast`. In addition, a `ProgressBar` would appear and remain when texts were being processed in the background during the lag time.

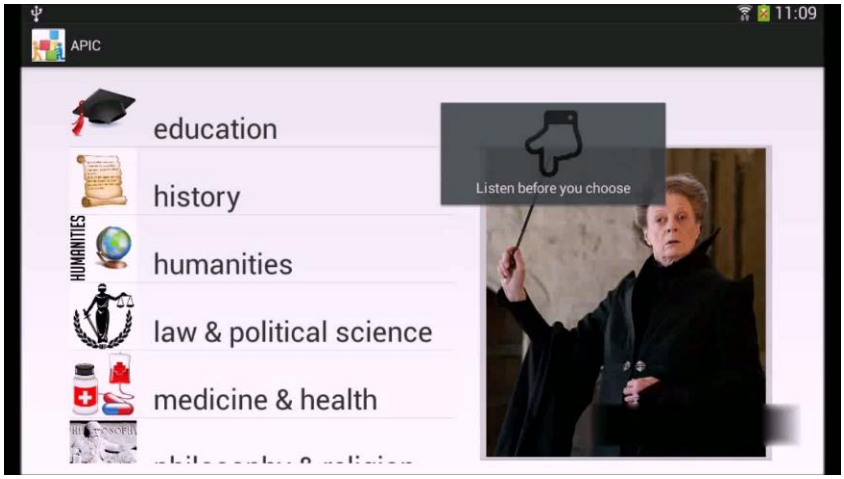


Figure 6.1 The modified discipline selection interface (Phase 3)

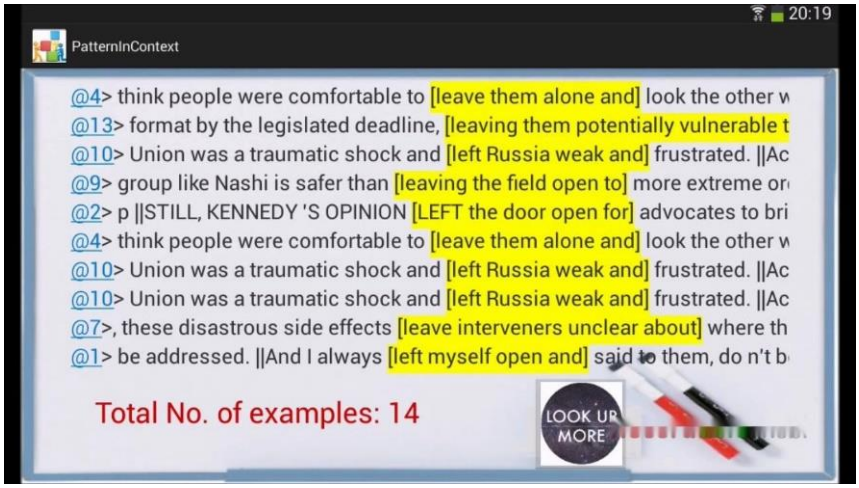


Figure 6.2 The modified concordancing interface in APIC (Phase 3)

A few less visible changes relating to procedure were also made to make the app run more smoothly. The multi-threads technique, that is, when different tasks are implemented concurrently, was used by adopting the method `newCachedThreadPool()`, so as to help streamline procedure. Firstly, loading disciplinary texts used to take some time in the app versions in Phases 1 and 2. This process was put into a separate thread which runs in the background simultaneously with pattern selection before PIC concordancing. As a result, there was almost no lag time after discipline selection. Secondly, the concordancing retrieval process was also time-consuming, depending on the search term, number of results, and complexity of the text and regex. To address the problem, the loaded texts were divided into 10 segments in the background, and the concordancing feature searched through the 10 parts in 10 independent threads concurrently. The results were later numbered and put together for presentation. Upon testing this, it was found that it helped save around 60% of lag time for concordance results.

6.3 Results of Phase 3

6.3.1 Data from automatic logs

6.3.1.1 APIC use in Phase 3

In Phase 3, 17 participants out of the 20 new participants produced valid app use data, and the other three did not actually use APIC. The raw data from automatic logs is

included in Appendix C, and the processed data is set out in Table 6.1 below. A participant in Phase 3 is identified by the combined letter OP (standing for APIC only) followed by the 'cohort number – serial number'.

Table 6.1 Processed Data of APIC Use (Phase 3)

User code	Distinct query	Query per session	Time per query (min)	Repetition ratio	Context check per query	Dictionary check per query
OP1-1	7	2.25	1.56	22.22%	0.44	2.86
OP1-2	2	0.67	2.50	0.00%	1	3.5
OP1-3	6	2.33	1.43	14.29%	0.29	1.17
OP1-5	1	1	5.00	0.00%	1	5
OP1-7	14	8	0.50	12.50%	0.19	0.21
OP1-8	1	0.25	1.00	0.00%	0	12
OP1-9	21	10.5	1.29	50.00%	0.4	0.67
OP1-10	7	1.8	1.78	22.22%	0.11	0.86
OP2-1	3	0.75	1.33	0.00%	1	19
OP2-2	9	2	1.60	10.00%	0.1	0.22
OP2-3	3	5	1.60	40.00%	0.2	0
OP2-4	14	2.14	1.33	6.67%	0.4	1.5
OP2-5	16	4.83	1.17	44.83%	0.14	0.38
OP2-6	9	1.33	1.58	25.00%	0.5	1.11
OP2-7	4	1	2.00	0.00%	0.75	1
OP2-9	4	0.8	2.75	0.00%	0.75	4.25
OP2-10	5	1.75	2.14	28.57%	0.29	2.4
Median	6	1.8	1.58	12.50%	0.4	1.17
C.V	77.81%	156.40%	62.24%	134.95%	84.24%	426.55%

It can be seen from the table that a typical APIC user searched six different words over the period of two weeks. In each session, typically 1.8 queries were made, and each query took about 1.58 minutes. The concordancing repetition ratio was 12.5%, that is, there was typically a repeat out of around every eight attempts. The functions of context check and dictionary check were used frequently at 0.40 and 1.17 respectively per query. As indicated by the C.V values, the intra-group variance in Phase 3 was high. The most significant was for dictionary check per query, amounting to 426.55%. It can be seen that some participants seldom used the function (e.g. OP2-3), while other users, such as OP1-8 and OP2-1, used it frequently; that is, 12 and 19 times per query.

A comparison of APIC app use during Phases 2 and 3 is shown in Table 6.2 below. The data for most indicators was similar between Phases 2 and 3. For example, the distinct queries made per week increased only slightly from 2.5 to 3.

Table 6.2 APIC Use in Phases 2 and 3

Phase	Distinct query per week	Query per session	Time per query (min)	Repetition ratio	Context check per query	Dictionary check per query
2nd	2.5	2.00	1.39	22.62%	0.43	1.00
3rd	3	1.80	1.58	12.50%	0.40	1.17

Entered queries show that the words participants wanted to look up remained diverse. For example, the 17 participants searched 64 distinct words, including 14 less frequent words, e.g. *catastrophe*, *censorship* and *arbitrary*. In addition, they did a context check about every 2.5 queries and a dictionary check nearly once per query. The time used for each query increased slightly from 1.39 minutes to 1.58 minutes. The significant difference is in the repetition ratio, which declined sharply from 22.62% to 12.50%. It seems that the participants in Phase 3 made a smaller number of repetitive queries than those in Phase 2.

6.3.1.2 Time of mobile use

Two additional lines on the time of app use are added in the line charts for Phases 1 and 2, so as to check when the participants used the apps over the three phases. The results are illustrated in Figures 6.3 and 6.4 below.

As is consistent with the results in Phases 1 and 2, the participants tended to use the apps frequently during the middle of a week, that is, Tuesday and Wednesday. It seems that again the apps were used less on Monday and Friday as the two days immediately after and before weekends. Sometimes the participants spent more time on working with the apps on weekends than on Monday and Friday. Morning was always the preferred time to work with the app during the day, and considerable time was also spent in the afternoon. An increase of use of the app again at night was an indication of the penetration of mobile devices into the daily lives of the participants, and showed that the participants frequently

and autonomously used the apps outside of their usual classroom times.

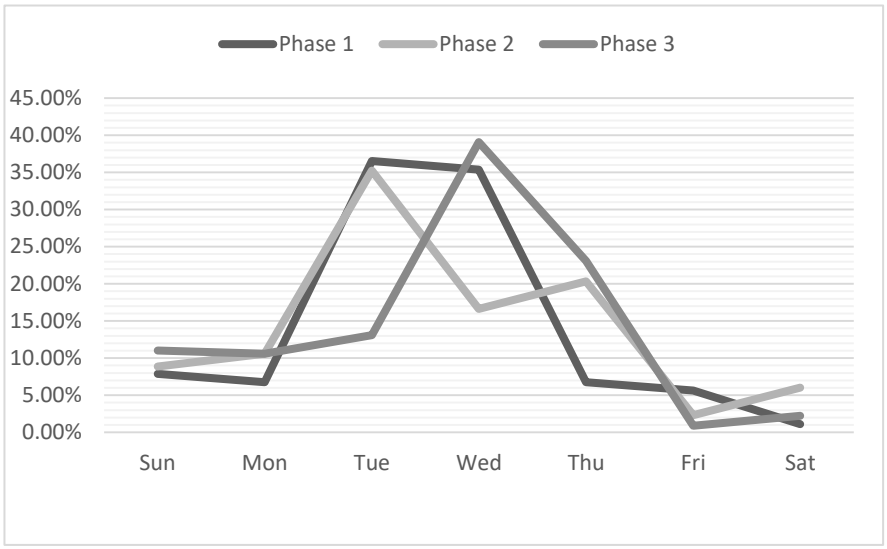


Figure 6.3 Daily app use throughout the week over the three phases

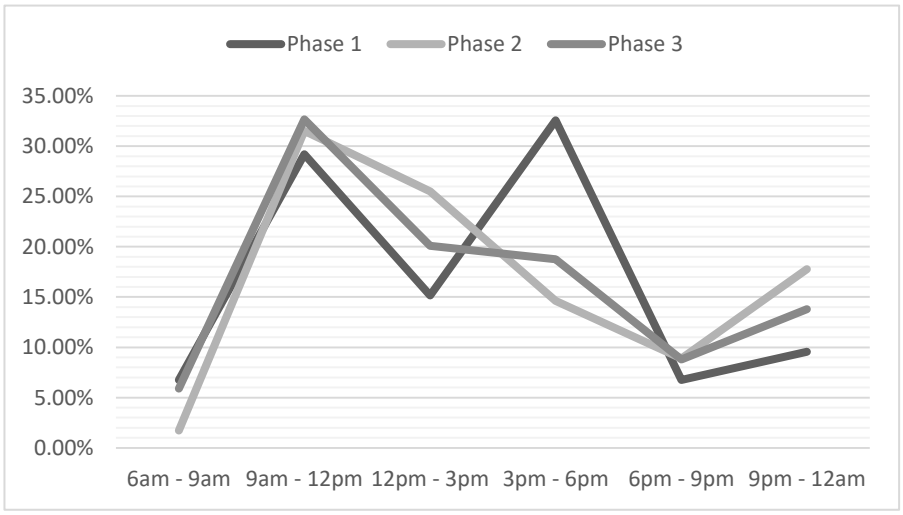


Figure 6.4 Time of APIC use in a day over the three phases

6.3.2 Questionnaire and interview responses

Links to the questionnaire were emailed to the 17 participants who made valid queries, and seven of them, around 40%, volunteered for an interview. Phase 3 continued to use the Likert-scale questionnaire used in Phase 2. The responses to the questions are presented in the figures from Figure 6.5 to Figure 6.9. The difference from the previous phase is that there was only feedback on APIC.

Figure 6.5 shows the overall evaluation of the app by APIC users in Phase 3. Although slightly over half of the participants gave positive feedback, it seems the other half did not think the app was helpful for their academic writing as they selected 'neutral' or 'disagree'. One user (accounting for 6%) even 'completely disagree[d]' with the positive statement. In other words, a considerable number of the participants felt negative about the helpfulness of APIC for their academic writing.

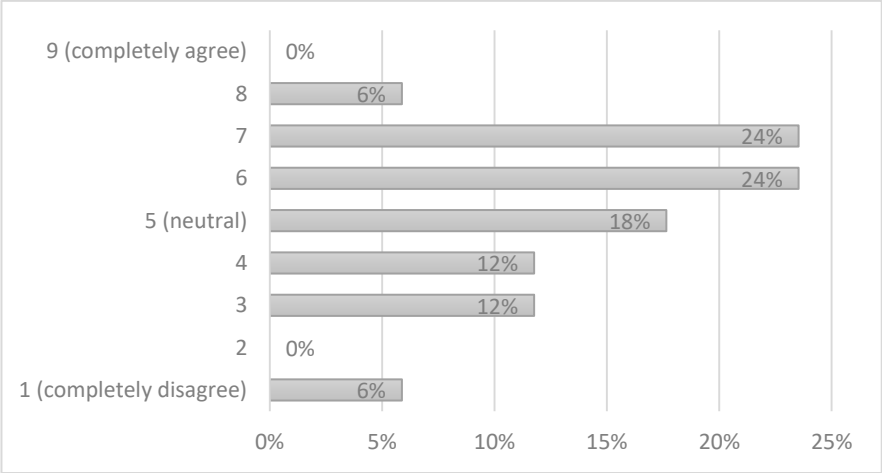


Figure 6.5 Responses to Q1: Overall the app is helpful for your academic writing in English (N=17)

Compared to Q1, Q2 on the helpfulness of highlighting provided more positive results. As shown in Figure 6.6, the overwhelming majority of the participants acknowledged that the highlighted yellow parts in the search results were helpful, and only one (6%) in Figure 6.6 was slightly negative, choosing point 4.

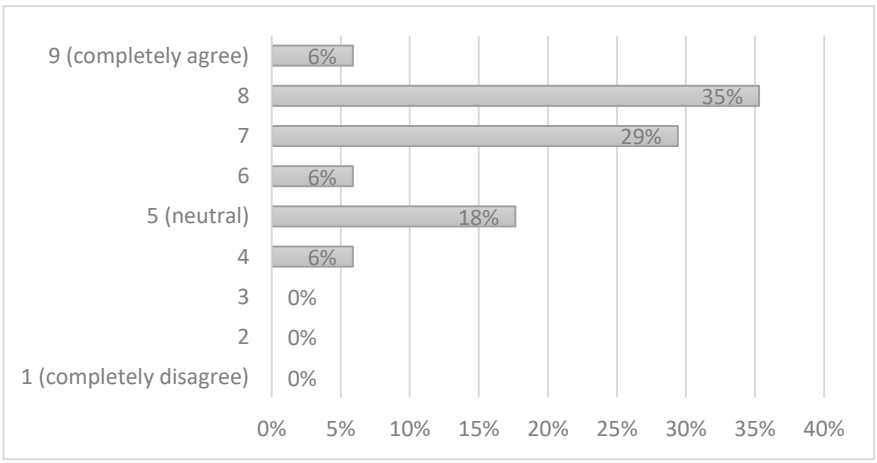


Figure 6.6 Responses to Q2: The highlighted yellow part of the search results helped you notice and observe the word usage (N=17)

Figure 6.7 shows a slight divergence in the responses to Q3. Although most of the participants were positive, about 1/4 of them thought that the process of finding the word usage out of PIC concordances was not usually quick and easy.

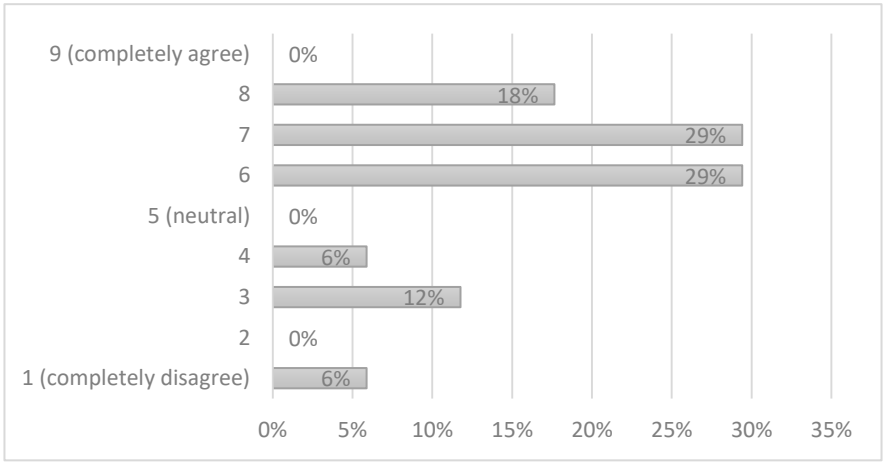


Figure 6.7 Responses to Q3: It was usually quick and easy for you to find the word usage you were looking for (N=17)

On the ease of app use, Figure 6.8 shows that a small number of the participants were neutral, and others were almost evenly divided between positive or negative points.

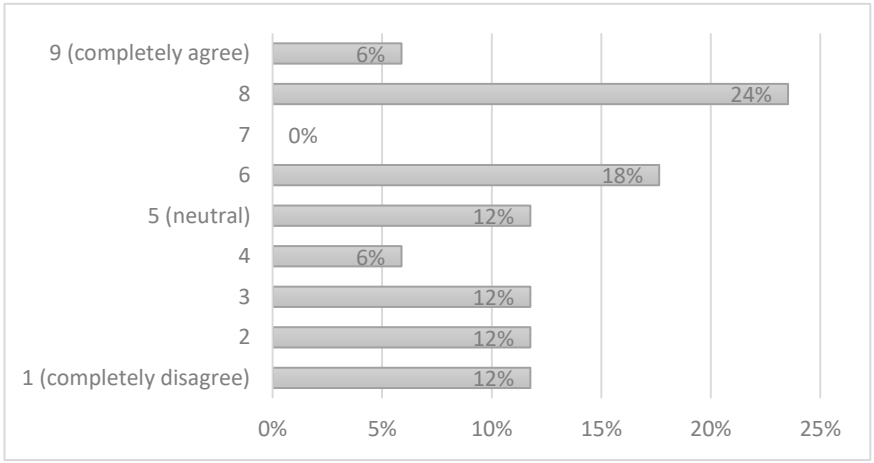


Figure 6.8 Responses to Q4: The app was easy to use (N=17)

More difference emerged in the willingness of future use, as shown by the columns in Figure 6.9. Although 70% of the participants in total indicated that they would use APIC in the future to help them, the remaining 30% did not.

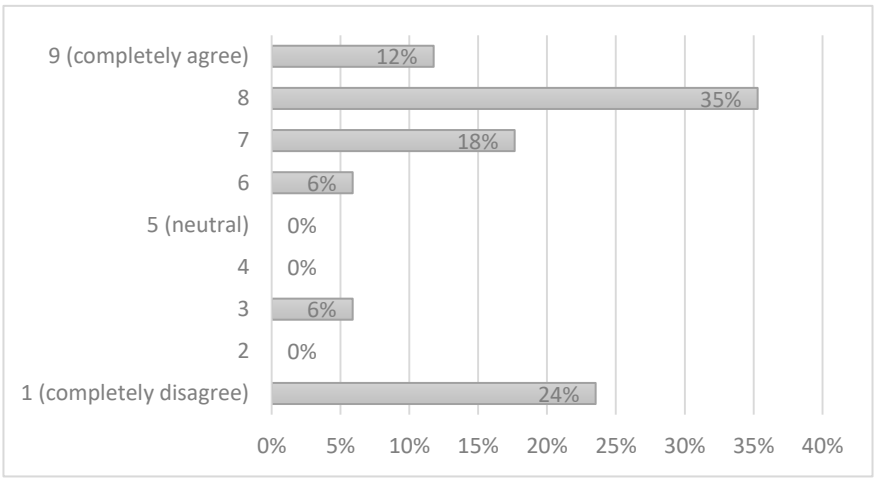


Figure 6.9 Responses to Q5: I would use this app in the future to help me with my academic writing (N=17)

Table 6.3 below shows that the mean scores for evaluation of the highlighting method and efficiency of app had no significant changes, while the average values for the other three questions declined. According to the APIC-focused participants in Phase 3, it appears that APIC became more difficult to use, and thought to provide less help for academic writing, so some users became less willing to continue using it in future.

Table 6.3 Mean Scores of the Questionnaire Questions

Question	APIC mean score (Phase 2)	APIC mean score (Phase 3)
Q1. Overall the app is helpful for your academic writing in English.	5.8	5.29
Q2. The highlighted yellow part of the search results helped you notice and observe the word usage.	6.75	6.88
Q3. It was usually quick and easy for you to find the word usage you were looking for.	6.15	5.88
Q4. The app was easy to use.	5.5	5
Q5. I would use this app in the future to help me with my academic writing.	6.3	5.88

The drop in the participants' evaluation was unexpected to the researcher. In fact, the main functionality of APIC was fully maintained in Phase 3, and only minor changes were made to the interface design. Apart from individual differences between the two groups of participants over the two phases, the interface redesign might be the major reason. It

was found from the interview responses that the interface redesign failed to produce positive effects. The new interfaces were thought to be “a little bit old-fashioned” and “not very comfortable for users” (OP2-3); it was suggested by the interviewee that the interfaces should be made “more attractive”. Therefore, the Phase 3 redesign of the graphic and procedural elements was not viewed as particularly effective. The unsatisfactory user interfaces may even negatively affect participants’ willingness to use the APIC app in the future.

As indicated by the data from automatic logging, for the largely identical app APIC, the ratio of repeated queries declined (see Section 6.3.1 of this chapter). To find the reason, the participants were asked how often they requested more examples. It was found that the participants made fewer repeated queries because it was not necessary to have more examples. OP2-1 put it as:

> The ‘Look Up More’ button, I did not use it actually. I can understand the usage when I finished reading the examples on the screen. That is all. There is no need to have more. And maybe I need to move to the next word.

Other information obtained from the interview answers in Phase 3 is largely consistent with that from the previous two phases. For example, the feature of the online dictionary remained very popular and highly rated. OP2-6 described her experience as:

> I couldn't find the definition at the beginning. Then it’s like finding some treasure when I got support from the online dictionary. It’s great and really useful.

Some of their suggestions for further development of the app are worthy of consideration. OP2-1 suggested reducing the number of interfaces by arranging the functions of pattern selection, online dictionary check and concordancing on the same interface. Another request was to provide a list of discipline-specific recommended words: “if there are some recommended words for each subject it would be fantastic” (OP1-10). The suggestion reflects the participant’s awareness of discipline-specific vocabulary, which is important in EAP research. However, it also reflects their lack of awareness of the importance of

the most frequently used academic words as provided in the original AVL (Academic Vocabulary List) or the previously created AWL (Academic Word List).

6.4 Summary and reflections

In Phase 3, minor changes in graphic and procedural design were made to APIC, the only app experienced and evaluated by two cohorts of participants. The use of APIC by the participants remained largely the same over Phases 2 and 3. However, the new group of participants in Phase 3 were less positive in the evaluation of perceived helpfulness for academic writing and willingness to use it in future. It seems that the effort to improve the interface design in Phase 3 was unsuccessful, which had an adverse impact on the evaluation and the participants' willingness to use the app in future. Therefore, more professional mobile developers, particularly graphic interface design experts, might be needed to increase the future uptake of the apps and make them more appealing to users. This is beyond the capacity of the researcher, and also beyond the scope of this research. The gain from Phase 3 is that the aesthetic design of the app interface is no less important than the development of its core functionality. The apps with a clear and appealing layout may help enhance the positive experience and uptake from prospective users.

In the next chapter, there is a summary of all the three phases to answer the research questions outlined in Chapter 3. The implications for two concerns of this research, m-learning and DDL, will also be discussed in detail.

CHAPTER 7:

CONCLUSION

This research explored the potential of Data-driven Learning (DDL), a corpus-based pedagogical approach (Chambers, 2010; G. Hadley, 2002; T. Johns, 1991, 1994, 2002; T. Johns & King, 1991; Rüschoff, 2003), to benefit academic writing in the context of mobile learning ('m-learning' for short) (Crompton, 2013; Hockly, 2013; Peter, 2009; Traxler, 2007, 2009b, 2011), or more exactly, mobile-assisted language learning (MALL) (Burston, 2015; Chinnery, 2006; Eisenlauer, 2014; Hockly, 2013; Kukulska-Hulme, 2009b; Kukulska-Hulme & Shield, 2008; Stockwell, 2013). There have been recent studies of using m-learning and DDL to assist academic writing instruction (Almad & Yunus, 2015; Alshaar & AbuSeileek, 2013; Chang, 2014; L. Flowerdew, 2015; Garner, 2011; Lee & Kim, 2013; Noriega, 2016; Tribble & Wingate, 2013), and this research aimed to further these attempts by applying 'mobile DDL', i.e. concordancing from mobile apps. In this research, mobile DDL was delivered to the participants in combination with PIC (patterns in context), an alternative concordancing method based on patterns (Hanks, 2008; Hunston, 2010, 2013a; Hunston & Francis, 2000). Making mobile concordancing more accessible and user-friendly to non-expert students, the integrated approach of mobile DDL and PIC did not only help address some of the technical and pedagogical concerns with DDL (Boulton, 2009a, 2011; Chambers, 2007, 2010; Cheng et al., 2003; L. Flowerdew, 2012), but also shed some light on how to deal with the problems with m-learning and MALL (Burston, 2013, 2014a, 2014b; Pachler, 2009; Sharples et al., 2009; Vavoula & Sharples, 2011).

Although corpus consultation tends to be complicated and challenging for students (L. Flowerdew, 2012; Osborne, 2004), the study found that the combination of mobile DDL and PIC contributed to the positive experience and uptake of mobile concordancing to help students with their academic writing.. The following sections will review and discuss the research results and implications, and also the limitations of this study and directions for future research on m-learning and/or DDL.

7.1 Findings and responses to the research questions

The results of the three-phase research have been presented and analysed in detail in the preceding three chapters. Based on the results, conclusions can be drawn which respond to the three research questions (RQ) set out at the beginning of Chapter 3.

RQ 1: To what extent can mobile-based concordancing software tools contribute to ESL students' positive experience and uptake of these tools for their academic writing?

The results of the study suggest that mobile-based concordancing software tools can help enhance ESL students' positive experience and uptake of these tools for their academic writing from three dimensions in particular: search capacity, supplementary features, and app design. Such mobile concordancers, with strong search capacity and helpful supplementary features, can provide students with easy access, at the point of need, to obtain concordance lines showing how words are used in academic texts.

Search capability

Concordancing, which retrieves and presents multiple lines containing a search word or word combination at the node, is believed to be helpful for language teaching and learning with its various applications (Chambers & Kelly, 2004; J. Flowerdew, 1996). Johns thought concordancing to be "one of the most powerful tools that we can offer the language learner" (1988, p. 15), and therefore based his entire DDL approach on concordancing. Searching concordance lines was the core function of both mobile apps in this research. Concordancing on the mobile platform can enable students to have access to a large number of examples of academic text, and see how words are used in these examples at any time. The instant queries into language use in discipline-specific contexts can assist the students to view real examples of academic writing in their own disciplines (Hyland, 2000).

A broad search capacity is central to a successful concordancing app. In Phase 1, it was found that the participants were not satisfied with the small number of set verbs (52) taken

from the Academic Vocabulary List (AVL) (Gardner & Davies, 2014) as search terms[25]. Based on the feedback, the range of search terms was expanded to more or less open-query in Phase 2 (searching adverbs was not available for APIC), including more than 20,000 verbs, nouns and adjectives. In other words, for the students to view the mobile concordancing experience positively, they wanted the ability to carry out searches on most words they might encounter or employ in their academic writing. This major extension of vocabulary range turned out to be popular with the users: the number of distinct queries per week rose from 1.5 to 2 for AKWIC, and more than tripled from 0.75 to 2.5 for APIC (see Section 5.3.1 of Chapter 5). The enhanced engagement with the concordancing apps, especially APIC, might be largely attributed to the enhanced search capacity. This preference of the participants implies that students tend to favour a large quantity of materials and resources available from mobile devices for personalised queries. To fully realise the portability and personalisation potential of m-learning (Kearneya et al., 2012; Kukulska-Hulme, 2009b), it is important to provide abundant resources on the mobile platform to improve the users experience.

Supplementary features

The study also showed that the students' positive experience and uptake of these tools was enhanced if they were able to access a range of different technological affordances besides those conventionally used for simple concordancing. TTS (text-to-speech) and an online Longman dictionary were the two most popular supplementary features, which were often used and highly rated by most of the participants. The TTS module was always embedded in both apps from the prototypes. In recent years, TTS has been used in almost all aspects of language education: vocabulary, grammar, pronunciation, reading, writing, speaking and listening (Z. Hadley, 2013). It seems advantageous to introduce TTS to students for self-directed learning. In this research, the participants appreciated the benefits of having TTS, which provided them with an additional dimension of language exposure. In Phase 2, the feature was enhanced with an updated voice bank to enable more natural voices generated by machine.

[25] It was initially thought that a focus on the most frequently used verbs in academic texts would satisfy the aims of the research. However, the participants did not appreciate the importance of the AVL, and they instead preferred to have a far wider range of search choices.

An online dictionary was added in Phase 2, based on the request of the participants in Phase 1. Since examples of the words in context were provided by the concordancer, the participants tended to use the dictionary seeking quick access to definitions. Despite the limited information provided, the online dictionary was popular with the student users, and some referred to it without looking for additional examples of how the search terms were used via concordancing. The popularity of the online dictionary indicates that the combination of emerging technology and traditional tools can result in a positive experience for ESL student users of a mobile-concordancing app. While students increasingly favour online dictionaries more than paper ones, more research is needed to facilitate the transition from static paper to interactive digital screens (Lew, 2015).

App design

Another important aspect that contributes to students' positive experience of mobile-based concordancing software is app design in terms of interface and operation design. Unsatisfactory app design will adversely affect users' experience and willingness to use the app in future. In this research, the participants gave negative comments about the interface design (messy/ugly) and operation of the apps (a long wait before getting the results). Whilst the changes for Phase 2 focused on enhancing the functionality of the apps, those for Phase 3 shifted to optimising the graphic and operational design for improved usability. For example, the participants wanted more attractive interfaces with clear instructions identifying what to do next. Consequently, many of the graphic elements of the app were changed, and pop-up instructions were added on each interface. However, in the Likert-scale questionnaire for the Phase 3 users, the average rating of both the perceived helpfulness of the app APIC and the willingness to use the App in the future dropped significantly, and the interface design might be the major reason (see Section 6.3.2 of Chapter 6). Ultimately, it became clear that the attempt to establish and evaluate the interface design of the apps was a limitation of the study, and this will be discussed in detail later in Section 7.3 of this chapter, together with the discussion of usability (Harrison, Flood, & Duce, 2013). Participants were also critical of the time required for the concordancing to take place, so a multi-threads technique was developed

to provide faster results. The improvements also included a protection mechanism to prevent crashes.

In brief, strong functionality, helpful features and an attractive interface design can help mobile concordancers gain positive feedback from users.

RQ 2: Could ESL students' positive experience and uptake of mobile concordancing software tools be enhanced by the implementation of an alternative pattern-oriented approach, patterns in context (PIC), for searching and retrieving concordances?

According to the results of the three phases, the pattern-oriented approach of PIC can contribute to ESL students' positive experience and uptake of mobile concordancing apps. This is primarily because PIC in this study helped students more easily and more quickly obtain their desired search results, compared to the traditional KWIC method. As mentioned in Section 1.4.2 of Chapter 1, PIC is designed to extend the basic unit of concordancing from individual words - as occurs in KWIC - to a focus on grammar patterns (Hunston & Francis, 2000), that is, structured combinations of lexical choices and grammatical forms. While KWIC-based software simply retrieves indiscriminate lists of concordance lines of a node word, PIC retrieves the node word within certain patterns, so that users are directly exposed to examples of a specific usage of a word. For example, the pattern '*leave* + noun phrase + adj.', a special use of *leave*, is shared by many different word combinations, e.g. *leave me alone* and *don't leave your belongings unattended*. PIC can accurately extract examples of this usage out of all patterns with *leave*, whatever the noun phases in the middle of the pattern may be. The traditional KWIC method cannot deal with such pattern-focused concordancing without POS-tagged corpus texts and regular expressions (see Section 2.3.4 of Chapter 2). Thus, PIC is expected to help the ESL users of the app recognise and identify structural usages of words in a number of examples.

The comparison of the two concordancing apps, AKWIC and APIC, representing the KWIC and PIC methods respectively, was an important component in Phases 1 and 2. In Phase 1, it was the use of the two separate apps that was being compared as well as their evaluation of the app that they were given. The two apps were loaned to two separate groups of voluntary participants for an evaluation period of four weeks. The members of each group tried only one of the apps. Data from Phase 1 showed that APIC tended to be better than AKWIC in helping users notice the target language form in less time, and was also better rated in effectiveness and participants' willingness to use the app in future. However, the APIC users looked up fewer words when working with the designated app than the AKWIC users. Thus, while APIC showed some advantages over AKWIC, it seemed that APIC was used less for word searches by the participants during this period.

In Phase 1, the evaluation was made by two different groups of participants, one using APIC and the other using AKWIC (either group was unaware of the other app). To compare the two apps more accurately, two changes were made to the research design in Phase 2. The first change involved the participants exchanging the APIC and AKWIC apps after two weeks, so that each participant could experience and evaluate both apps. The second change was to introduce a nine-scale Likert questionnaire to more accurately reflect the participants' evaluation.

Data in Phase 2 showed that APIC remained more efficient than AKWIC, since less search time was used for each query. This was supported by the Likert scale results, which clearly indicated that the APIC users thought it easier to find the target form by using the app. APIC also gained better user engagement and was used more often since the participants used the app to look up more words, compared to the participants in Phase 1. Additionally, the questionnaire responses indicated that participants were more willing to use APIC in future. This was supported by the interview responses where Phase 2 participants explicitly described APIC as being 'better' than AKWIC. In brief, the evidence of app use statistics and user evaluation in Phase 2 combined to show that APIC was more efficient and effective than AKWIC in helping students search specific usages of academic vocabulary.

Since the above comparative evaluation in Phase 2 involved each participant using both apps, the results provided additional insights and support compared to the results in Phase 1. Consequently, it could be argued that the proposed PIC method can contribute to a more positive experience and an increased uptake of mobile concordancing, compared to the traditional KWIC concordancing method.

The results from the first two phases led to the decision to end the comparison of the two mobile apps. Because the method of PIC, as represented by APIC, was shown to help promote a positive experience and uptake of mobile concordancing for the participants, AKWIC was removed from the tablets in Phase 3 and only APIC was provided. Each participant in Phase 3 used the APIC app for two weeks, the same period of time as the participants in Phase 2. This would enable investigating whether the data of APIC use and evaluation was similar between different groups of users. The results showed that there was very little difference in how APIC was used across the two phases in terms of the number of words looked up. Regarding the time spent on each query and the use of context extension and online dictionary, the participants' evaluative ratings over the two phases on the app's helpfulness, ease of use, etc. were also very similar.

Results for RQ 3 are discussed next.

RQ 3: What technical affordances can be utilised to develop such mobile-based concordancing tools?

RQ 3 is closely related to RQ 1, however, the answers to this question here involve more technical details. The development of the mobile-based concordancing apps in this research considerable knowledge and skills related to Java and Android programming. To be specific, the technical affordances employed in this research included text processing and formatting, information search and retrieval, database management, speech synthesis, Internet access, interface design, threading optimisation and so on (see Appendix F for the steps of progressive development; also see the corresponding sections of development

details in Chapters 4, 5 and 6). With technology continually advancing, more sophisticated operations and techniques may be introduced in future for apps developed for educational purposes.

With regard to this study, firstly, the core function of concordancing involved text processing and retrieval. A Java-based algorithm in a linear approach, i.e. with texts processed letter by letter, was used to execute KWIC and PIC concordancing. PIC concordancing especially involved additional affordances of POS (part-of-speech) tagging and regular expressions ('regex'). POS tagging is a form of annotation that attaches word class information to each word in a text, and well-established taggers and tagsets can put words into finely divided categories at a high accuracy rate of 95%-97%. Regex is a string of characters to match different combinations of letters and symbols, allowing variances at certain locations. Regex, with POS information included, can accurately and flexibly retrieve semi-structured patterns with variable components, e.g. greatly varying noun phases. For details of POS tagging and regex in this research, please see Appendix E.

Secondly, four SQLite databases were established in this research for concordancing which were insensitive to inflections and enabled pattern association with certain words. The inflection database covered over 40,000 words, mapping each word to its different forms. The pattern databases covered more than 20,000 words, with each word associated with its patterns. The latter was much more complicated, e.g. the verb pattern database involved mapping more than 6,000 verbs to a selection of 20 patterns. All the databases ran well in the research due to the light and fast characteristics of the SQLite system.

Thirdly, the speech synthesis technology, TTS (text-to-speech), was helpful in providing students with on-request conversion of written texts to audio tracks. Nowadays most mobile devices enable TTS, which can be initiated with an updated voice bank. In general, the larger a voice bank is, the more natural or human-like the machine-generated voice will be.

Fourthly, the online dictionary was popular with the participants of this research from Phase 2 on. A free-of-charge one, the online version of the Longman Dictionary of Contemporary English, was used in this research. Access to other online dictionaries, e.g. a variety of Cambridge and Oxford ones, is also available via API (application programming interface) for a monthly license fee. JSON, a common format for the type of dictionary data, could help retrieve information under some or all categories.

Fifthly, a number of interface design elements were involved in this research, including text display, multi-layered list building, clickable button, and hidden word list. They were essential for the participants to be able to use the apps smoothly. It was found that good graphic design of overall layout and components could help enhance user experience and uptake.

Sixthly, process optimisation is also integral to the development of mobile resources for educational purposes. Though optimisation to enable the apps to run more smoothly tends to be less visible, that is, not presented on the interface, such effort underlies more stable and faster performance of mobile apps. For example, the multi-threads technique, allowing multiple tasks to be processed concurrently, saved more than half of the lag time to produce concordance results. Since none of the users in Phase 3 complained about the long wait, it was assumed that the multi-threads technique was successful.

7.2 Implications

The two mobile concordancing apps in this research were developed as an attempt to provide practical and helpful solutions to problems with the uptake of DDL, and ultimately to help users with the difficulty in academic writing. It is hoped that the findings from the participants' use and evaluation of the two apps can shed light on the potential of PIC (Patterns in Context) and DDL (Data-driven Learning) for language education and on how to further promote m-learning in the future.

7.2.1 Implications for DDL

The motivation to conduct this research was to address the current problem that DDL as a resource to help ESL students with their academic writing (Adel, 2010; Charles, Pecorari, & Hunston, 2009; A. Johns, 2001; McLaughlin, 2013; Tribble, 2002) is only minimally applied in language education (Boulton, 2009a, 2009b; T. Johns et al., 2008; Leńko-Szymańska & Boulton, 2015). In this research, the participants received enhanced DDL experience on the mobile platform via the PIC method. Their behaviour and evaluation provided some indication as to how DDL can be developed to improve the chances of being integrated into mainstream pedagogy and to further release its potential as a helpful resource for language education.

Easier accessibility

Firstly, with a more user-friendly operation process and more appropriate materials, the apps show that DDL can and should be made more accessible to student users in terms of ease of use and text appropriateness. As mentioned in Chapter 1, online corpus query portals, such as the BYU corpora and BNCweb, represent the attempt that has been made to enable convenient consultation by students and other non-expert users directly with corpora in recent years. These web-based resources have greatly enhanced the accessibility of concordancing and other information about language use that can be derived from corpus queries, in that they have largely addressed the problem of 'logistics', i.e. the lack of corpus resources to non-expert users (Gilquin & Granger, 2010), since no corpora are required to be stored in local hard drives and all tasks of search, retrieval and presentation are completed online. More specialised corpora suitable for specific user groups are also open to use from online portals. For example, specialised corpora of academic English, such as MICUSP (Michigan Corpus of Upper-Level Student Papers) and BAWE (British Academic Written English), have been made available for online queries for those who aim to improve their academic writing in English.

The apps developed and evaluated in this research were inspired by such efforts, and were designed to evaluate whether DDL could be made simpler, more accessible and more

tailored to students, thus encouraging a more positive user experience and uptake of mobile-based concordancing tools as a resource for academic writing Unlike earlier desktop-based DDL, participants in this research did not need to prepare their own texts, and their searches were supported by suggested search words (from 52 academic verbs in Phase 1 to 500 core words in Phases 2 and 3). The corpus-query function in the apps were confined to concordancing only, while other features of sorting, statistical analysis, etc., although common in other concordancers, were not included. Students with little training in corpus linguistics can complete the entire process of concordancing, and successfully seek examples of language use, using only the touchscreen, In fact, an improvement of the apps during the phases was to activate the feature of context extension by finger movement, instead of manually setting the context range. In addition, discipline-specific texts taken from the subcorpus of academic English of COCA were pre-loaded into the apps. It is believed beneficial that the participants can find subject-specific texts for their academic study (Gavioli, 2005). In the future, more appropriate texts may be drawn from better indexed and annotated specialised corpora. Alternatively the difficulty, familiarity and predictability of content can be adjusted from existing data (Gavioli, 2001; Kilgrriff, 2009; Partington, 2001), which would, however, take more time to prepare. In a word, further attempts to make DDL more accessible to student users, on whatever platform, should focus on improvement of user-friendliness and appropriateness of materials.

Based on technology

Secondly, the promotion of DDL should be dependent on technology, especially mobile technology, as shown in this research. The birth of the online corpus-query tools mentioned above are impossible without up-to-date Internet and database technology. In the present research, the two apps were adjusted with technology to deliver different concordancing experience: random concordancing results were displayed while more could be retrieved if required; PIC involved regex formulation. In addition, a freely available online learner's dictionary was introduced in Phase 2 of the research as an optional reference. At the same time, new affordances of mobile technology, such as touch screen and TTS, were utilised to enhance the positive experience of use.

The above-mentioned technology-based enhancements, which were highly rated by the participants, contributed to their positive experience and uptake of DDL. Therefore, future development of DDL should be technology-based rather than technology-free: although it is possible to conduct DDL on paper (Boulton, 2010b, 2010c) or by handwriting (J. Willis, 2011), none of the enhanced experiences in this research – random results, PIC or multi-media support – could have been achieved with paper-based or handwritten DDL.

To sum up, to promote the use of DDL in language education, it seems to be desirable that student users have convenient access to appropriate prepared language resources. The tools of DDL can be reduced to simple concordancers, and some introduction or training, without referring to special terms, can be helpful to facilitate autonomous corpus queries. Furthermore, emerging technology is expected to continuously support and enhance DDL. It is recommended to actively incorporate state-of-the-art technical affordances in DDL development, rather than using only paper-based DDL practice.

7.2.2 Implications for m-learning

As mentioned in Section 2.4.4 of Chapter 2, m-learning, which involves a portable, personal and informal learning experience (Kearneya et al., 2012; Kukulska-Hulme, 2009b; Pachler, 2009; Peter, 2009; Traxler, 2007; Udell, 2015a), has become an increasing trend in education (Hockly, 2013; Kukulska-Hulme, 2009b; Traxler, 2009b). The results of this research indicate that multi-functionality is a desirable feature of mobile tools, and more complicated tasks for education, like PIC concordancing in this research, can be introduced to the mobile platform. In addition, interface design seems to be increasingly important in the development of educational apps. Furthermore, in the context of methodological approaches employed for investigating m-learning research, it was found that the mixed-methods approach used in this study was an effective and efficient way to enhance data triangulation and complementarity (Creswell, 1999; Johnson & Onwuegbuzie, 2004).

Better functionality

It was found that the majority of the participants in this research desired a mobile learning tool that was in essence a comprehensive platform, containing a range of supporting resources and tools. While concordancing was the core function of the apps, enhancement and improvement of additional features were often the focus of the participants' feedback. As a result, an online dictionary was added in both apps to complement the core function of concordancing, and TTS was improved with a better voice bank. The participants' advice to make the apps more versatile, e.g. including vocabulary exercises and academic writing suggestions, could also be adopted in future development. Given the app users' desire for multi-functionality, the designers of m-learning tools should consider including a number of functions to meet the different needs of users in different settings.

One of the features worth stressing is the access to the Internet. As suggested by the online dictionary which was highly rated by the participants, Internet access can expand the reach of resources beyond the device and the holder. This is an attempt to make best use of the advantage of 'connectivity' of m-learning (Guder, 2010; Siemens, 2005; Transue, 2013). At the same time, Internet access should always be a supportive feature, and the major function(s) of an app should not rely on it. In this research, the core functionality of concordancing could run offline, so that the user experience would not be affected by access and speed of the Internet.

In addition, mobile tools for education can handle sophisticated data processing to enable more interactive user experience. In this research, carrying out searches through millions of words was not a problem even on the entry-level tablet computers with very fundamental configurations. Also, the additional features, e.g. TTS and the online dictionary, which would consume a considerable amount of computer resources (e.g. memory), ran smoothly on the devices. However, current educational apps tend to be largely confined to transferring instructions, practice and games for language learning in the traditional forms to the mobile platform. Aarts et al. (2012) developed an app called 'iGrammar of English (iGE)' to teach grammar to the iPhone generation. The app was based on the *Internet Grammar of English*, a web-based structured grammar course with

exercises. Although it was claimed that "[c]reating the App was not simply a matter of converting the Internet Grammar website into a different form" (p. 5), the main effort seemed to be making paragraphs and examples shorter so as to fit smaller-size screens. A limited number of authentic examples from corpora were available to support exercises. iGE may represent the development practice of the majority of educational apps nowadays: static pedagogical content for presentation, followed by exercises for practice. To realise the potential of m-learning, it might be best to have more complicated and interactive operations on mobile tools, such as concordancing and TTS in the apps of this research.

For the development of future m-learning tools, it is crucial to consider what new approaches and resources for educational purposes can be incorporated into an app among its multiple functions. Mobile DDL has proved that corpus resources and methods can be used on the mobile platform. Similarly, interactive and engaging activities can be integrated into mobile apps, no matter how sophisticated the activities might be. In short, more pedagogical resources and approaches should be included in mobile apps to benefit students who are often constrained by time and location.

Better interface design

It was found that the participants in this research favoured attractive app interfaces. Interface design has been a focus of concern in technology-enhanced education for some time (Banga & Weinhold, 2014; Cho, Cheng, & Lai, 2009; Plass, 1998). Developing successful interface designs for mobile apps tends to be more difficult than that of desktop software packages, because mobile devices have smaller screens than computers and laptops. Furthermore, the requirement that apps are multi-functional means that creating attractive and easy to use apps is somewhat challenging. In other words, we need to consider how best to organise the different modules, resources and links in a presentable layout, and how best to connect different interfaces so that users can quickly access and negotiate the different procedures involved in using an app. Therefore, it seems that professional mobile developers with expertise in graphic design may become increasingly important in the development of m-learning apps.

Research methods

Mixed-methods (Creswell, 2009, 2014) were employed in this research. Triangulation of qualitative and quantitative data collected via different methods and sources (Creswell, 1999; Flick, 2004; Johnson & Onwuegbuzie, 2004) was proved effective for mutual support and complementation. It seems that the research on m-learning has been faced with the problem of evaluation due to its informal nature (Sharples, 2009). It is noted that subjective data, such as self-evaluation and assessment, was often used in m-learning research, while statistically reliable data was rare (Burston, 2015; Traxler & Kukulska-Hulme, 2006). In this research, common methods for data collection in m-learning research - online questionnaires, interviews and focus groups - were adapted to contribute most of the qualitative data. At the same time, automatic logging, an effective means to capture passive data of how mobile devices are used (Trinder et al., 2009), provided reliable quantitative data on the participants' app use. In addition, it also provided a small amount of qualitative data, for example, the searched words and written comments in Phases 2 and 3. Through data triangulation, the findings were made more valid.

Due to the multi-dimensional mobility (devices, content and learners) of m-learning (Kukulska-Hulme, 2009b), reliance on manual observation alone is not appropriate for collecting data on how m-learning tools are actually used. For individual learners, personalised experience of m-learning may be obtained in different contexts and over different time periods, so an m-learning study based on observation may be reduced to a case study with a very limited number of participants. To implement manual observation, the participants need to be gathered in a certain location to do the same learning tasks, as in a traditional classroom. However, such a process would be entirely conflictive with the nature and features of m-learning. Therefore, a feasible way to replace observation, like automatic logging, is indispensable in m-learning research to collect usage data for statistical processing. Screen recording would be another option to capture every detail of user behaviour as reflected on the screen, while this alternative involves more ethical concerns and interpreting of video records.

7.3 Limitations

There are several limitations of this research, and additional items which further study could address. Firstly, this three-phase research involved only 58 students preparing for university study in total, a relatively small number. This was mainly because only 10 uniform tablets were affordable with the available funds, so the total number of participants turned out to be limited even after six cohorts. Because of this, the results of this research may not be applicable to ESL students in general, or to other disciplines. The participants were also from a limited range of nationalities (mostly from Asian countries), age groups (pre-university) and language proficiency (upper intermediate). Similarly, as the participants were recruited on a voluntary basis, and were likely to involve technologically-proficient participants, or those interested in technology, their engagement with the mobile apps may not necessarily reflect the experience and evaluation of the wider cohort of ESL students. However, it seems that a number of m-learning studies adopt case study investigations, often involving a small number of participants. For example, the case study by Gromik (2012) on using cell phone video recording as a language learning tool recruited only nine participants. Gromik argues that a small number of participants is sufficient to provide an understanding of an emerging m-learning phenomenon.

Secondly, while longitudinal studies may be desirable for research on m-learning, the period of app use for each cohort of participants in this study was relatively short (two to four weeks), due to the academic calendar of the participants who were enrolled in short courses. At the same time, a longitudinal study may not generate useful data related to the comparison of apps, unless participants are surveyed and feedback is gathered regularly. This research consisted of six short cycles rather than a longitudinal study. It would have been better if the same groups of students could have gone through all the three phases, using all the versions of the apps under iterative and progressive improvement and then given phase-by-phase feedback. If based on use data and comments from the same participants, the results could be more convincing and reliable.

Thirdly, there were no pre- and post-tests to monitor learning outcomes. For example, the benefits that the participants obtained from using the apps were not measured and evaluated in this research. The evaluation problem found in m-learning research (Sharples, 2009) was taken into consideration at the beginning. Since m-learning practice may spread across different locations and time periods, it is always difficult to observe students' use of mobile devices and apps. That is the major reason why most m-learning studies had to be based on subjective comments from teachers and self-reflections by students. Due to this limitation, it is largely impossible to monitor and attribute learning outcomes to m-learning.

Fourthly, in this research, the interface design elements in Phases 1 and 2 were added and arranged on the basis of researcher's knowledge of Java programming, and the design changed before Phase 3 as a response to the feedback in Phase 2. The factor of graphic design might have been excluded at the beginning, and the interfaces of the two apps could have been formed only by text-based commands and displays. This approach may have facilitated a better comparison of the perceived usefulness and usage of the two apps. In Phase 3, when the problem of interface design became the focus, graphic elements could have been added to test the effects of having better interface design with graphic elements.

Fifthly, interface design is part of usability evaluation. Another limitation is the lack of specialised knowledge on usability evaluation, which has been a vital part of software development (Patel & Dalal, 2013). It is not uncommon that many apps suffer from usability issues, and it is noted that in apps for education, flexibility, minimal action, aesthetic elements are among the main factors that influence user perceived usability (Ismail, Ahmad, Kamaruddin, & Ibrahim, 2016). To introduce usability evaluation from a systematic perspective would be advantageous for future m-learning research. There have been a few usability evaluation models (Freire, Arezes, & Campos, 2012), and a recently proposed one is called PACMAD (People at the Centre of Mobile Application Development) (Harrison et al., 2013). As a comprehensive usability evaluation model drawing upon previous ones, PACMAD identifies three factors of usability: user, task and

context, as well as seven attributes: effectiveness, efficiency, satisfaction, learnability, memorability, errors and cognitive load.

7.4 Future research

Future research could address the limitations of this study by removing the restrictions on time and number of participants. Regarding ESL students' positive experience and uptake of concordancing tools, future studies could involve more participants from different levels and nationalities, and longer periods of app use. With regard to whether ESL students' positive experience and uptake of mobile concordancing software tools could be enhanced, future studies could involve an app interface designer to help make the app more appealing to users. In addition, a specialist ESL or EAP teacher could be involved to add features such as vocabulary or writing exercises that would provide additional functionality of academic writing for target users. Future research could also involve usability evaluation.

7.5 Final summary

DDL (Data-driven Learning), an approach based on corpus resources and methods for language education, features extensive exposure to a number of language examples in original contexts (Gabrielatos, 2005; Higgins & Johns, 1984). DDL has the potential to help with English learning via enhanced language input and learner autonomy (Boulton, 2009a, 2011; Hunston, 2002a), as evidenced by a number of empirical studies (Chambers & O'Sullivan, 2004; Huang, 2014; D. Liu, 2011; D. Liu & Jiang, 2009; O'Sullivan & Chambers, 2006; Sun, 2007; H. Yoon & Hirvela, 2004). However, the approach has long been excluded from educational practice due to the complexity of operating the tools and the way the results are presented (Chambers, 2007; Cheng et al., 2003; L. Flowerdew, 2012; T. Johns et al., 2008). This research proposed and investigated two concepts - mobile DDL and PIC - using two specially designed concordancing apps, which were used and evaluated by participating students. The aim was to test whether PIC could enhance ESL students' positive experience and uptake of DDL, and to investigate learners'

behaviour and expectations regarding m-learning.

Two special apps - APIC and AKWIC - were designed and developed for the research purpose. The two apps add to the list of concordancing tools for non-expert users. Different from existing concordancers, the apps feature pre-loaded corpus texts specific to a range of disciplines, so that the target audience – upper-intermediate ESL students – could do queries through authentic texts of academic English for their own fields of study. The core functionality of concordancing being kept offline could also ensure the user experience of the apps would not be affected by unavailable or unstable network access. Most importantly, the PIC app, which in this study was seen to be the app preferred by student participants, offers pattern-oriented concordancing with pre-set regex, a capability which is currently unavailable on existing tools, whether desktop-based, online or mobile.

Mixed-methods (Creswell, 2009, 2014) and action research (Burns, 2010a; Somekh, 2006) were adopted as the methodology in this research. Over three phases with improvement and adjustment, six cohorts of pre-university language students were provided with two mobile concordancing tools as digital references of language use in academic writing and then were invited to give feedback on the apps. Both quantitative and qualitative data were collected from automatic logging, questionnaires and focus-group interviews. After processing and analysis, the triangulated data revealed that ESL students' positive experience and uptake of using concordancing to help with academic writing can be enhanced by mobile-based concordancing tools and the alternative pattern-oriented search and retrieval approach of PIC. On the one hand, mobile concordancers, as the apps developed in this research, can provide convenient access to corpus consultation for language reference. On the other hand, PIC is designed to make frequent multi-word patterns more observable and accessible to learners by exempting them from the often demanding technical requirements (e.g. regex) which are usually associated with pattern-focused concordancing. The benefits of mobile DDL and PIC imply that DDL can be made more accessible and acceptable to students through the use of certain technical affordances and attention to multi-functionality and interface design.

The original contribution of research might be more in the aspect of m-learning than concordancing for language learning purposes. The research tested the feasibility of implementing DDL on mobile devices. The new mobile platform could enable DDL to be more accessible to non-expert users, especially ESL students. Technical affordances, such as an embedded online dictionary, finger movement detection and TTS, turned out to help enhance positive user experience and uptake of such mobile corpus consultation. At the same time, resources and approaches proven in linguistics research (corpora and DDL) can be transferred and integrated in mobile devices to enable more interactive and data-rich experience. As evidenced in this research by concordancing on mobile devices, the mobile platform can accommodate large-scale data and complicated processing. The research results confirmed the features and benefits of m-learning, and also shed light on how mobile technology can provide resources that enhance the academic writing experiences of ESL students.

REFERENCES

Aarts, B., Clayton, D., & Wallis, S. (2012). Bridging the grammar gap: Teaching English grammar to the iPhone generation. *English Today, 28*(1), 3-8.

Abrahamse, J., & Lotriet, H. (2012). Towards an understanding, through Action Research, of the socio-organizational issues impacting on mobile technology adoption and diffusion within a small-to-medium South African construction company. *Systemic Practice and Action Research, 25*, 57-79.

Ackermann, K., & Chen, Y.-H. (2013). Developing the Academic Collocation List (ACL) - A corpus-driven and expert-judged approach. *Journal of English for Academic Purposes, 12*, 235-247.

Adel, A. (2010). Using corpora to teach academic writing: Challenges for the direct approach. In M. C. Campoy-Cubillo, B. Belles-Fortuno & G.-V. M. Lluisa (Eds.), *Corpus-based approaches to English language teaching* (pp. 39-55). London: Continuum.

Ahmad, K., Corbett, G., Rodgers, M., & Sussex, R. (1985). *Computers, language learning, and language teaching*. Cambridge: Cambridge University Press.

Al-Wasy, B., & Mahdi, H. (2016). The effect of mobile phone applications on improving EFL learners' self-editing. *Journal of Education and Human Development, 5*(3), 149-157.

Allen, G., & Dovey, K. (2016). Action Research as a leadership strategy for innovation: The case of a global high-technology organisation. *International Journal of Action Research, 12*(1), 8-37.

Almad, A., & Yunus, M. (2015). Potential of mobile learning in teaching of ESL academic writing. *English Language Teaching, 8*(6), 11-19.

Alshaar, A. A., & AbuSeileek, A. F. (2013). Using concordancing and word processing to improve EFL graduate students' written English. *The JALT CALL Journal, 9*(1), 59-77.

Anthony, L. (2015). AntConc (Version 3.5.0 Development). Tokyo, Japan: Waseda University.

Axinn, W. G., & Pearce, L. D. (2006). *Mixed method data collection strategies*. Cambridge: Cambridge University Press.

Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). London: Routledge.

Bailin, A. (1995). Intelligent computer-assisted language learning: A bibliography. *Computers and the Humanities, 29*(5), 375-387.

Baker, P., Hardie, A., & McEnery, T. (2006). *A glossary of corpus linguistics*. Edinburgh: Edinburgh University Press.

Banga, C., & Weinhold, J. (2014). *Essential mobile interaction design: Perfecting interface design in mobile apps*. Upper Saddle River, NJ: Addison-Wesley.

Barlow, M. (1999). MonoConc 1.5 and ParaConc. *International Journal of Corpus Linguistics, 4*(1), 173-184.

Baskerville, R., & Myers, M. D. (2004). Special issue on action research in information systems: Making IS research relevant to practice: Foreword. *MIS Quarterly, 28*(3), 329-335.

Bauer, L., & Nation, I. S. P. (1993). Word families. *International Journal of Lexicography, 6*(4), 253-279.

Baugh, S., Harley, A., & Jellis, S. (1996). The role of corpora in compiling the Cambridge International Dictionary of English. *International Journal of Corpus Linguistics, 1*, 39-59.

Baumann, J., & Graves, M. (2010). What is academic vocabulary? *Journal of Adolescent and Adult Literacy, 54*(1), 4-12.

Bax, S. (2003). CALL - past, present and future. *System, 31*, 13-28.

Bax, S. (2011). Normalisation revisited: The effective use of technology in language education. *International Journal of Computer-Assisted Language Learning and Teaching, 1*(2), 1-15.

Bazeley, P., & Jackson, K. (2013). *Qualitative data analysis with NVivo* (2nd ed.). London: Sage.

Beatty, K. (2010). *Teaching and researching computer-assisted language learning* (2nd ed.). London: Pearson.

Beaufort, A. (2004). Developmental gains of a history major: A case for building a theory of disciplinary writing expertise. *Research in the Teaching of English, 39*, 136-185.

Belkhir, F. Z. (2013). A survey on teachers' awareness and attitudes on computer-corpus data: An assisted technology-based EFL vocabulary selection and instruction source. *Social and Behavioral Sciences, 103*, 77-85.

Bennett, G. R. (2010). *Using corpora in the language learning classroom: Corpus linguistics for teachers*. Ann Arbor: University of Michigan Press.

Benson, M., Benson, E., & Ilson, R. (Eds.). (2010). *The BBI combinatory dictionary of English: Your guide to collocations and grammar* (3rd ed.). Amsterdam: John Benjamins.

Benson, P. (1996). Concepts of autonomy in language learning. In P. R., L. E., O. W. & P. H. (Eds.), *Taking Control: Autonomy in Language Learning* (pp. 27-34). Hong Kong: Hong Kong University Press.

Benson, P. (2001). *Teaching and researching autonomy in language learning*. Harlow, Essex: Longman.

Benson, P. (2007). Autonomy in language teaching and learning. *Language Teaching, 40*(1), 21-40.

Bhatia, V. K. (2002). A generic view of academic discourse. In J. Flowerdew (Ed.), *Academic discourse* (pp. 21-39). London: Longman.

Biber, D., Conrad, S., & Cortes, V. (2004). *If you look at ...*: Lexical bundles in university teaching and textbooks. *Applied Linguistics, 25*(3), 371-405.

Biber, D., Conrad, S., & Leech, G. (2002). *Longman student grammar of spoken and written English*. Harlow: Pearson.

Blessinger, P., & Wankel, C. (2013). Novel approaches in higher education: An introduction to Web 2.0 and blended learning technologies. In C. Wankel & P. Blessinger (Eds.), *Increasing student engagement and retention in E-Learning environments: Web 2.0 and blended learning technologies* (pp. 3-16). Bingley: Emerald Group.

Blin, F. (2004). CALL and the development of learner autonomy: Towards an activity-theoretical perspective. *ReCall, 16*(2), 377-395.

Bloch, J. (2009). The design of an online concordancing program for teaching about reporting verbs. *Language Learning and Technology, 13*(1), 59-78.

Bloor, M., & Wood, F. (2006). *Keywords in qualitative methods: A vocabulary of research concepts*. London: Sage.

Boers, F., Kappel, J., Stengers, H., & Demecheleer, M. (2006). Formulaic sequences and perceived oral proficiency: Putting a Lexical Approach to the test. *Language Teaching Research, 10*(3), 245-261.

Boers, F., & Lindstromberg, S. (2012). Experimental and intervention studies on formulaic sequences in a second language. *Annual Review of Applied Linguistics, 32*, 83-110.

Boulton, A. (2008). Looking for empirical evidence of data-driven learning at lower levels. In B. Lewandowska-Tomaszczyk (Ed.), *Corpus linguistics, computer tools, and applications: State of the art* (pp. 581-598). Frankfurt: Peter Lang.

Boulton, A. (2009a). Data-driven learning: Reasonable fears and rational reassurance. *Indian Journal of Applied Linguistics, 35*(1), 81-106.

Boulton, A. (2009b). Testing the limits of data-driven learning: Language proficiency and training. *ReCall, 21*(1), 37-51.

Boulton, A. (2010a). Bringing corpora to the masses: Free and easy tools for interdisciplinary language studies. In N. Kubler (Ed.), *Corpora, language, teaching, and resources: From theory to practice* (pp. 69-96). Frankfurt: Peter Lang.

Boulton, A. (2010b). Data-driven learning: On paper, in practice. In T. Harris & M. Moreno-Jaen (Eds.), *Corpus linguistics in language teaching* (pp. 17-52). Bern: Peter Lang.

Boulton, A. (2010c). Data-driven learning: Taking the computer out of the equation. *Language Learning, 60*(3), 534-572.

Boulton, A. (2011). Data-driven learning: The perpetual enigma. In S. Gozdz-Roszkowski (Ed.), *Explorations across languages and corpora* (pp. 563-580). Frankfurt: Peter Lang.

Boulton, A. (2012). Empirical research in data-driven learning: A summary. Retrieved from Boulton's homepage website: http://arche.univ-nancy2.fr/course/view.php?id=967

Boulton, A., & Pérez-Paredes, P. (2014). ReCALL special issue: Researching uses of corpora for language teaching and learning. *ReCall, 26*(2), 121-127.

Braun, S. (2005). From pedagogically relevant corpora to authentic language learning contents. *ReCall, 17*(1), 47-64.

Braun, S. (2007). Integrating corpus work into secondary education: From data-driven learning to needs-driven corpora. *ReCall, 19*(3), 307-328.

Breyer, Y. (2009). Learning and teaching with corpora: Reflections by student teachers. *Computer Assisted Language Learning, 22*(2), 153-172.

Browne, C., Culligan, B., & Phillips, J. (2015). *A new academic word list.* Retrieved from http://www.newacademicwordlist.org/about-authors/

Bruce, I. (2011). *Theory and concepts of English for academic purposes*. New York: Palgrave Macmillan.

Brydon-Miller, M., Greenwood, D. J., & Maguire, P. (2003). Why action research? *Action Research, 1*(1), 9-28.

Burns, A. (1999). *Collaborative action research for English language teachers*. Cambridge: Cambridge University Press.

Burns, A. (2010a). Action research. In B. Paltridge & A. Phakiti (Eds.), *Continuum companion to research methods in applied linguistics* (pp. 80-97). London: Continuum.

Burns, A. (2010b). *Doing action research in English language teaching: A guide for practitioners*. New York: Routledge.

Burston, J. (2013). Mobile-assisted language learning: A selected annotated bibliography of implementation studies 1994-2012. *Language Learning and Technology, 17*(3), 157-225.

Burston, J. (2014a). MALL: The pedagogical challenges. *Computer Assisted Language Learning, 27*(4), 344-357.

Burston, J. (2014b). The reality of MALL: Still on the fringes. *CALICO Journal, 31*(1), 103-125.

Burston, J. (2015). Twenty years of MALL project implementation: A metaanalysis of learning outcomes. *ReCall, 27*(1), 4-20.

Campion, M., & Elley, W. (1971). *An academic vocabulary list*. Wellington: New Zealand Council for Educational Research.

Carr, W., & Kemmis, S. (2004). *Becoming critical: Education, knowledge and action research*. London: Routledge.

Celik, S., & Keser, H. (2010). The effect of data-driven learning approach on EFL learners' lexical acquisition. *Education and Science, 35*(158), 184-198.

Chambers, A. (2005). Integrating corpus consultation in language studies. *Language Learning and Technology, 9*(2), 111-125.

Chambers, A. (2007). Integrating corpora in language learning and teaching. *ReCall, 19*(3), 249-251.

Chambers, A. (2010). What is data-driven learning? In A. O'Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 345-358). London: Routledge.

Chambers, A., & Bax, S. (2006). Making CALL work: Towards normalisation. *System, 34*, 465-479.

Chambers, A., & Kelly, V. (2004). Corpora and concordancing: Changing the paradigm in language learning and teaching. In A. Chambers, J. E. Conacher & J. Littlemore (Eds.), *ICT and language learning: Integrating pedagogy and practice* (pp. 183-201). Birmingham, UK: University of Birmingham Press.

Chambers, A., & O'Sullivan, I. (2004). Corpus consultation and advanced learners' writing skills in French. *ReCall, 16*(1), 158-172.

Chang, J.-Y. (2014). The use of general and specialized corpora as reference sources for academic English writing: A case study. *ReCall, 26*(2), 243-259.

Chapelle, C. (1989). Using intelligent computer-assisted language learning. *Computers and the Humanities, 23*(1), 59-70.

Chapelle, C. (2001). *Computer applications in second language acquisition: Foundations for teaching, testing, and research*. Cambridge: Cambridge University Press.

Chapelle, C. (2007). Challenges in evaluation of innovation: Observations from technology research. *Innovation in Language Learning and Teaching, 1*(1), 30-45.

Chapelle, C., & Jamieson, J. (1991). Internal and external validity issues in research on CALL effectiveness. In P. Dunkel (Ed.), *Computer assisted language learning and testing: Research issues and practice* (pp. 37-59). New York: Newbury House.

Charles, M., Pecorari, D., & Hunston, S. (Eds.). (2009). *Academic writing: At the interface of corpus and discourse*. London: Continuum.

Cheng, W., Warren, M., & Xu, X.-F. (2003). The language learner as language researcher: Putting corpus linguistics on the timetable. *System, 31*(2), 173-186.

Chinnery, G. M. (2006). Going to the MALL: Mobile assisted language learning. *Language Learning and Technology, 10*(1), 9-16.

Cho, V., Cheng, T. C., & Lai, W. M. (2009). The role of perceived user-interface design in continued usage intention of self-paced e-learning tools. *Computer and Education, 53*, 216-227.

Christie, F., & Maton, K. (2011). Why disciplinarity? In F. Christie & K. Maton (Eds.), *Disciplinarity: Functional linguistic and sociological perspectives* (pp. 1-9). London: Continuum.

Chujo, K., Anthony, L., Oghigian, K., & Uchibori, A. (2012). Paper-based, computer-based, and combined data-driven learning using a web-based concordancer. *Language Education in Asia, 3*(2), 132-145.

Church, K., & Hanks, P. (1990). Word association norms, mutual information and lexicography. *Computational Linguistics, 16*(1), 22-19.

Ciussi, M., Rosner, G., Augier, M., & Suder, G. (2011). M-Learning and Y Generation: The reality behind the myth. In D. Parsons (Ed.), *Combining e-learning and m-learning: New applications of blended educational resources* (pp. 266-280). Hershey, PA: Information Science Reference.

Cobb, T. (1997). Is there any measurable learning from hands-on concordancing? *System, 25*(3), 305-315.

Cochrane, T., & Bateman, R. (2010). Smartphones give you wings: Pedagogical affordances of mobile Web 2.0. *Australasian Journal of Educational Technology, 26*(1), 1-14.

Cochrane, T., & Bateman, R. (2011). Transforming pedagogy using mobile Web 2.0: 2006 to 2009. In D. Parsons (Ed.), *Combining e-learning and m-learning: New applications of blended educational resources* (pp. 281-307). Hershey, PA: Information Science Reference.

Coffin, C., Curry, M. J., Goodman, S., Hewings, A., Lillis, T. M., & Swann, J. (2003). *Teaching academic writing: A toolkit for higher education*. London: Routledge.

Conole, G. (2010). Personalisation through technology-enhanced learning. In J. O'Donoghue (Ed.), *Technology-supported environments for personalized learning: Methods and case studies* (pp. 1-15). Hershey: Information Science Referenc.

Conrad, S., & Biber, D. (2009). *Real grammar: A corpus-based approach to English* (1st ed.). New York: Pearson Education ESL.

Cook, J., Pachler, N., & Bradley, C. (2008). Bridging the gap? Mobile phones at the interface between informal and formal learning. *Journal of the Research Center for Educational Technology, 4*(1), 3-18.

Costello, P. J. M. (2003). *Action research*. London: Continuum.

Coxhead, A. (2000). A new Academic Word List. *TESOL Quarterly, 34*(2), 213-238.

Coxhead, A. (2008). Phraseology and English for academic purposes: Challenges and opportunities. In F. Meunier & S. Granger (Eds.), *Phraseology in foreign language learning and teaching* (pp. 149-161). Amsterdam: John Benjamins.

Coxhead, A. (2011). The Academic Word List 10 years on: Research and teaching implications. *TESOL Quarterly, 45*(2), 355-362.

Creswell, J. W. (1999). Mixed-method research: Introduction and application. In G. J. Cizek (Ed.), *Handbook of educational policy* (pp. 455-472). San Diego: Academic Press.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). London: Sage.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). London: Sage.

Crompton, H. (2013). A historical overview of M-Learning: Towards learner-centred education. In Z. L. Berge & L. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 80-107). New York: Routledge.

Davies, G., Otto, S. E. K., & Rüschoff, B. (2013). Historical perspectives on CALL. In M. Thomas, H. Reinders & M. Warschauer (Eds.), *Contemporary computer-assisted language learning* (pp. 19-38). London: Bloomsbury Academic.

Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Davis, M. (2009). The 385+million word corpus of contemporary American English (1990-2008+): Design, architecture, and linguistic insights. *International Journal of Corpus Linguistics, 14*(2), 159-190.

Dornyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methodologies*. Oxford: Oxford University Press.

dos Santos, P. S. M., & Travassos, G. H. (2011). Action research can swing the balance in experimental software engineering. *Advances in Computers, 83*, 205-276.

Dudeney, G., & Hockly, N. (2012). ICT in ELT: How did we get here and where are we going? *ELT Journal, 66*(4), 533-542.

Dunkel, P. (1991). The effectiveness research on computer-assisted instruction and computer-assisted language learning. In P. Dunkel (Ed.), *Computer assisted language learning and testing: Research issues and practice* (pp. 5-36). New York: Newbury House.

Durrant, P. (2014). Discipline and level specificity in university students' written vocabulary. *Applied Linguistics, 35*(3), 328-356.

Dziemianko, A. (2010). Paper or electronic? The role of dictionary form in language reception, production and the retention of meaning and collocations. *International Journal of Lexicography, 23*(3), 257-273.

Dziemianko, A. (2012). Why one and two do not make three: Dictionary form revisited. *Lexikos, 22*, 195-216.

Easterbrook, S., Singer, J., Storey, M.-A., & Damian, D. (2008). Selecting empirical methods for software engineering research. In F. Shull, J. Singer & D. I. K. Sjøberg (Eds.), *Guide to advanced empirical software engineering* (pp. 285-311). London: Springer.

Egbert, J. (2015). Publication type and discipline variation in published academic writing: Investigating statistical interaction in corpus data. *International Journal of Corpus Linguistics, 20*(1), 1-29.

Eisenlauer, V. (2014). Multimodality in mobile-assisted language learning. In M. Kalz, Y. Bayyurt & M. Specht (Eds.), *Mobile as mainstream - Towards future challenges in mobile learning* (pp. 328-338). Heidelberg: Springer.

Elliot, J. (1991). *Action research for educational change*. Buckingham: Open University Press.

Ellis, N. (2003). Constructions, chunking, and connectionism: The emergence of second language structure. In C. Doughty & M. Long (Eds.), *The handbook of second language acquisition* (pp. 63-103). Oxford: Blackwell.

Ellis, R. (2012). *Language teaching research and language pedagogy*. Oxford: Wiley-Blackwell.

Ellis, R., & Shintani, N. (2014). *Exploring language pedagogy through second language acquisition research*. London: Routledge.

Feilzer, M. Y. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research, 4*(1), 6-16.

Felix, U. (2005a). Analysing recent CALL effectiveness research - Towards a common agenda. *Computer Assisted Language Learning, 18*(1-2), 1-32.

Felix, U. (2005b). What do meta-analyses tell us about CALL effectiveness? *ReCall, 17*(2), 269-288.

Felix, U. (2008). The unreasonable effectiveness of CALL: What have we learned in two decades of research? *ReCall, 20*(2), 141-161.

Feser, J. (2015). mLearning is not e-Learning on a mobile device. In C. Udell & G. Woodill (Eds.), *Mastering mobile learning: Tips and techniques for success* (pp. 35-42). Hoboken, NJ: Wiley.

Fillmore, C. (1992). "Corpus linguistics" or "Computer-aided armchair linguistics". In J. Svartvik (Ed.), *Directions in corpus linguistics* (pp. 35-60). Berlin: Mouton de Gruyter.

Finger, G., Russell, G., Jamieson-Proctor, R., & Russell, N. (2007). *Transforming learning with ICT: Making IT happen*. Frenchs Forest, NSW: Pearson Education Australia.

Flick, U. (2004). Triangulation in qualitative research. In U. Flick, E. v. Kardorff & I. Steinke (Eds.), *A companion to qualitative research* (pp. 178-183). London: Sage.

Flowerdew, J. (1996). Concordancing in language teaching. In M. Pennington (Ed.), *The power of CALL* (pp. 97-113). Houston, TX: Athelstan.

Flowerdew, J., & Li, Y. (2007). Language re-use among Chinese apprentice scientists writing for publication. *Applied Linguistics, 28*(3), 440-465.

Flowerdew, L. (2005). An integration of corpus-based and genre-based approaches to text analysis in EAP/ESP: Countering criticisms against corpus-based methodologies. *English for Specific Purposes, 24*, 321-332.

Flowerdew, L. (2012). *Corpora and language education*. Basingstoke, UK: Palgrave Macmillan.

Flowerdew, L. (2015). Using corpus-based research and online academic corpora to inform writing of the discussion section of a thesis. *Journal of English for Academic Purposes, 20*, 58-68.

Fotos, S., & Browne, C. M. (2004). The development of CALL and current options. In S. Fotos & C. M. Browne (Eds.), *New perspectives on CALL for second language classrooms* (pp. 3-14). Mahwah, NJ: Lawrence Erlbaum.

Fox, J. (1985). Humanistic CALL: Teachers' needs and learners' needs in the design of computer-assisted language learning systems. In C. Brumfit (Ed.), *Computers in English Language Teaching* (pp. 91-97). Oxford: Pergamon.

Francis, G. (1993). A corpus-driven approach to grammar. In M. Baker, G. Francis & E. Tognini-Bonelli (Eds.), *Text and technology: In honour of John Sinclair* (pp. 137-156). Amsterdam: John Benjamins.

Francis, G., Hunston, S., & Manning, E. (Eds.). (1996). *Collins COBUILD grammar patterns 1: Verbs*. London: HarperCollins Publishers Ltd.

Francis, G., Hunston, S., & Manning, E. (Eds.). (1998). *Collins COBUILD grammar patterns 2: Nouns and adjectives*. London: HarperCollins.

Francis, G., Manning, E., & Hunston, S. (1997). *Verbs: Patterns and practice*. London: HarperCollins.

Frankenberg-Garcia, A. (2012). Raising teachers' awareness of corpora. *Language Teaching, 45*(4), 475-489.

Freire, L. L., Arezes, P. M., & Campos, J. C. (2012). A literature review about usability evaluation methods for e-learning platforms. *Work, 41*, 1038-1044.

Gablasova, D., Brezina, V., & McEnery, T. (2017). Collocations in corpus-based language learning research: Identifying, comparing, and interpreting the evidence. *Language Learning, 67*(Suppl. 1), 155-179.

Gabrielatos, C. (2005). Corpora and language teaching: Just a fling, or wedding bells? *TESL-EJ, 8*(4), 1-37.

Gangaiamaran, R. (2017). Review on use of mobile apps for language learning. *International Journal of Applied Engineering Research, 12*(21), 11242-11251.

Gardner, D. (2007). Validating the construct of *word* in applied corpus-based vocabulary research: A critical survey. *Applied Linguistics, 28*(2), 241-265.

Gardner, D., & Davies, M. (2014). A new Academic Vocabulary List. *Applied Linguistics, 35*(3), 305-327.

Garner, J. R. (2011). *Does data-driven learning lead to better academic writing.* (Master of Arts), The University of Alabama, Tuscaloosa, Alabama.

Garside, R., Leech, G., & McEnery, T. (Eds.). (1997). *Corpus annotation: Linguistic information from computer text corpora*. London: Longman.

Garside, R., & Smith, N. (1997). A hybrid grammatical tagger: CLAWS4. In R. Garside, G. Leech & A. McEnery (Eds.), *Corpus annotation: Linguistic information from computer text corpora* (pp. 102-121). London: Longman.

Gavioli, L. (2001). The learner as researcher: Introducing corpus concordancing in the classroom. In G. Aston (Ed.), *Learning with corpora* (pp. 108-137). Houston, TX: Athelstan.

Gavioli, L. (2005). *Exploring corpora for ESP learning*. Amsterdam: John Benjamins.

Gayeski, D. (2002). *Learning unplugged: Using mobile technologies for organizational training and performance improvement*. New York: AMACOM.

Geeb, F. (2009). Lexicalgraphical data in natural-language systems. In S. Nielsen & S. Tarp (Eds.), *Lexicography in the 21st Century: In honour of Henning Bergenholtz* (pp. 207-236). Amsterdam: John Benjamins.

Gelo, O., Braakman, D., & Benetka, G. (2008). Quantitative and qualitative research: Beyond the debate. *Integrative Psychological Behavior, 42*, 266-290.

Ghadessy, P. (1979). Frequency counts, words lists, and materials preparation: A new approach. *English Teaching Forum, 17*, 24-27.

Gilquin, G., & Granger, S. (2010). How can data-driven learning be used in language teaching? In A. O'Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 359-370). London: Routledge.

Godwin-Jones, R. (1999). Emerging technologies: Mobile computing and language learning. *Language Learning and Technology, 2*(2), 7-11.

Godwin-Jones, R. (2008). Emerging technologies: Mobile-computing trends: Lighter, faster, smarter. *Language Learning and Technology, 12*(3), 3-9.

Godwin-Jones, R. (2011). Emerging technologies: Mobile apps for language learning. *Language Learning and Technology, 15*(2), 2-11.

Golonka, E., Bowles, A., Frank, V., Richardson, D., & Freynik, S. (2014). Technologies for foreign language learning: A review of technology types and their effectiveness. *Computer Assisted Language Learning, 27*(1), 70-105.

Graham, D. (2014). *The Engineering Phrases List: Towards teachable ESP phrases*. Paper presented at the ThaiTESOL 2014, Chiangmai.

Granger, S., & Meunier, F. (2008). Phraseology in language learning and teaching: Where to from here? In F. Meunier & S. Granger (Eds.), *Phraseology in foreign language learning and teaching* (pp. 247-252). Amsterdam: John Benjamins.

Greenwood, D. J., & Levin, M. (2007). *Introduction to action research: Social research for social changes* (2nd ed.). Oxford: Sage Publications.

Grgurović, M., Chapelle, C. A., & Shelley, M. C. (2013). A meta-analysis of effectiveness studies on computer technology-supported language learning. *ReCall, 25*(2), 165-198.

Gromik, N. A. (2012). Cell phone video recording feature as a language learning tool: A case study. *Computer and Education, 58*, 223-230.

Guan, X. (2013). A study on the application of data-driven learning in vocabulary teaching and learning in China's EFL class. *Journal of Language Teaching and Research, 4*(1), 105-112.

Guder, C. (2010). Patrons and pedagogy: A look at the theory of connectivism. *Public Services Quarterly, 6*(1), 36-42.

Hadley, G. (2002). An introduction to Data-Driven Learning. *RELC Journal, 33*(99), 99-124.

Hadley, Z. (2013). Text-to-speech synthesis in computer-assisted language learning. In C. A. Chapelle (Ed.), *The encyclopedia of applied linguistics* (pp. 5846-5851). Oxford: Blackwell Publishers.

Hager, P., & Halliday, J. (2009). *Recovering informal learning: Wisdom, judgment and community*. Dordrecht, The Netherlands: Springer.

Hall, D. (2010). *The ICT handbook for primary teachers: A guide for students and professionals*. London: Routledge.

Hammond, M. (2002). *Programming for linguists: Java technology for language researchers*. Oxford: Blackwell.

Hammond, M. (2013). The contribution of pragmatism to understanding educational action research: Value and consequences. *Educational Action Research, 21*(4), 603-618.

Hanks, P. (2008). *Lexical Patterns: From Hornby to Hunston and beyond.* Paper presented at the The XIII EURALEX International Congress, Barcelona.

Hardie, A. (2012). CQPweb - Combining power, flexibility and usability in a corpus analysis tool. *International Journal of Corpus Linguistics,, 17*(3), 380-409.

Hardy, J., & Römer, U. (2013). Revealing disciplinary variation in student writing: A multi-dimensional analysis of the Michigan Corpus of Upper-level Student Papers (MICUSP). *Corpora, 8*(2), 183-207.

Harris Interactive. (2013). Pearson Student Mobile Device Survey 2013.

Harrison, R., Flood, D., & Duce, D. (2013). Usability of mobile applications: Literature review and rationale for a new usability model. *Journal of Interaction Science, 1*(1), 2-16.

Healey, D., Hanson-Smith, E., Hubbard, P., Ioannou-Georgiou, S., Kessler, G., & Ware, P. (2011). *TESOL technology standards: Description, implementation, integration*. Alexandria, VA: TESOL International Association.

Healey, D., Hegelheimer, V., Hubbard, P., Ioannou-Georgiou, S., Kessler, G., & Ware, P. (2008). *TESOL technology standards framework*. Alexandria, Virginia: TESOL.

Heuberger, R. (2016). Corpora as game changers: The growing impact of corpus tools for dictionary makers and users: Corpus tools have created a paradigm shift in English lexicography. *English Today, 32*(2), 24-30.

Heuboeck, A., Holmes, J., & Nesi, H. (2010). *The BAWE corpus manual (version III).* Retrieved from http://wwwm.coventry.ac.uk/researchnet/BAWE/Documents/BAWEmanual%20v3.pdf

Higgins, J. (1988). *Language, learners and computers: Human intelligence and artificial unintelligence*. London: Longman.

Higgins, J., & Johns, T. (1984). *Computers in language learning*. London and Glasgow: Collins ELT.

Hiltunen, T. (2010). *Grammar and disciplinary culture: A corpus-based study.* (PhD thesis), University of Helsinki.

Hockly, N. (2013). Mobile learning. *ELT Journal, 67*(1), 80-84.

Hoey, M. (2000). A world beyond collocation: New perspectives on vocabulary teaching. In M. Lewis (Ed.), *Teaching collocations: Further developments in the Lexical Approach* (pp. 224-243). Hove, England: Thomson Heinle Language Teaching Publications ELT.

Hornby, A. S. (1976). *Guide to patterns and usage in English* (2nd Ed.). Oxford: Oxford University Press.

Horton, W. (2001). *Leading E-learning*. Alexandria, VA: ASTD.

Huang, Z. (2014). The effects of paper-based DDL on the acquisition of lexico-grammatical patterns in L2 writing. *ReCall, 26*(2), 163-183.

Hubbard, P. (2003). A survey of unanswered questions in CALL. *Computer Assisted Language Learning, 16*(2-3), 141-154.

Huh, K., & Hu, W.-c. (2005). Criteria for effective CALL research. In J. L. Egbert & G. M. Petrie (Eds.), *CALL research perspectives* (pp. 9-21). Mahwah, NJ: Lawrence Erlbaum.

Hunston, S. (2001). Colligation, lexis, pattern, and text. In M. Scott & G. Thompson (Eds.), *Patterns of text: In honour of Michael Hoey* (pp. 13-33). Amsterdam: John Benjamins.

Hunston, S. (2002a). *Corpora in applied linguistics*. Cambridge: Cambridge University Press.

Hunston, S. (2002b). Pattern grammar, language teaching, and linguistic variation: Applications of a corpus-driven grammar. In R. Reppen, S. M. Fitzmaurice & D. Biber (Eds.), *Using corpora to explore linguistic variation* (pp. 167-183). Amsterdam: John Benjamins.

Hunston, S. (2004). The corpus, grammar patterns, and lexicography. *Lexicographica, 20*, 100-113.

Hunston, S. (2010). How can a corpus be used to explore patterns? In A. O'Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 152-166). London: Routledge.

Hunston, S. (2013a). Pattern grammar. In C. A. Chapelle (Ed.), *The encyclopedia of applied linguistics* (pp. 4366-4371). Oxford: Blackwell Publishers.

Hunston, S. (2013b). Systemic functional linguistics, corpus linguistics, and the ideology of science. *Text and Talk, 33*(4), 617-640.

Hunston, S., & Francis, G. (1998). Verbs observed: A corpus-driven pedagogic grammar. *Applied Linguistics, 19*(1), 45-72.

Hunston, S., & Francis, G. (2000). *Pattern grammar: A corpus-driven approach to the lexical grammar of English*. Amsterdam: John Benjamins.

Hunston, S., Francis, G., & Manning, E. (1997). Grammar and vocabulary: Showing the connections. *ELT Journal, 51*(3), 208-216.

Hunter, K., & Tse, H. (2013). Making disciplinary writing and thinking practices an integral part of academic content teaching. *Active Learning in Higher Education, 14*(3), 227-239.

Hyland, K. (1999). Academic attribution: Citation and the construction of disciplinary knowledge. *Applied Linguistics, 20*(3), 341-367.

Hyland, K. (2000). *Disciplinary discourses: Social interactions in academic writing*. Harlow, Essex: Longman.

Hyland, K. (2002). Specificity revisited: How far should we go now? *English for Specific Purposes, 21*, 385-395.

Hyland, K. (2003). *Second language writing*. Cambridge: Cambridge University Press.

Hyland, K. (2006a). Disciplinary differences: Language variation in academic discourses. In K. Hyland & M. Bondi (Eds.), *Academic discourse across disciplines* (pp. 17-45). New York: Peter Lang.

Hyland, K. (2006b). *English for academic purposes: An advanced resource book*. New York: Routledge.

Hyland, K. (2008a). Academic clusters: Text patterning in published and postgraduate writing. *International Journal of Applied Linguistics, 18*(1), 41-62.

Hyland, K. (2008b). As can be seen: Lexical bundles and disciplinary variation. *English for Specific Purposes, 27*, 4-21.

Hyland, K. (2012a). Bundles in academic discourse. *Annual Review of Applied Linguistics, 32*, 150-169.

Hyland, K. (2012b). Corpora and academic discourse. In K. Hyland, C. M. Huat & M. Handford (Eds.), *Corpus applications in applied linguistics* (pp. 30-46). London: Continuum.

Hyland, K. (2013a). Faculty feedback: Perceptions and practices in L2 disciplinary writing. *Journal of Second Language Writing, 22*, 240-253.

Hyland, K. (2013b). Writing in the university: Education, knowledge and reputation. *Language Teaching, 46*(1), 53-70.

Hyland, K. (2017). Learning to write for academic purposes: Specificity and second language writing. In J. Bitchener, N. Storch & R. Wette (Eds.), *Teaching writing for academic purposes to multilingual students: Instructional approaches* (pp. 24-41). New York: Routledge.

Hyland, K., & Tse, P. (2005). Hooking the reader: A corpus study of evaluative *that* in abstracts. *English for Specific Purposes, 24*, 123-139.

Hyland, K., & Tse, P. (2007). Is there an "academic vocabulary"? *TESOL Quarterly, 41*(2), 235-253.

Ismail, N. A., Ahmad, F., Kamaruddin, N. A., & Ibrahim, R. (2016). A review on usability issues in mobile applications. *IOSR Journal of Mobile Computing and Application, 3*(3), 47-52.

Ivankova, N. V. (2015). *Mixed methods applications in action research: From methods to community action*. Thousand Oaks, CA: Sage.

Iversen, J., & Eierman, M. (2014). *Learning mobile app development: A hands-on guide to building apps with iOS and Android*. Upper Saddle River, NJ: Addison-Wesley.

Jarvis, H., & Achilleos, M. (2013). From computer assisted language learning (CALL) to mobile assisted language use (MALU). *TESl-EJ, 16*(4), 1-18.

Jiang, N., & Nekrasova, T. M. (2007). The processing of formulaic sequences by second language speakers. *The Modern Language Journal, 91*(3), 433-445.

Johns, A. (2001). The future is with us: Preparing diverse students for the challenges of university texts and cultures. In M. Hewings (Ed.), *Academic writing in context: Implications and applications - Paper in honour of Tony Dudley-Evans* (pp. 30-42). Birmingham: University of Birmingham Press.

Johns, T. (1986). Micro-concord: A language learner's research tool. *System, 14*(2), 151-162.

Johns, T. (1988). Whence and whither classroom concordancing? In P. Bongaerts, P. de Haan, S. Lobbe & H. Wekker (Eds.), *Computer Applications in Language Learning* (pp. 9-27). Dordrecht: Foris.

Johns, T. (1991). Should you be persuaded - two examples of data-driven learning materials. In T. Johns & P. King (Eds.), *Classroom concordancing (English Language Journal, 4)* (pp. 1-16). Birmingham: Birmingham University.

Johns, T. (1994). From printout to handout: Grammar and vocabulary teaching in the context of Data-driven Learning. In T. Odlin (Ed.), *Perspectives on pedagogical grammar* (pp. 293-314). Cambridge: Cambridge University Press.

Johns, T. (1997). Contexts: The background, development and trialling of a concordance-based CALL program. In A. Wichmann, S. Fligelstone, T. McEnery & G. Knowles (Eds.), *Teaching and language corpora* (pp. 100-115). London: Longman.

Johns, T. (2002). Data-driven Learning: The perpetual challenge. In B. Kettemann & G. Marko (Eds.), *Teaching and learning by doing corpus linguistics* (pp. 107-117). Amsterdam: Rodopi.

Johns, T., & King, P. (1991). Classroom concordancing. *English Language Research Journal, 4*.

Johns, T., Lee, H., & Wang, L. (2008). Integrating corpus-based CALL programs in teaching English through children's literature. *Computer Assisted Language Learning, 21*(5), 483-506.

Johns, T., & Wang, L. (1999). Four versions of a sentence-shuffling program. *System, 27*, 329-338.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Jones, C. (1986). It's not so much the program, more what you do with it: The importance of methodology in CALL. *System, 14*(2), 171-178.

Jung, U. O. H. (2005). An international bibliography of computer-assisted language learning: Sixth instalment. *System, 33*, 135-185.

Kaur, J., & Hegelheimer, V. (2005). ESL students' use of concordance in the transfer of academic word knowledge: An exploratory study. *Computer Assisted Language Learning, 18*(4), 287-310.

Kearneya, M., Schucka, S., Burdenb, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology, 20*, 1-17.

Kenning, M.-M. (2007). *ICT and language learning: From print to the mobile phone*. Basingstoke: Palgrave Macmillan.

Kenning, M., & Kenning, M.-M. (1983). *An introduction to computer assisted language teaching*. Oxford: Oxford University Press.

Kilgarriff, A., Baisa, V., Bušta, J., Jakubíček, M., Kovář, V., Michelfeit, J., . . . Suchomel, V. (2014). The Sketch Engine: Ten years on. *Lexicography, 1*, 7-36.

Kilgarriff, A., & Grefenstette, G. (2003). Introduction to the special issue on the Web as corpus. *Computational Linguistics, 29*(3), 333-347.

Kilgarriff, A., & Kosem, I. (2012). Corpus tools for lexicographers. In S. Granger & M. Paquot (Eds.), *Electronic lexicography* (pp. 31-55). Oxford: Oxford University Press.

Kilgrriff, A. (2009). *Corpora in the classroom without scaring the students*. Paper presented at the ETA-ROC 18th International Symposium on English Teaching, Taipei.

Kim, D., Rueckert, D., Kim, D.-J., & Seo, D. (2013). Students' perceptions and experience of mobile learning. *Language Learning and Technology, 17*(3), 52-73.

Klopfer, E. (2008). *Augmented learning: Research and design of mobile educational games*. Cambridge, MT: The MIT Press.

Klotz, M. (1999). Word complementation in English learners' dictionaries - A quantitative study of CIDE, COBUILD2, LDOCE3 and OALD5. In T. Herbst & K. Popp (Eds.), *The Perfect Learners' Dictionary (?)* (pp. 33-44). Tubingen: Max Niemeyer Verlag.

Kock, N. (Ed.). (2007). *Information systems action research: An applied view of emerging concepts and methods*. New York: Springer.

Kontio, J., Bragge, J., & Lehtola, L. (2008). The focus group method as an empirical tool in software engineering. In F. Shull, J. Singer & D. I. K. Sjøberg (Eds.), *Guide to advanced empirical software engineering* (pp. 93-116). London: Springer.

Koshy, V. (2005). *Action research for improving practice: A practical guide*. London: Paul Chapman Publishing.

Krajka, J. (2007). Corpora and language teachers: From ready-made to teacher-made collections. *CORELL: Computer Resources for Language Learning, 1*, 36-55.

Krishnamurthy, R. (2008). Corpus-driven lexicography. *International Journal of Lexicography, 21*(3), 231-242.

Kuebler, S., & Zinsmeister, H. (2015). *Corpus linguistics and linguistically annotated corpora*. London: Bloomsbury.

Kukulska-Hulme, A. (2005). Introduction. In A. Kukulska-Hulme & J. Traxler (Eds.), *Mobile learning: A handbook for educators and trainers* (pp. 1-6). Abingdon, Oxon: Routledge.

Kukulska-Hulme, A. (2009a). Conclusions: Future directions in researching mobile learning. In G. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools and research designs* (pp. 351-363). Bern: Peter Lang.

Kukulska-Hulme, A. (2009b). Will mobile learning change language learning? *ReCall, 21*(2), 157-165.

Kukulska-Hulme, A. (2013). Mobile-assisted language learning. In C. A. Chapelle (Ed.), *The encyclopedia of applied linguistics* (pp. 3701-3709). Oxford: Blackwell Publishers.

Kukulska-Hulme, A., Sharples, M., Milrad, M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Innovation in mobile learning: A European perspective. *International Journal of Mobile and Blended Learning, 1*(1), 13-35.

Kukulska-Hulme, A., & Shield, L. (2008). An overview of mobile assisted language learning: From content delivery to supported collaboration and interaction. *ReCall, 20*(3), 271-289.

Kukulska-Hulme, A., & Traxler, J. (Eds.). (2005). *Mobile learning: A handbook for educators and trainers*. Abingdon, Oxon: Routledge.

Kulik, J. A., Kulik, C.-L. C., & Cohen, P. A. (1980). Effectiveness of computer-based college teaching: A meta-analysis of findings. *Review of Educational Research, 50*, 525-544.

Kuteeva, M., & Negretti, R. (2016). Graduate students' genre knowledge and perceived disciplinary practices: Creating a research space across disciplines. *English for Specific Purposes, 41*, 36-49.

Kwan, R., McNaught, C., Tsang, P., Wang, F. L., & Li, K. C. (Eds.). (2011). *Enhancing learning through technology - Education unplugged: Mobile technologies and Web 2.0 (International Conference, ICT 2011 Proceedings)*. New York: Springer.

Lea, D. (Ed.). (2014). *Oxford learner's dictionary of academic English*. Oxford: Oxford University Press.

Leakey, J. (2011). *Evaluating computer-assisted language learning: An integrated approach to effectiveness research in CALL*. Berlin: Peter Lang.

Lee, K., & Kim, J. (2013). A mobile-based learning tool to improve writing skills of EFL learners. *Procedia-Social and Behavioral Sciences, 106*, 112-119.

Leech, G. (1997). Teaching and language corpora: A convergence. In A. Wichmann, S. Fligelstone, T. McEnery & G. Knowles (Eds.), *Teaching and language corpora* (pp. 1-23). New York: Longman.

Leńko-Szymańska, A., & Boulton, A. (2015). Introduction: Data-driven learning in language pedagogy. In A. Lenko-Szymanska & A. Boulton (Eds.), *Multiple affordances of language corpora for data-driven learning* (pp. 1-14). Amsterdam: John Benjamins.

Levy, M. (1997). *Computer-assisted language learning: Context and conceptualization*. New York: Oxford University Press.

Levy, M., Blin, F., Siskin, C. B., & Takeuchi, O. (Eds.). (2011). *WorldCALL: International perspectives on computer-assisted language learning*. London: Routledge.

Levy, M., Hubbard, P., Stockwell, G., & Colpaert, J. (2015). Research challenges in CALL. *Computer Assisted Language Learning, 28*(1), 1-6.

Lew, R. (2015). Research into the use of online dictionaries. *International Journal of Lexicography, 28*(2), 232-253.

Lewis, M. (1993). *The lexical approach: The state of ELT and a way forward*. Hove, England: Language Teaching Publications.

Lewis, M. (1997). *Implementing the lexical approach: Putting theory into practice*. Hove: Language Teaching Publications.

Lewis, R. (1986). Computers and language teaching. In G. Leech & C. Candlin (Eds.), *Computers in English language teaching and research* (pp. 56-59). New York: Longman.

Little, D. (2003). Learner autonomy and second/foreign language learning. In CIEL Language Support Network (Ed.), *The Guide to Good Practice for Learning and Teaching in Languages, Linguistics and Area Studies*.

Little, D. (2007). Language learner autonomy: Some fundamental considerations revisited. *Innovation in Language Learning and Teaching, 1*(1), 14-29.

Liu, D. (2011). Making grammar instruction more empowering: An exploratory case study of corpus use in the learning/teaching of grammar. *Research in the Teaching of English, 45*(4), 353-377.

Liu, D., & Jiang, P. (2009). Using a corpus-based lexicogrammatical approach to grammar instruction in EFL and ESL contexts. *The Modern Language Journal, 93*, 61-78.

Liu, J., & Han, L. (2015). A corpus-based environmental academic word list building and its validity test. *English for Specific Purposes, 39*, 1-11.

Lu, X. (2014). *Computational methods for corpus annotation and analysis*. New York: Springers.

Lynn, R. W. (1973). Preparing word-lists: A suggested method. *RELC Journal, 4*(1), 25-28.

Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers and Education, 68*, 76-85.

Masie, E. (2002). Mobile and untethered learning. *E-Learning, 3*(10), 6.

Mason, O. (2000). *Programming for corpus linguistics: How to do text analysis with Java*. Edinburgh: Edinburgh University Press.

Mason, O., & Hunston, S. (2004). The automatic recognition of verb patterns: A feasibility study. *International Journal of Corpus Linguistics, 9*(2), 253-270.

McCarthy, M. (2008). Accessing and interpreting corpus information in the teacher education context. *Language Teaching, 41*(4), 563-574.

McCarthy, M. (2010). *Touchstone: From corpus to course book*. Cambridge: Cambridge University Press.

McEnery, T., & Hardie, A. (2012). *Corpus linguistics: Method, theory and practice*. Cambridge: Cambridge University Press.

McEnery, T., Xiao, R., & Tono, Y. (2006). *Corpus-based language studies: An advanced resource book*. London: Routledge.

Mcintyre, A. (2008). *Participatory action research*. London: Sage Publications.

McLaughlin, J.-M. (2013). *English academic writing: Social constructivism and corpora*. Aachen: Shaker.

McNiff, J. (1993). *Teaching as learning: An action research approach*. London: Routledge.

McNiff, J., Lomax, P., & Whitehead, J. (2003). *You and your action research project* (2nd ed.). London: RoutledgeFalmer.

McQuiggan, S., McQuiggan, J., Sabourin, J., & Kosturko, L. (2015). *Mobile learning: A handbook for developers, educators, and learners*. Hoboken, NJ: Wiley.

Meddings, L., & Thornbury, S. (2009). *Teaching unplugged: Dogme in English language teaching*. Crystal Lake, IL: Delta Publishing.

Mehl, S., Wallis, S., & Aarts, B. (2013). *Academic Writing in English*. London: Survey of English Usage/UCL Business PLC.

Meunier, F. (2012). Formulaic language and language teaching. *Annual Review of Applied Linguistics, 32*, 111-129.

Miller, C., & Doering, A. (Eds.). (2014). *The new landscape of mobile learning: Redesigning education in an app-based world*. New York: Routledge.

Mizumoto, A., & Chujo, K. (2016). Who is data-driven learning for? Challenging the monolithic view of its relationship with learning styles. *System, 61*, 55-64.

Murison-Bowie, S. (1996). Linguistic corpora and language teaching. *Annual Review of Applied Linguistics, 16*, 182-199.

Murray, R., & Moore, S. (2006). *The handbook of academic writing: A fresh approach*. Berkshire, England: Open University Press.

Nasongkhla, J., & Sujiva, S. (2015). Teacher competency development: Teaching with tablet technology through Classroom Innovative Action Research (CIAR) coaching process. *Procedia - Social and Behavioral Sciences, 174*, 992-999.

Noriega, H. (2016). Mobile learning to improve writing in ESL teaching. *TEFLIN Journal, 27*(2), 182-202.

Nyns, R. R. (1989). Is intelligent computer-assisted language learning possible? *System, 17*(1), 35-47.

O'Keeffe, A., & Farr, F. (2003). Using language corpora in initial teacher education: Pedagogic issues and practical applications. *TESOL Quarterly, 37*(3), 389-418.

O'Sullivan, I., & Chambers, A. (2006). Learners' writing skills in French: Corpus consultation and learner evaluation. *Journal of Second Language Writing, 15*, 49-68.

Oakes, M. (1998). *Statistics for corpus linguistics*. Edinburgh: Edinburgh University Press.

Olsen, W. (2004). Triangulation in social research: Qualitative and quantitative methods can really be mixed. In M. Holborn (Ed.), *Developments in sociology* (Vol. 20, pp. 103-118). Harlow: Causeway Press.

Olson, B. D., & Jason, L. A. (2015). Participatory mixed methods research. In S. Hesse-Biber & R. B. Johnson (Eds.), *The Oxford handbook of multimethod and mixed methods research inquiry* (pp. 393-405). Oxford: Oxford University Press.

Osborne, J. (2004). Top-down and bottom-up approaches to corpora in language teaching. In T. Upton (Ed.), *Applied corpus linguistics: A multidimensional perspective* (pp. 251-265). Amsterdam: Rodopi.

Pachler, N. (2009). Research methods in mobile and informal learning: Some issues. In G. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools and research designs* (pp. 1-15). Bern: Peter Lang.

Pachler, N., Bachmair, B., & Cook, J. (2010). *Mobile learning: Structures, agency, practices*. New York: Springer.

Palalas, A. (2011). Mobile-assisted language learning: Designing for your students. In S. Thouësny & L. Bradley (Eds.), *Second language teaching and learning with technology: Views of emergent researchers* (pp. 71-94). Dublin, Ireland: Research-publishing.net.

Paley, J. (2008). Positivism. In L. M. Given (Ed.), *The Sage encyclopedia of qualitative research methods* (pp. 646-650). London: Sage.

Parsons, D., Ryu, H., & Cranshaw, M. (2007). A design requirements: Framework for mobile learning environments. *Journal of Computers, 2*(4), 1-8.

Partington, A. (1998). *Patterns and meanings: Using corpora for English language research and teaching*. Amsterdam: John Benjamins.

Partington, A. (2001). Corpus-based description in teaching and learning. In G. Aston (Ed.), *Learning with corpora* (pp. 63-84). Houston, TX: Athelstan.

Patel, N. N., & Dalal, P. (2013). Usability evaluation of mobile applications. *International Journal of Engineering Research and Technology, 2*(11), 299-302.

Pertti, J. (2007). Action research is similar to design science. *Quality and Quantity, 41*, 37-54.

Peter, K. (2009). M-learning: Positioning educators for a mobile, connected future. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 113-132). Edmonton: AU Press, Athabasca University.

Plass, J. L. (1998). Design and evaluation of the user interface of foreign language multimedia software: A cognitive approach. *Language Learning and Technology, 2*(1), 40-53.

Poole, R. (2012). Concordance-based glosses for academic vocabulary acquisition. *CALICO Journal, 29*(4), 679-693.

Powell, T. (2001). Competitive advantage: Logical and philosophical considerations. *Strategic Management Journal, 22*, 875-888.

Praninskas, J. (1972). *American university word list*. London: Longman.

Prensky, M. (2001a). Digital natives, digital immigrants Part 1. *On the Horizon, 9*(5), 1-6.

Prensky, M. (2001b). Digital natives, digital immigrants Part 2: Do they really think differently? *On the Horizon, 9*(6), 1-6.

Procter, P. (Ed.). (1995). *Cambridge International Dictionary of English*. Cambridge: Cambridge University Press.

Reason, P. (2003). Pragmatist philosophy and action research: Readings and conversation with Richard Rorty. *Action Research, 1*(1), 103-123.

Reinders, H., & Hubbard, P. (2013). CALL and learner autonomy: Affordances and constraints. In M. Thomas, H. Reinders & M. Warschauer (Eds.), *Contemporary computer-assisted language learning* (pp. 359-375). London: Bloomsbury Academic.

Richards, J. (2006). *Communicative language teaching today*. Cambridge: Cambridge University Press.

Richards, J., & Schmidt, R. (Eds.). (2010). *Longman dictionary of language teaching and applied linguistics* (4th ed.). Harlow: Longman.

Rogers, K. D. (2011). *Mobile learning devices*. Bloomington, IN: Solution Tree.

Romer, U. (2008). Corpora and language teaching. In A. Ludeling & M. Kyto (Eds.), *Corpus linguistics: An international handbook* (Vol. 1, pp. 112-131). Berlin: Walter de Gruyter.

Romer, U. (2009). The inseparability of lexis and grammar: Corpus linguistic perspectives. *Annual Review of Cognitive Linguistics*(7), 141-163.

Roozen, K. (2010). Tracing trajectories of practice: Repurposing in one student's developing disciplinary writing processes. *Written Communication, 27*(3), 318-354.

Roschelle, J. (2003). Unlocking the learning value of wireless mobile devices. *Journal of Computer Assisted Learning, 19*(3), 260-272.

Rüschoff, B. (2003). Data-driven learning (DDL): The idea. In B. Rüschoff (Ed.), *Information and communication technologies in vocationally oriented language learning* (pp. 63-71). Kapfenberg: Council of Europe Publishing.

Sampson, D., & Karagiannidis, C. (2002). Personalised learning: Educational, technological and standardisation perspective. *Interactive Educational Multimedia 4*, 24-39.

Sampson, G., & McCarthy, D. (Eds.). (2004). *Corpus linguistics: Readings in a widening discipline*. London: Continuum.

Santos, I., & Ali, N. (2012). Exploring the uses of mobile phones to support informal learning. *Education and Information Technologies, 17*, 187-203.

Sazalli, N. (2014). Pedagogical affordances of smart mobile devices integrated with Web 2.0 tools to enhance English language teaching and learning. In M. Kalz, Y. Bayyurt & M. Specht (Eds.), *Mobile as mainstream - Towards future challenges in mobile learning* (pp. 321-327). Heidelberg: Springer.

Scharle, A., & Szabo, A. (2000). *Learner autonomy: A guide to developing learner responsibility*. Cambridge: Cambridge University Press.

Schulenberg, J. L. (2007). Analysing police decision-making: Assessing the application of a mixed-method/mixed-model research design. *International Journal of Social Research Methodology, 10*(2), 99-119.

Schulze, M., & Heift, T. (2013). Intelligent CALL. In M. Thomas, H. Reinders & M. Warschauer (Eds.), *Contemporary computer-assisted language learning* (pp. 249-265). London: Bloomsbury Academic.

Scipicharn, P. (2010). How can we prepare learners for using language corpora? In A. O'Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 371-384). London: Routledge.

Scott, M. (2014). WordSmith tools 6.0. Liverpool: Lexical Analysis Software.

Sedgewick, R., & Wayne, K. (2011). *Algorithms* (4th ed.). Upper Saddle River, NJ: Addison-Wesley.

Seidhofer, B. (2002). Pedagogy and local learner corpora: Working with learning-driven data. In S. Granger, J. Hung & S. Petch-Tyson (Eds.), *Computer learner corpora, second language acquisition and foreign language teaching* (pp. 213-234). Amsterdam: John Benjamins.

Shamsudina, S., Husinb, N., & Manand, A. (2013). Exploring fundamental engineering word list for engineering students: A literature review. *Procedia - Social and Behavioral Sciences, 70*(1275-1281).

Sharples, M. (2009). Methods for evaluating mobile learning. In G. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools and research designs* (pp. 17-39). Bern: Peter Lang.

Sharples, M., Arnedillo-Sanchez, I., Milrad, M., & Vavoula, G. (2009). Mobile learning: Small devices, big issues. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder & S. Barnes (Eds.), *Technology-enhanced learning: Principles and products* (pp. 233-249). New York: Springer.

Shi, J. (2013). The application of data-driven learning in Business English teaching for MBA students in China: A critical assessment. *International Journal of English Linguistics, 3*(1), 26-30.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *Journal of Instructional Technology and Distance Learning, 2*(1), 3-10.

Simpson-Vlach, R., & Ellis, N. (2010). An Academic Formulas List: New methods in phraseology research. *Applied Linguistics, 31*(4), 487-512.

Sinclair, J. (1991). *Corpus, concordance, collocation*. Oxford: Oxford University Press.

Sinclair, J. (Ed.). (1987a). *Collins COBUILD English language dictionary* (1st ed.). London: Collins.

Sinclair, J. (Ed.). (1987b). *Looking up: An account of the COBUILD Project in lexical computing and the development of the Collins COBUILD English Language Dictionary*. London and Glasgow: Collins ELT.

Siraj-Blatchford, J., & Whitebread, D. (2003). *Supporting ICT in the early years*. Berkshire, England: Open University Press.

Smart, J. (2014). The role of guided induction in paper-based data-driven learning. *ReCall, 26*(2), 184-201.

Snow, C. (2010). Academic language and the challenge of reading for learning about science. *Science, 328*(5977), 450-452.

Snow, C., & Uccelli, P. (2009). The challenge of academic language. In D. R. Olson & N. Torrance (Eds.), *The Cambridge handbook of literacy* (pp. 112-133). Cambridge: Cambridge University Press.

Sølvberg, A. M., & Rismark, M. (2012). Learning spaces in mobile learning environments. *Active Learning in Higher Education, 13*(1), 23-33.

Somekh, B. (2006). *Action research: A methodology for change and development*. New York: Open University Press.

Steel, C., & Levy, M. (2013). Language students and their technologies: Charting the evolution 2006-2011. *ReCall, 25*(3), 306-320.

Stevens, V. (1991). Classroom concordancing: Vocabulary materials derived from relevant, authentic text. *English for Specific Purposes, 10*, 35-46.

Stevens, V. (1992). Humanism and CALL: A coming of age. In M. C. Pennington & V. Stevens (Eds.), *Computers in applied linguistics: An international perspective* (pp. 11-38). Clevedon: Multilingual Matters.

Stevens, V., Sussex, R., & Tuman, W. V. (1984). *A bibliography of computer-aided language learning.* Washington, D.C.: ERIC.

Stockwell, G. (2008). Investigating learner preparedness for and usage patterns of mobile learning. *ReCall, 20*(3), 253-270.

Stockwell, G. (2013). Mobile-assisted language learning. In M. Thomas, H. Reinders & M. Warschauer (Eds.), *Contemporary computer-assisted language learning* (pp. 201-216). London: Bloomsbury Academic.

Stubbs, M. (1993). British traditions in text analysis - From Firth to Sinclair. In M. Baker, G. Francis & E. Tognini-Bonelli (Eds.), *Text and technology: In honour of John Sinclair* (pp. 1-33). Philadelphia: John Benjamins.

Stubbs, M. (1995/2007). Collocations and semantic profiles: On the cause of the trouble with quantitative studies. In W. Teubert & R. Krishnamurthy (Eds.), *Corpus linguistics: Critical concepts in linguistics* (pp. 1-24). London: Routledge.

Sun, Y.-C. (2003). Learning process, strategies and web-based concordancers: a case study. *British Journal of Educational Technology, 34*(5), 601-613.

Sun, Y.-C. (2007). Learner perceptions of a concordancing tool for academic writing. *Computer Assisted Language Learning, 20*(4), 323-343.

Sun, Y.-C., & Wang, L.-Y. (2003). Concordancers in the EFL classroom: Cognitive approaches and collocation difficulty. *Computer Assisted Language Learning, 16*(1), 83-94.

Sung, Y.-T., Chang, K.-E., & Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers and Education, 94*, 252-275.

Sung, Y.-T., Chang, K.-E., & Yang, J.-M. (2015). How effective are mobile devices for language learning? A meta-analysis. *Educational Research Review, 16*, 68-84.

Swales, J. (1990). *Genre analysis: English in academic and research settings*. Cambridge: Cambridge University Press.

Swales, J. (2006). Corpus linguistics and English for academic purposes. In E. A. Macia, A. S. Cervera & C. R. Ramos (Eds.), *Information technology in languages for specific purposes: Issues and prospects* (pp. 19-33). New York: Springer.

Tavakoli, H. (2012). *A dictionary of research methodology and statistics in applied linguistics*. Tehran, Iran: Rahnama Press.

Teubert, W. (2005). My version of corpus linguistics. *International Journal of Corpus Linguistics, 10*(1), 1-13.

Thomas, C. (2010). Teaching mixed methods and action research: Pedagogical practice, and evaluative considerations. In A. Tashakkori & C. Teddlie (Eds.), *SAGE handbook of mixed methods in social & behavioral research* (2nd ed., pp. 643-676). London: Sage.

Thomas, J. (1986). Adapting dBase II: The use of database management systems in English language teaching and research. In G. Leech & C. Candlin (Eds.), *Computers in English language teaching and research* (pp. 112-131). New York: Longman.

Thomas, M., Reinders, H., & Warschauer, M. (2013a). Contemporary computer-assisted language learning: The role of digital media and incremental change. In M. Thomas, H. Reinders & M. Warschauer (Eds.), *Contemporary computer-assisted language learning* (pp. 1-12). London: Bloomsbury Academic.

Thomas, M., Reinders, H., & Warschauer, M. (Eds.). (2013b). *Contemporary computer-assisted language learning*. London: Bloomsbury Academic.

Thornbury, S. (2004). *Natural grammar: The keywords of English and how they work*. Oxford: Oxford University Press.

Thurnbull, J. (Ed.). (2009). *Oxford collocations dictionary for students of English* (2nd ed.). Oxford: Oxford University Press.

Thurstun, J., & Candlin, C. N. (1998). Concordancing and the teaching of the vocabulary of academic English. *English for Specific Purposes, 17*(3), 267-280.

Tognini-Bonelli, E. (2001). *Corpus linguistics at work*. Amsterdam: John Benjamins.

Tollefson, J. W. (2011). Ideology in second language education. In E. Hinkel (Ed.), *Handbook of research in second language teaching and learning* (Vol. II, pp. 801-816). London: Routledge.

Tomal, D. R. (2003). *Action research for educators*. Oxford: Scarecrow Press.

Tracy, S. J. (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Oxford: Blackwell.

Transue, B. M. (2013). Connectivism and information literacy: Moving from learning theory to pedagogical practice. *Public Services Quarterly, 9*(3), 185-195.

Traxler, J. (2005). *Defining mobile learning*. Paper presented at the IADIS International Conference Mobile Learning 2005.

Traxler, J. (2007). Defining, discussing and evaluating mobile learning: The moving finger writes and having writ .... *International Review of Research in Open and Distributed learning, 8*(2).

Traxler, J. (2009a). Current state of mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 9-24). Edmonton: AU Press, Athabasca University.

Traxler, J. (2009b). Learning in a mobile age. *International Journal of Mobile and Blended Learning, 1*(1), 1-12.

Traxler, J. (2011). Learning in a mobile age, a more and more mobile age. In D. Parsons (Ed.), *Combining e-learning and m-learning: New applications of blended educational resources* (pp. 15-27). Hershey, PA: Information Science Reference.

Traxler, J., & Kukulska-Hulme, A. (2006). *The evaluation of next generation learning technologies: The case of mobile learning.* Paper presented at the the 13th Association for Learning Technology, Heriot-Watt University, Scotland.

Traxler, J., & Vosloo, S. (2014). Introduction: The prospects for mobile learning. *Prospect, 44*, 13-28.

Trentin, G., & Repetto, M. (Eds.). (2013). *Using network and mobile technology to bridge formal and informal learning*. Oxford: Chandos.

Tribble, C. (2002). Corpora and corpus analysis: New windows on academic writing. In J. Flowerdew (Ed.), *Academic discourse* (pp. 131-149). London: Longman.

Tribble, C., & Wingate, U. (2013). From text to corpus - A genre-based approach to academic literacy instruction. *System, 41*, 307-321.

Trinder, J., Roy, S., & Magill, J. (2009). Using automatic logging to collect information on mobile device usage for learning. In G. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools and research designs* (pp. 241-256). Bern: Peter Lang.

Udell, C. (2015a). The six Ps of mobile learning strategy. In C. Udell & G. Woodill (Eds.), *Mastering mobile learning: Tips and techniques for success* (pp. 45-58). Hoboken, NJ: Wiley.

Udell, C. (2015b). Ubiquity and mobility as design considerations for mobile learning. In C. Udell & G. Woodill (Eds.), *Mastering mobile learning: Tips and techniques for success* (pp. 191-197). Hoboken, NJ: Wiley.

Unlu, Z. K., Dokme, I., & Tufekci, A. (2015). An action research on teaching science through technology supported inquiry-based learning: A pilot study. *Procedia - Social and Behavioral Sciences, 186*, 46-52.

Vannestal, M. E., & Lindquist, H. (2007). Learning English grammar with a corpus: Experimenting with concordancing in a university grammar course. *ReCall, 19*(03), 329-350.

Vavoula, G. (2009). Issues and requirements for mobile learning research. In G. Vavoula, N. Pachler & A. Kukulska-Hulme (Eds.), *Researching mobile learning: Frameworks, tools and research designs* (pp. 339-349). Bern: Peter Lang.

Vavoula, G., & Sharples, M. (2011). Meeting the challenges in evaluating mobile learning: A 3-level evaluation framework. In D. Parsons (Ed.), *Combining e-learning and m-learning: New applications of blended educational resources* (pp. 178-194). Hershey, PA: Information Science Reference.

Vyatkina, N. (2016). Data-driven learning for beginners: The case of German verb-preposition collocations. *ReCall, 28*(2), 207-226.

Walker, A., & White, G. (2013). *Technology enhanced language learning: Connecting theory and practice*. Oxford: Oxford University Press.

Wang, S., & Higgins, M. (2006). Limitations of mobile phone learning. *The JALT CALL Journal, 2*(1), 3-14.

Wang, S., & Smith, S. (2013). Reading and grammar learning through mobile phones. *Language Learning and Technology, 17*(3), 117-134.

Warschauer, M. (1998). *CALL vs. electronic literacy: Reconceiving technology in the language classroom.* Paper presented at the Centre for Information on Language Teaching and Research Information Technology Research Forum, London.

Warschauer, M., & Healey, D. (1998). Computers and language learning: An overview. *Language Teaching, 31*, 57-71.

Werquin, P. (2010). *Recognising non-formal and informal learning: Outcomes, policies and practices*: OECD.

Wilcox, K. C., & Jeffery, J. V. (2015). Adolescent English language learners' stances toward disciplinary writing. *English for Specific Purposes, 38*, 44-56.

Willcocks, L. P., Sauer, C., & Lacity, M. C. (Eds.). (2016). *Enacting research methods in information systems: Volume 2*. Basingstoke: Palgrave Macmillan.

Willis, D. (1991). *Collins COBUILD student's grammar*. London: Collins.

Willis, D., & Willis, J. (1989). *Collins COBUILD English course*. London: HarperCollins.

Willis, J. (2011). Concordances in the classroom without a computer: Assembling and exploiting concordances of common words. In B. Tomlinson (Ed.), *Materials development in language teaching* (pp. 51-77). Cambridge: Cambridge University Press.

Wilock, G. (2009). *Introduction to linguistic annotation and text analytics*. San Rafael, CA: Morgan & Claypool.

Wingate, U., Andon, N., & Cogo, A. (2011). Embedding academic writing instruction into subject teaching: A case study. *Active Learning in Higher Education, 12*(1), 69-81.

Wishart, J. (2008). Challenges faced by modern foreign language teacher trainees in using handheld pocket PCs (Personal Digital Assistants) to support their teaching and learning. *ReCall, 20*(3), 348-360.

Wong, L. (2013). Technological innovation and teacher change: IT in teacher professional development. In K. Hyland & L. Wong (Eds.), *Innovation and change in English language education* (pp. 248-262). New York: Routledge.

Wood, D. (2010). *Formulaic language and second language speech fluency: Background, evidence and classroom applications*. London: Continuum.

Woodill, G. (2015). Unique affordances of mobile learning. In C. Udell & G. Woodill (Eds.), *Mastering mobile learning: Tips and techniques for success* (pp. 111-126). Hoboken, NJ: Wiley.

Wray, A. (2012). What do we (think we) know about formulaic language? An evaluation of the current state of play. *Annual Review of Applied Linguistics, 32*, 231-254.

Wray, A. (2013). Formulaic language. *Language Teaching, 46*(3), 316-334.

Wu, S., Witten, H., & Franken, M. (2010a). Supporting collocation learning with a digital library. *Computer Assisted Language Learning, 23*(1), 87-110.

Wu, S., Witten, H., & Franken, M. (2010b). Utilizing lexical data from a Web-derived corpus to expand productive collocation knowledge. *ReCALL, 22*(1), 83-102.

Xu, J., & Wu, L. (2014). Web-based fourth generation corpus analysis tools and the BFSU CQPweb case. *Computer-assisted Foreign Language Education, 5*, 10-15.

Xue, G. Y., & Nation, I. S. P. (1984). A university word list. *Language Learning and Communication, 3*, 215-229.

Yoon, C. (2011). Concordancing in L2 writing class: An overview of research and issues. *Journal of English for Academic Purposes, 10*, 130-139.

Yoon, H. (2008). More than a linguistic reference: The influence of corpus technology on L2 academic writing. *Language Learning and Technology, 12*(2), 31-48.

Yoon, H., & Hirvela, A. (2004). ESL student attitudes towards corpus use in L2 writing. *Journal of Second Language Writing, 13*, 257-283.

Zhao, Y. (2003). Recent developments in technology and language learning: A literature review and meta-analysis. *CALICO Journal, 21*(1), 7-27.

Zou, B., & Yan, X. (2014). Chinese students' perceptions of using mobile devices for English learning. *International Journal of Computer-Assisted Language Learning and Teaching, 4*(3), 20-33.

APPENDIX A:

ETHICS APPROVAL AND RELATED DOCUMENTS

This appendix includes the final Ethics Approval granted by Auckland University of Technology Ethics Committee (AUTEC) on 28 January 2015 before the commencement of this research. Two other required documents are also presented: the Consent Form and the Participant Information Sheet. Each participant in this research was given a copy of the Participant Information Sheet to know about the research project, and they all signed the Consent Form to be recruited in this research on a voluntary basis. To keep the original format, the letter of Ethics Approval is presented in the next page separately, followed by an empty Consent Form and a Participant Information Sheet.

AUTEC
SECRETARIAT

28 January 2015

Lynn Grant
Faculty of Culture and Society

Dear Lynn

Re: Ethics Application: **14/174 An investigation of the effectiveness of using a mobile app platform for helping students preparing for academic study learn about verb Patterns in Context (PIC) to improve their academic writing.**

Thank you for your request for approval of an amendment to your ethics application.

I have approved the minor amendment to your ethics application allowing minor changes to the research procedures.

I remind you that as part of the ethics approval process, you are required to submit the following to the Auckland University of Technology Ethics Committee (AUTEC):

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 2 July 2017;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 2 July 2017 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee
Cc: Zhi Quan wisdomquan@gmail.com, Darryl Hocking

Consent Form

For use when interviews are involved.

Project title: Patterns in Context: A new approach for language feature retrieval from text corpora to benefit EFL academic writing

Project Supervisor: *Dr Lynn Grant & Dr Darryl Hocking*

Researcher: *Zhi Quan (Bill)*

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 12 Jan 2015.
- ○ I understand that if I am selected I may have the use of an AUT Android tablet for 2 weeks, and report my usage of the tablet for a PhD student's research project.
- ○ I understand that when I use the tablet, there will be a passive recording of my uses of the app on the tablet.
- ○ I understand that I should return the tablet and the researcher will interview me after 2 weeks; notes will be taken during the interviews and that the interviews will also be audio-taped and transcribed.
- ○ I understand that I will be identified by code/number and not by name in all released data, and that I can approve the transcription of my interview before it is used.
- ○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- ○ If I withdraw, I must return the tablet, and all relevant information including the electronic audio records and transcripts, or parts thereof, will be destroyed.
- ○ I agree to take part in this research.
- ○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature:

……

Participant's name:

……

Participant's Contact Details (if appropriate):

……..

……..

Date:

***Approved by the Auckland University of Technology Ethics Committee on 2 July 2014 AUTEC Reference number* 14/174**

Note: The Participant should retain a copy of this form.

Participant Information Sheet

Date Information Sheet Produced:

12 Jan 2015

Project Title

Patterns in Context: A new approach for language feature retrieval from text corpora to benefit EFL academic writing

An Invitation

My name is Zhi Quan (Bill). I am a PhD student at AUT University. I am inviting you to participate in my research programme, which will form the basis of a PhD thesis. I am interested in having you test my app designed to help you learn core words that you could use in your 'Academic Writing'. In other words, I would like to learn from you about how helpful the app is, your attitude towards using the app when doing writing and whether the app helps with the challenges you face in your academic writing. I would also like to learn from you about how the app could be improved to better help you with the writing you will have to do for your course. In short, I need your feedback on the new app, in order to help you and more students learn core words useful in your academic writing.

What is the purpose of this research?

The purpose of this research is to investigate whether and how the app can help you in academic writing, and how your behaviour of use may change over a period of 2 weeks. In future, I also hope to publish the research data and findings in language and literacy journals.

How was I chosen for this research?

You have been approached because you are in a bridging programme to AUT. You are invited to be part of this research, but your participation is completely voluntary, and you can withdraw from it up to the end of data collection. Some of your personal information, such as age, gender, major, language proficiency, etc. will be considered as criteria for the final decision of selection, to ensure you are a suitable subject for the method and material built in the tool to test in this research. However, there is no discriminatory treatment, and such information will not be released to any third party.

What will happen in this research?

In this research, those who volunteer to participate are supposed to go through the following stages:

1) Attend a training session on how you may use the app for your writing, lasting for at most 30 minutes.

2) Keep and use a tablet with the app installed for a period of 2 weeks' use on a loan agreement.

3) Return the tablets after two weeks' use, and have a focus-group interview together with 2-3 other participants to share ideas on the usefulness/uselessness of the app and any suggestions for possible improvement. The interview of the group may take you about 1 hour.

4) Have a look at the transcribed interview texts for 'member checking', to see if what is written is correct, and to give you the chance to withdraw anything that you feel unhappy with.

What are the discomforts and risks?

You might feel uncomfortable criticising the app in the exit questionnaire and the final interview. But this research was done because there is widespread concern both here in New Zealand and in many other countries from students and teachers about the challenges of academic writing. I wish to focus on the core words that you were or were not able to use in your writing.

The mobile app itself will not record any personal information, like visited locations, personal communications and social networking data. However, the time of use (of the app provided hereto) will be logged automatically by the system, which might be used at the end of this research. Additionally, the tablets may face virus attacks if connected to the internet, as well as technical problems that may happen, in which case you need to refer to the researcher.

How will these discomforts and risks be alleviated?

As a measure to maintain confidentiality no names will be identified in the interviews, and as indicated earlier, the emphasis is on emerging trends and patterns rather than individual opinions.

You are supposed to take good care of the tablet loaned to you for the 2 week period. In case you lose it or damage it, you must return the damaged tablet or report the missing tablet. Then because there are no additional tablets available, you will not be able to complete the research.
The app rely on a built-in database, and can be used without internet access. Anti-virus software has been installed, and the users are advised to visit safe websites when using the tablets. In case of any breakdown including a virus attack, they can contact the researcher directly for trouble shooting.

What are the benefits?

I am hoping that by doing this research, all participants will learn more about the effectiveness of the app for showing word patterns to use in academic writing, and what we learn will contribute to your academic development in the practice of academic writing. I also hope to publish the research findings of this study in language and literacy journals.

How will my privacy be protected?

See above.

What are the costs of participating in this research?

Training in using the app may take up to 30 minutes. The interview should take approximately 1 hour in a focus group, and reading the transcript should take between 10-15 minutes, in addition to 5 minutes to complete the exit questionnaire.

What opportunity do I have to consider this invitation?

Please let me know whether you are willing to participate within 2 weeks of receiving the invitation.

How do I agree to participate in this research?

You may sign a loan agreement before taking away a tablet, and the researcher will send a consent form to you for you to sign prior to participating in the research. Return of the signed forms marks the start of your participation.

Will I receive feedback on the results of this research?

A summary of the research will be given to all participants who indicate their interest. In addition, any journal articles published will be made available to you. Your participation is much appreciated and valued, as it will benefit you and your peers.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisors, Lynn Grant or Darryl Hocking.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext. 6038.

Whom do I contact for further information about this research?

Researcher Contact Details:

Zhi Quan (Bill)
Zhi Quan (wisdomquan@gmail.com)

Project Supervisor Contact Details:

Dr Lynn Grant
School of Language and Culture

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Approved by the Auckland University of Technology Ethics Committee on *28 January 2015,* AUTEC Reference number *14/174*.

APPENDIX B:

QUESTIONS IN THE QUESTIONNAIRES, INTERVIEWS AN FOCUS GROUPS

The online questionnaire in Phase 1 contained 13 questions covering four broad themes: perceived effectiveness of the apps, personal experience with the apps, views towards concordancing search and views towards mobile learning. On the questionnaire website, the participants would be presented with the following questions to answer.

Questionnaire for people who volunteered to use the app (click only one answer for each question):

1. I use a paper dictionary when I am doing academic writing.
    a. Never
    b. Sometimes
    c. Often
    d. Always
    e. Don't know
2. I use an electronic dictionary when I am doing academic writing.
    a. Never
    b. Sometimes
    c. Often
    d. Always
    e. Don't know
3. Do you think mobile devices can help you with your learning?
    a. Not at all
    b. A little
    c. Helpful
    d. Very helpful
    e. Don't know
4. I liked the app that I was given to try.
    a. Not at all
    b. A little

c. Quite a lot

d. Very much

e. Don’t know

5. How did you find learning to use the app?

a. Easy

b. Just right

c. Slightly difficult

d. Too difficult

e. Don’t know

6. Are the 10 random examples displayed after you do a search:

a. Not enough

b. Almost enough

c. Just right

d. Too many

e. Don’t know

7. Is the level of the academic texts used in the app:

a. Easy

b. Just right

c. Slightly difficult

d. Too difficult

e. Don’t know

8. This selection of verbs provided by the app was:

a. Not helpful at all

b. A little helpful

c. Helpful

d. Very helpful

e. Don’t know

9. The way the search results are displayed helped you find the correct verb structure:

a. Never

b. Sometimes

c. Often

d. Always

e. Don’t know

10. You were usually able to find the verb structure you were looking for:

a. Easily

b. With some effort

c. With difficulty

d. Never

e. Don’t know

11. Do you think it’s helpful to have the texts divided into different disciplines?

a. Not at all

b. A little

c. Helpful

d. Very helpful

e. Don’t know

12. Overall do you think the app is helpful for your academic writing in English?

a. Not at all

b. A little

c. Helpful

d. Very helpful

e. Don’t know

13. I would use this app in the future to help me with my academic writing:

a. Never

b. Maybe

c. Probably

d. Definitely

e. Don’t know

In Phases 2 and 3, the questionnaire form was changed from multiple-choice questions to

Likert-scale ones, and the numbers of questions was reduced to five, focusing on the users' evaluation of the concordancing apps in effectiveness, efficiency, easiness of use, and so on. On the questionnaire website, the participants would be presented with the following positive statements one by one:

To what extent do you agree with the following statements (choose one scale from 1-9 to represent from 'completely disagree' to 'completely agree'):

1. Overall the app is helpful for your academic writing in English.
2. The highlighted yellow part of the search results helped you notice and observe the word usage.
3. It was usually quick and easy for you to find the word usage you were looking for.
4. The app was easy to use.
5. I would use this app in the future to help me with my academic writing.

More than a dozen indicative questions were used in the semi-structured interviews and focus groups in the three phases, so as to elicit information from the participants on their uptake and behaviour of working with the mobile apps. The actual interviews, especially focus groups, were open to the interviewees' discussion and did not necessarily stick to the following questions:

- Do you often meet and use the verbs provided? Are you happy with the amount 52?
- Do you like the texts to be further divided/tailored to your needs?
- How did you read the lines of examples? One by one or skimming?
- Is the part highlighted in yellow helpful to keep focused on the target?
- Is it difficult to find a verb structure? At a glance or with many attempts?
- Are you happy with the incomplete sentences? Is it helpful to extend the context on demand? Is the continuous context better for understanding?

- Which part of language use did you find the app most helpful for, if any (vocabulary, grammar, sentence structure, terminology, hard to identify)?
- What did you use the app for? Only to deal with writing assignments? Did you browse the verbs or texts?
- How did you use the app? Alone? With textbooks or hand-outs? With a dictionary? A search engine?
- Where did you use the app most frequently (in class; at home; in the library, learning centre or other facilities on campus)? Did you ever tried on the move (e.g. commuting)?
- Which feature of the app do you feel is most helpful? Which is the least helpful? Why? (text division; random searching; context extension; audio reading);
- Are you currently using any app for learning on your mobile devices? Name one or two.
- What do you want the app to be? Any suggestions for its improvement?

APPENDIX C:

RAW QUANTITATIVE DATA FROM AUTOMATIC LOGGING

As mentioned in Chapter 3, statistic information of app use was derived from automatic logs. The raw data produced by cohorts of participants is set out in the following five tables from C-1 to C-5. In the three chapters which presenting research results in this thesis, only processed data of app use is analysed and interpreted. The reason for this separated presentation of raw and processed data is that the main body of the thesis may look messy with all the data congested together, especially for Phase 2, when there were 20 users for each app.

Only the data from the participants who actually used the apps is included in the tables. The user codes for these participants follow different systems specific to each phase. In Phase 1, the AKWIC users were titled with the letter K (standing for 'KWIC') followed by the 'cohort number – serial number', while the APIC group were represented by the letter P (standing for 'PIC') followed by the cohort number – serial number. For example, K2-1 stands for the first AKWIC user in Cohort 2. In Phase 2, since there was a swap of apps after two weeks, the participants switching from AKWIC to APIC were coded with 'K-P' plus the cohort number and serial number, and those switching from APIC to AKWIC were labeled with P-K plus the cohort number and serial number. For example, K-P2-2 refers to the second user in Cohort 2 who switched from AKWIC to APIC. The participants in Phase 3 were labeled with OP (standing for 'only PIC') followed by the cohort number and serial number, since only the app APIC was provided in this phase.

The raw data of app use through the three phases is presented below:

Table C-1 Raw Data of AKWIC Use (Phase 1)

User code	Session	Query	Repeat	Total time (min)	Context check
K1-1	5	12	5	23	3
K1-2	12	20	8	42	9
K1-3	3	5	1	11	6
K1-4	4	25	14	44	8
K2-1	7	53	33	100	40

K2-2	2	8	3	33	3
K2-3	2	7	4	11	3
K2-4	1	3	2	1	0

Table C-2 Raw Data of APIC use (Phase 1)

User code	Session	Query	Repeat	Total time (min)	Context check
P1-1	2	6	3	9	3
P1-3	3	3	0	6	1
P1-4	7	9	2	14	2
P1-5	3	7	4	9	6
P2-1	1	2	1	2	0
P2-2	1	1	0	3	1
P2-3	1	4	0	8	3

Table C-3 Raw Data of AKWIC Use (Phase 2)

User code	Session	Query	Repeat	Total time (min)	Context check	Dictionary check
K-P1-1	5	17	7	32	2	1
K-P1-2	3	3	0	16	5	3
K-P1-3	2	7	3	15	4	3
K-P1-4	1	6	2	15	9	8
K-P1-5	12	17	3	28	17	5
P-K1-1	4	22	13	55	5	14
P-K1-2	3	8	4	13	2	5
P-K1-3	2	8	6	13	1	2
P-K1-4	7	34	20	60	2	64
P-K1-5	2	4	2	2	1	0
K-P2-1	1	14	2	30	9	5
K-P2-2	6	20	6	46	9	12
K-P2-3	1	3	0	4	2	0
K-P2-4	3	16	11	13	3	4
K-P2-5	1	2	0	4	1	4
P-K2-1	2	7	4	6	1	1
P-K2-2	1	12	0	38	0	1
P-K2-3	5	14	8	11	6	5
P-K2-4	1	1	0	2	1	0
P-K2-5	1	2	1	1	0	3

Table C-4 Raw Data of APIC Use (Phase 2)

User code	Session	Query	Repeat	Total time (min)	Context check	Dictionary check
K-P1-1	2	2	0	3	2	30
K-P1-2	1	1	0	1	0	1

K-P1-3	2	4	2	14	2	2
K-P1-4	2	6	2	6	3	20
K-P1-5	6	9	3	15	8	7
P-K1-1	3	4	0	5	1	18
P-K1-2	4	6	0	5	4	2
P-K1-3	4	6	1	15	1	5
P-K1-4	5	8	1	7	1	1
P-K1-5	1	2	0	2	0	0
K-P2-1	8	9	4	9	6	8
K-P2-2	2	6	0	14	7	3
K-P2-3	3	7	2	17	2	1
K-P2-4	1	3	2	3	1	1
K-P2-5	2	4	2	31	3	20
P-K2-1	3	9	3	13	2	2
P-K2-2	8	11	0	24	4	22
P-K2-3	14	42	19	95	26	4
P-K2-4	4	9	3	12	6	34
P-K2-5	1	2	0	2	0	0

Table C-5 Raw Data of APIC Use (Phase 3)

User code	Session	Query	Repeat	Total time (min)	Context check	Dictionary check
OP1-1	4	9	2	14	4	20
OP1-2	3	2	0	5	2	7
OP1-3	3	7	1	10	2	7
OP1-5	1	1	0	5	1	5
OP1-7	2	16	2	8	3	3
OP1-8	4	1	0	1	0	12
OP1-9	4	42	21	54	17	14
OP1-10	5	9	2	16	1	6
OP2-1	4	3	0	4	3	57
OP2-2	5	10	1	16	1	2
OP2-3	1	5	2	8	1	0
OP2-4	7	15	1	20	6	21
OP2-5	6	29	13	34	4	6
OP2-6	9	12	3	19	6	10
OP2-7	4	4	0	8	3	4
OP2-9	5	4	0	11	3	17
OP2-10	4	7	2	15	2	12

APPENDIX D:

SELECTED ACADEMIC CORE WORDS

In Phase 1, 52 academic core verbs were provided in AKWIC as set search words, and the patterns associated with such core verbs were presented in APIC. In the next two phases, open query of words (verbs, nouns and adjectives) and structured patterns was made available, while 500 academic core words were still provided in a drop-down list as optional choices. All the words are taken from the frequency-based Academic Vocabulary List (Gardner & Davies, 2014).

The 52 academic core verbs set for concordancing search in Phase 1 were:
provide | *include* | *develop* | *suggest* | *require* | *report* | *base* | *describe* | *indicate* | *produce* | *identify* | *support* | *increase* | *note* | *represent* | *determine* | *occur* | *present* | *reduce* | *involve* | *focus* | *relate* | *establish* | *seek* | *compare* | *argue* | *state* | *examine* | *reflect* | *recognize* | *maintain* | *associate* | *design* | *address* | *define* | *apply* | *contain* | *form* | *reveal* | *affect* | *achieve* | *conduct* | *perform* | *discuss* | *exist* | *improve* | *observe* | *demonstrate* | *result* | *experience* | *control* | *measure*

The 500 optional academic core words in Phases 2 and 3 were:
study | *group* | *system* | *social* | *provide* | *research* | *level* | *result* | *include* | *process* | *development* | *data* | *information* | *effect* | *change* | *table* | *policy* | *university* | *model* | *experience* | *activity* | *human* | *history* | *develop* | *suggest* | *economic* | *low* | *relationship* | *value* | *require* | *role* | *difference* | *analysis* | *practice* | *society* | *control* | *form* | *report* | *rate* | *significant* | *figure* | *factor* | *interest* | *culture* | *need* | *base* | *population* | *international* | *technology* | *individual* | *type* | *describe* | *indicate* | *image* | *subject* | *science* | *material* | *produce* | *condition* | *identify* | *knowledge* | *support* | *performance* | *project* | *response* | *approach* | *period* | *organization* | *increase* | *environmental* | *source* | *nature* | *cultural* | *resource* | *century* | *strategy* | *theory* | *product* | *method* | *goal* | *likely* | *note* | *represent* | *general* | *article* | *similar* | *environment* | *language* | *determine* | *section* | *common* | *current* | *available* | *present* | *term* | *reduce* | *measure* | *involve* | *movement* | *specific* | *focus* | *region* | *relate* | *quality* | *establish* | *author* | *seek* | *compare* | *growth* |

natural | *various* | *standard* | *example* | *management* | *scale* | *argue* | *degree* | *design* | *concern* | *state* | *examine* | *pattern* | *researcher* | *task* | *traditional* | *finding* | *positive* | *central* | *act* | *impact* | *reflect* | *recognize* | *context* | *relation* | *maintain* | *concept* | *discussion* | *associate* | *purpose* | *address* | *define* | *particular* | *benefit* | *survey* | *effective* | *apply* | *contain* | *understanding* | *production* | *association* | *reveal* | *range* | *affect* | *attitude* | *status* | *necessary* | *function* | *global* | *conflict* | *achieve* | *conduct* | *critical* | *perform* | *discuss* | *exist* | *improve* | *observe* | *demonstrate* | *unit* | *modern* | *literature* | *principle* | *element* | *challenge* | *historical* | *aspect* | *perspective* | *basic* | *tradition* | *belief* | *western* | *procedure* | *test* | *category* | *tend* | *technique* | *outcome* | *future* | *mean* | *importance* | *application* | *feature* | *influence* | *basis* | *interaction* | *refer* | *communication* | *negative* | *primary* | *characteristic* | *lack* | *obtain* | *potential* | *variety* | *component* | *following* | *access* | *contribute* | *assume* | *express* | *tool* | *promote* | *participate* | *labor* | *engage* | *review* | *additional* | *appropriate* | *publish* | *encourage* | *successful* | *assess* | *view* | *client* | *instrument* | *meaning* | *limit* | *previous* | *demand* | *vision* | *female* | *attempt* | *independent* | *solution* | *direct* | *conclusion* | *presence* | *scientific* | *ethnic* | *complex* | *active* | *male* | *claim* | *participation* | *contrast* | *failure* | *internal* | *journal* | *multiple* | *facility* | *user* | *emerge* | *protection* | *extent* | *mental* | *explore* | *consequence* | *generate* | *content* | *device* | *requirement* | *broad* | *observation* | *visual* | *difficulty* | *regional* | *perceive* | *urban* | *capacity* | *increased* | *ensure* | *select* | *emphasize* | *institute* | *extend* | *connection* | *sector* | *commitment* | *interpretation* | *evaluate* | *conclude* | *notion* | *domestic* | *consist* | *reference* | *initial* | *adopt* | *comparison* | *depend* | *predict* | *employ* | *definition* | *essential* | *contact* | *colleague* | *actual* | *account* | *dimension* | *theme* | *link* | *desire* | *overall* | *useful* | *consistent* | *distribution* | *minority* | *analyze* | *psychological* | *unique* | *experiment* | *trend* | *exchange* | *percentage* | *objective* | *implication* | *contribution* | *enable* | *organize* | *emotional* | *locate* | *scholar* | *enhance* | *improvement* | *flow* | *estimate* | *phase* | *rural* | *long-term* | *core* | *volume* | *limited* | *propose* | *framework* | *existing* | *creation* | *code* | *emphasis* | *industrial* | *external* | *waste* | *climate* | *explanation* | *technical* | *mechanism* | *description* | *vary* | *reduction* | *discipline* | *construct* | *equal* | *origin* | *rely* | *fundamental* | *transition* | *assumption* | *existence* | *formal* | *manner* | *assistance* | *combination* | *increasing* | *hypothesis* | *phenomenon* | *planning* | *error* | *household* | *cite* | *judgment* | *constitute* | *relevant* | *typical* | *selection* | *incorporate* | *illustrate* | *cycle* | *depression* | *consideration*

| *developing* | *separate* | *recognition* | *mode* | *resistance* | *diversity* | *practical* | *anxiety* | *acquire* | *characterize* | *differ* | *interpret* | *creative* | *limitation* | *resolution* | *implementation* | *numerous* | *significance* | *revolution* | *display* | *professional* | *publication* | *variation* | *derive* | *alternative* | *permit* | *initiative* | *employment* | *regard* | *cooperation* | *transform* | *absence* | *imply* | *comprehensive* | *observer* | *testing* | *evolution* | *intellectual* | *signal* | *passage* | *facilitate* | *discovery* | *biological* | *introduction* | *boundary* | *substantial* | *ratio* | *theoretical* | *gain* | *settlement* | *independence* | *yield* | *formation* | *insight* | *territory* | *conventional* | *inform* | *index* | *crucial* | *racial* | *detect* | *poverty* | *agricultural* | *distinction* | *relative* | *identification* | *shift* | *monitor* | *domain* | *integration* | *whole* | *subsequent* | *strategic* | *preference* | *profession* | *apparent* | *assign* | *joint* | *exception* | *dependent* | *presentation* | *proportion* | *universal* | *norm* | *tendency* | *considerable* | *resolve* | *competitive* | *related* | *symbol* | *consumption* | *calculate* | *dominant* | *extensive* | *barrier* | *advanced* | *motor* | *adjustment* | *shape* | *integrate* | *dominate* | *establishment* | *entry* | *visible* | *stability* | *efficiency* | *sequence* | *given* | *sufficient* | *dialogue* | *distinct* | *enterprise* | *transformation* | *scope* | *assert* | *capability* | *reflection* | *electronic* | *decline* | *distinguish* | *retain* | *expansion* | *evolve*

APPENDIX E:

REGEX FOR OPEN-QUERY PATTERNS

This appendix presents all the regular expressions ('regex' for short) used to retrieve patterns in APIC in Phases 2 and 3 of the research. Regex is sequence of characters that can match different forms of a strings of letters and/or symbols. Kuebler and Zinsmeister (2015, Chapter 10) provide a detailed description of regex use in linguistic queries. Since the academic texts used in this research are POS (part-of-speech)-tagged by CLAWS4 with the C7 tagset (see Table E-2 in this appendix), the regex strings (see Table E-1) are based on the C7 tagset. CLAWS4 is a hybrid automatic tagging system which combines probabilistic and rule-based tagging, renowned for the high accuracy at 96-97% (Garside & Smith, 1997). "Good annotations support good applications" (Wilock, 2009, p. 1), and this mature tagging system enables large-scale pattern retrieval on request.

Table E-1 below sets out all the regex strings used in this research to retrieve patterns.

Table E-1 Regex strings for patterns (examples in italics)

Pattern	Regex
Verb patterns	
[V] prep. (e.g. *see through*)	\b(Node)_V\w[^N]\s\S+_II\s\S+_([BCIRT]\w+|_\pP)\s
[V] prep. sth./sb. (e.g. *look up a word*)	\b(Node)_V\w[^N]\s\S+_I\w\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s
[V] sth./sb. prep. (e.g. *let me in*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_II\s\S+_([BCIRT]\w+|_\pP)\s
[V] sth./sb. (e.g. *see the results*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s
[V] sth./sb. sth./sb. (e.g. *do me a favour*)	\b(Node)_V\w[^N]\s\S+_P\w+\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_N\w+\s
[V] sth./sb. prep. sth./sb. (e.g. *give it to me*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_I\w\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s
[V] sth./sb. prep. doing (e.g. *prevent it from happening*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_I\w\s\S+_V\wG\s
[V] adj. (e.g. *looks good*)	\b(Node)_VV[^N]\s(\S+ly_RR\s)?\S+_J\w+\s\S+_[^(J|

	N|P)]\w+\s
[V] sth./sb. adj. (e.g. *drive me crazy*)	\b(Node)_VV[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s(\S+ly_RR\s)?\S+_JJ\w?\s\S+_[^(N|P)]\w+\s
[V] *to* do (e.g. *want to know*)	\b(Node)_ V\w[^N]\s\S+_TO\s\S+_V\wI\s
[V] doing (e.g. *go shopping*)	\b(Node)_V\w[^N]\s\S+_V\wG\s\S+_[^(N|P)]\w+\s
[V] do (e.g. *help find a job*)	\b(Node)_V\w[^N]\s\S+_V\wI\s
[V] sth./sb. *to* do (e.g. *require me to submit assignments*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_TO\s\S+_V\wI\s
[V] sth./sb. doing (e.g. *see the tutor entering*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_V\wG\s
[V] sth./sb. do (e.g. *make me cry*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_V\wI\s
[V]+prep.+doing (e.g. *keep on studying*)	\b(Node)_V\w[^N]\s\S+_I\w\s\S+_V\wG\s
[V] *that* (e.g. *he claims that...*)	\b(Node)_VV\w\s\S+_CST\s
[V] *wh-* (e.g. *show how to do it*)	\b(Node)_V\w[^N]\s\S+_RRQ\s
[V] sth./sb. *that* (e.g. *teach me that...*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_CST\s
[V] sth./sb. *wh-* (e.g. *tell me where to go*)	\b(Node)_V\w[^N]\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s\S+_RRQ\s
[V]-ed (passive voice)	\S+_[^(VH)]\w+\s(\S+_XX\s)?\b(Node)_V\wN\s
Noun patterns	
adj. [N] (e.g. *a good boy*)	\S+_JJ\w?(\S+_N\w+\s)?\s\b(Node)_NN\w*\s
do <prep.> [N] (e.g. *make a wish*)	\S+_V[^B][^N]\s(\S+[^(by)]_I(I|O|F)\s)?(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\b(Node)_NN\w*\s
prep. [N] (e.g. *in the sun*)	\S+[^(by)]_II\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\b(Node)_NN\w*\s
Adjective patterns	
[ADJ] sth./sb. (e.g. *despicable me*)	\bNode_JJ\w?\s(\S+_N\w+\s)?\S+_N\w+\s
adv. [ADJ] (e.g. *pretty good*)	\S+ly_RR\s\bNode_J\w+\s
[ADJ] prep. (e.g. *interested in the topic*)	\bNode_J\w+\s\S+_I\w\s(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s
[ADJ]+prep.+doing	\bNode_J\w+\s\S+_I\w\s\S+_V\wG\s
[ADJ]+*to* do (e.g. *eager to*	\bNode_J\w+\s\S+_TO\s\S+_V\wI\s

know)	
[ADJ] *that* (e.g. *it is clear that*…)	\bNode_JJ\w?\s\S+_CST\s

Please note that in Table E-1, the patterns are described in an informal way. For example, a noun phrase (including a pronoun) is referred to as 'sth./sb.' (short for 'something' and 'somebody'); different forms of general verbs are represented as *do*, *doing* or *done*, and an infinitive is described as *to do*. The capital letter(s) in a pair of square brackets represent the search terms with different word classes ('[V]' for verbs, '[N]' for nouns, and '[ADJ]' for adjectives). Though the symbols may still be confusing to students with inadequate linguistic knowledge, the examples in the following brackets may help them.

In the regex strings, 'Node' is the query word entered or selected by the user[26]. In order to match various word forms and combinations of the same pattern, meta-characters, e.g. '\S' and '\w', and wild cards, such as '+' and '?', are frequently used in the regex strings. This flexibility enables PIC searching to focus on a certain pattern while being insensitive to various changes of specific words. A noun phrase may have a number of identifiers, such as an optional determiner and/or an adverb and/or an adjective. One piece of regex[27] may fit almost all word combinations to refer to somebody or something (a noun phrase or a pronoun), ranging from complex ones, such as *an outrageously high cost*, to a single noun or pronoun like *cat* and *me*.

However, regex-enabled pattern concordancing is unable to achieve 100% accuracy and inclusiveness due to the complexity of natural language. In other words, either incorrect results may be retrieved, or some matched examples may be missed. Mason and Hunston (2004) identify four major problems during their work on automatic recognition of verb patterns: intervening words, multiple patterns, non-canonical patterns and tagging errors. The first three kinds of 'noises', which represent the fuzzy nature of natural language, can

[26] This is not accurate, since the entered word is not used directly as a search term in regex. In fact, an input word will be searched in the SQLite database of inflections mentioned in Appendix B, and then all inflective forms are retrieved to be used in inflection-insensitive concordancing. It can be seen for verbs and nouns, 'Node' has to be put in a pair of brackets, while for adjectives, which do not inflect, the entered form can be used directly.

[27] The regex string to represent almost all combinations of noun phrases (including pronouns, and using the C7 tagset can be '(\S+_[ADM]\w+\s)?(\S+ly_RR\s)?(\S+_JJ\w?\s)?(\S+_N\w+\s)?\S+_(N|P)\w+\s'. In the Java environment, each slash ('\') in the strings must be a double-slash ('\\') instead, otherwise the search results will be void.

hardly be solved or standardised. Here is a case in point for non-canonical patterns: a number of verbs and adjectives can be followed by a *that*-clause, but *that* as a before-clause is sometimes omitted. In such cases, the examples of this pattern 'verb/adjective + *that*' are neglected by machine.

Tagging errors are another major reason for missed or wrong examples of a certain pattern. The 96-97% tagging accuracy of CLAWS4 means that there are 3 to 4 errors on the POS tags per 100 words. In this research, the academic texts for each discipline contained one million words, so there are about 30,000 to 40,000 incorrectly tagged words in each collection of disciplinary texts. The wrong POS tags may probably lead to mismatched results. For example, *speak English* is a 'verb + noun' pattern, however, as *English* is wrongly tagged as an adjective, this word combination is taken for the pattern 'link auxiliary + adjective', such as *it sounds good*. This problem has been largely solved by the databases of word-pattern association in this research: the patterns of a word are identified and recorded manually in databases; the pattern 'link auxiliary + adjective' is not associated with the word *speak*, so the above wrong retrieval will not happen in APIC. Another problem is inherent in the tagging system. It is known that sometime the present participle (-*ing* form) and past participle (-*ed* form) of a verb may serve as an adjective, such as *a teaching plan* and *a finished project*. In POS tagging, the participles are still tagged as verbs, and then the mentioned examples will be mistakenly retrieved for the pattern 'verb + noun' rather than the correct one 'adjective + noun'.

At last, it is necessary to include the C7 tagset which the above regex strings are based on. C7 tagset is a comprehensive system of POS tags which can meet the requirements of a competent annotation scheme: explicit and complete; a one-to-one correspondence between the attached labels and the categories; with a set of explaining guidelines (Lu, 2014, p. 5). In addition to C7, there are other POS tagsets, such as the Penn Treebank tagset and ICE (International Corpus of English) tagset (cf. Kuebler & Zinsmeister, 2015). However, C7 is fine-divided with over 100 categories, so the results of pattern retrieval with the C7 tags tend to be more accurate. The complete tagset is presented in Table E-2.

Table E-2 CLAWS4 C7 tagset (examples in italics)

Tag	Represented word(s)
APPGE	possessive pronoun, pre-nominal (e.g. *my*, *your*, *our*)
AT	article (e.g. *the*, *no*)
AT1	singular article (e.g. *a*, *an*, *every*)
BCL	before-clause marker (e.g. *in order [that]*)
CC	coordinating conjunction (e.g. *and*, *or*)
CCB	adversative coordinating conjunction (*but*)
CS	subordinating conjunction (e.g. *if*, *because*, *unless*)
CSA	*as* (as conjunction)
CSN	*than* (as conjunction)
CST	*that* (as conjunction)
CSW	*whether* (as conjunction)
DA	any after-determiner or post-determiner capable of pronominal function (e.g. *such*, *former*, *same*)
DA1	singular after-determiner (e.g. *little*, *much*)
DA2	plural after-determiner (e.g. *few*, *several*, *many*)
DAR	comparative after-determiner (e.g. *more*, *less*, *fewer*)
DAT	superlative after-determiner (e.g. *most*, *least*, *fewest*)
DB	before determiner or pre-determiner capable of pronominal function (*all*, *half*)
DB2	plural before-determiner (*both*)
DD	determiner (capable of pronominal function) (e.g. *any*, *some*)
DD1	singular determiner (e.g. *this*, *that*, *another*)
DD2	plural determiner (*these*, *those*)
DDQ	*wh*-determiner (*which*, *what*)
DDQGE	*wh*-determiner, genitive (*whose*)
DDQV	*wh-ever* determiner (*whichever*, *whatever*)
EX	existential *there*
FO	formula
FU	unclassified word
FW	foreign word
GE	Germanic genitive marker - ('or 's)
IF	*for* (as preposition)
II	general preposition
IO	*of* (as preposition)
IW	*with*, *without* (as prepositions)
JJ	any general adjective
JJR	general comparative adjective (e.g. *older*, *better*, *stronger*)
JJT	general superlative adjective (e.g. *oldest*, *best*, *strongest*)
JK	catenative adjective (*able* in *be able to*, *willing* in *be willing to*)
MC	cardinal number, neutral for number (*two*, *three*.)
MC1	singular cardinal number (*one*)
MC2	plural cardinal number (e.g. *tens*, *twenties*)
MCGE	genitive cardinal number, neutral for number (two's, 100's)
MCMC	hyphenated number (*40-50*, *1770-1827*)

MD	ordinal number (e.g. *first*, *second*, *next*, *last*)
MF	fraction, neutral for number (e.g. *quarters*, *two-thirds*)
ND1	singular noun of direction (e.g. *north*, *southeast*)
NN	any common noun, neutral for number (e.g. *sheep*, *cod*, *headquarters*)
NN1	singular common noun (e.g. *book*, *girl*)
NN2	plural common noun (e.g. *books*, *girls*)
NNA	following noun of title (e.g. *M.A.*)
NNB	preceding noun of title (e.g. *Mr.*, *Prof.*)
NNL1	singular locative noun (e.g. *Island*, *Street*)
NNL2	plural locative noun (e.g. *Islands*, *Streets*)
NNO	numeral noun, neutral for number (e.g. *dozen*, *hundred*)
NNO2	numeral noun, plural (e.g. *hundreds*, *thousands*)
NNT1	temporal noun, singular (e.g. *day*, *week*, *year*)
NNT2	temporal noun, plural (e.g. *days*, *weeks*, *years*)
NNU	unit of measurement, neutral for number (e.g. *in*, *cc*)
NNU1	singular unit of measurement (e.g. *inch*, *centimetre*)
NNU2	plural unit of measurement (e.g. *ins.*, *feet*)
NP	proper noun, neutral for number (e.g. *IBM*, *Andes*)
NP1	singular proper noun (e.g. *London*, *Jane*, *Frederick*)
NP2	plural proper noun (e.g. *Browns*, *Reagans*, *Koreas*)
NPD1	singular weekday noun (e.g. *Sunday*)
NPD2	plural weekday noun (e.g. *Sundays*)
NPM1	singular month noun (e.g. *October*)
NPM2	plural month noun (e.g. *Octobers*)
PN	indefinite pronoun, neutral for number (*none*)
PN1	indefinite pronoun, singular (e.g. *anyone*, *everything*, *nobody*, *one*)
PNQO	objective *wh*-pronoun (*whom*)
PNQS	subjective *wh*-pronoun (*who*)
PNQV	*wh-ever* pronoun (*whoever*)
PNX1	reflexive indefinite pronoun (*oneself*)
PPGE	nominal possessive personal pronoun (e.g. *mine*, *yours*)
PPH1	third person sing. neuter personal pronoun (*it*)
PPHO1	third person sing. objective personal pronoun (*him*, *her*)
PPHO2	third person plural objective personal pronoun (*them*)
PPHS1	third person sing. subjective personal pronoun (*he*, *she*)
PPHS2	third person plural subjective personal pronoun (*they*)
PPIO1	first person sing. objective personal pronoun (*me*)
PPIO2	first person plural objective personal pronoun (*us*)
PPIS1	first person sing. subjective personal pronoun (*I*)
PPIS2	first person plural subjective personal pronoun (*we*)
PPX1	singular reflexive personal pronoun (e.g. *yourself*, *itself*)
PPX2	plural reflexive personal pronoun (e.g. *yourselves*, *themselves*)
PPY	second person personal pronoun (*you*)
RA	any adverb after nominal head (e.g. *else*, *galore*)
REX	any adverb introducing appositional constructions (*namely*, *e.g.*)
RG	degree adverb (*very*, *so*, *too*)

RGQ	*wh-* degree adverb (*how*)
RGQV	*wh-ever* degree adverb (*however*)
RGR	comparative degree adverb (*more*, *less*)
RGT	superlative degree adverb (*most, least*)
RL	locative adverb (e.g. *alongside, forward*)
RP	prep. adverb, particle (e.g. *about, in*)
RPK	prep. adv., catenative (*about* in *be about to*)
RR	general adverb (*quickly*)
RRQ	*wh-* general adverb (*where*, *when*, *why*, *how*)
RRQV	*wh-ever* general adverb (*wherever*, *whenever*)
RRR	comparative general adverb (e.g. *better*, *longer*)
RRT	superlative general adverb (e.g. *best*, *longest*)
RT	quasi-nominal adverb of time (e.g. *now*, *tomorrow*)
TO	infinitive marker (*to*)
UH	interjection (e.g. *oh*, *yes*, *um*)
VB0	*be*, base form (finite i.e. imperative, subjunctive)
VBDR	*Were*
VBDZ	*Was*
VBG	*being*
VBI	*be*, infinitive (*To be or not... It will be* ..)
VBM	*Am*
VBN	*been*
VBR	*are*
VBZ	*Is*
VD0	*do*, base form (finite)
VDD	*did*
VDG	*doing*
VDI	*do*, infinitive (I may do... To do...)
VDN	*done*
VDZ	*does*
VH0	*have*, base form (finite)
VHD	*had* (past tense)
VHG	*having*
VHI	*have*, infinitive
VHN	*had* (past participle)
VHZ	*has*
VM	modal auxiliary (*can*, *will*, *would*, etc.)
VMK	modal catenative (*ought*, *used*)
VV0	base form of lexical verb (e.g. *give, work*)
VVD	past tense of lexical verb (e.g. *gave, worked*)
VVG	-ing participle of lexical verb (e.g. *giving, working*)
VVGK	-ing participle catenative (*going* in *be going to*)
VVI	infinitive (e.g. *to give... It will work...*)
VVN	past participle of lexical verb (e.g. *given, worked*)
VVNK	past participle catenative (e.g. *bound* in *be bound to*)
VVZ	-s form of lexical verb (e.g. *gives, works*)

XX	*not, n't*
ZZ1	singular letter of the alphabet (e.g. *A, b*)
ZZ2	plural letter of the alphabet (e.g. *A's, b's*)

APPENDIX F:

STEPS OF APP DEVELOPMENT

The prototypes of the two mobile apps underwent a series of improvements according to the feedback from the voluntary participants. Among others, opening to all search queries was a major improvement in Phase 2. Prior to Phase 3, there was no further improvement to AKWIC, and minor changes were made to layout and graphic design of APIC. This was because the comparison between APIC and AKWIC had been completed in Phase 2, and Phase 3 focused on the experience and evaluation of pattern concordancing and mobile learning. The steps of app development are set out in Table F-1 below, and the details of phase-specific development can be found in Sections 4.1, 5.1 and 6.1.

Table F-1 Steps of app development

Aspect	Changes and improvements
Stage 1: initial development before the research commencement	
Java concordancers	A Java program for KWIC concordancing was developed.
	A Java program for PIC concordancing was developed, dealing with the search and retrieval of multi-word patterns in POS-tagged texts.
Adaptation to mobile use	The initial Android graphic interface was created for concordances.
	Random selection of KWIC and PIC results was introduced, with 10 examples displayed per search, and the matched words or patterns highlighted in yellow.
	Extendable context range was added, by which users could set the context span and have a longer sentence for better understanding.
	The text box to show concordances was made scrollable horizontally, and the text box for extended context was made scrollable vertically, so as to accommodate more words on request.
Additional features	Context extension feature was reduced to only one concordance, and was transferred to a separate interface, where users can enter the serial number of the target example and desired context span to focus on one result in a wider context.
	The matched target words or patterns in concordances were put into clickable links, so that users could click to be navigated to the interface of context extension.
	The clickable links to the wider-context interface were changed to serial numbers on either side of the incomplete sentences, since the matched form became obscure in the links, and when users scrolled the examples, they might mistakenly touch the links in the middle.
	The TTS module in Android was initialised to read out the displayed

	wider-context example.
Integration of SQLite databases	A concise English-English dictionary in SQLite format was set up to provide essential definitions of the searched words, while it was removed later due to the poor quality of entry definitions.
	A SQLite database of lexical inflections were established based on the lemma list compiled by Yasumasa Someya. With the database any query can be made insensitive to word inflections in KWIC or PIC concordancing.
Tailored to research use	Disciplinary texts across nine broad areas were introduced, with one million words for each discipline.
	It was determined to provide the most frequent 52 core verbs informed by the new Academic Vocabulary List (Gardner & Davies, 2014) in AKWIC as set search terms.
	Patterns associated with the 52 academic verbs were formulated, amounting to over 100. The patterns were provided as selectable items under each search word in APIC.
	Automatic logging was inserted to collect use data.
Stage 2: follow-up development after Phase 1	
Open query	AKWIC was expanded to be open to any word query.
	Three SQLite databases for verb, noun and adjective patterns were established and maintained.
	Regex strings for POS-based patterns were formulated and tested.
	APIC was upgraded to be open to queries of major notional words: verbs, noun and adjectives.
Enhancement of additional features	Access to the online dictionary data in JSON format from the Longman Dictionary of Contemporary English was introduced.
	Finger movement detection could be detected for context extension, so that learners could use two fingers to enlarge or reduce context range, rather than manually setting a figure in an input box.
	Google TTS was installed in the tablets to improve the voice quality of audio reading by machine.
Stage 3: follow-up development after Phase 2	
Graphic and operational optimisation	The interfaces were redesigned with new layout and more graphic elements.
	Audio guide and pop-up graphic instructions were added to direct each step of app use.
	Clearance mechanism was added to kill all operating processes when the app was shut down.
	Protection mechanism was added to reduce crashes.
	Multi-threads technique was adopted during discipline selection and concordancing to reduce lag time.