THE UNIVERSITY OF QUEENSLAND
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# Language Immersion

*Designing a social and mobile AR application*

by

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# Abstract

The purpose of this thesis was to discover the usefulness of integrating social and mobile methodologies with augmented reality to facilitate effective and engaging language learning environments. This project focuses primarily on the French language due to its popularity and accessibility. Throughout conducting the thesis, immersive language pedagogies founded in social and mobile contexts were identified, built upon and evaluated through research, stakeholder interviews and prototype evaluations. A novel prototype was designed in collaboration with language teachers and learners to facilitate flexible language pedagogies, which provided domain specific insight through evaluations. This prototype demonstrated the potential usefulness of immersive Language learning AR applications used in conjunction with supportive methodologies that have supplementary, effective pedagogical groundings. Recommendations for future work included further investigations to verify the accuracy of such designs, findings and the stated outcomes.

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# Chapter 1 - Introduction

## *Background*

Language is a universal bridge for human connectivity and is heavily influenced by location, culture and context. As language plays a heavy role in the identity of communities and determines the appropriate communication methods amongst individuals within those communities, it is important to continue facilitating spaces where language can be preserved through education (Scarino et al., 2016). Thus, language learning provides a gateway for connection to cultural identities and contextualised phenomena. Language learners themselves come from various backgrounds, experiences and motivations (Osterweil et al., 2016). Traditional classroom language learning can be conducted with kindergarteners through to adults. The goals of these varying learner groups may also vary from simplistic language recognition to language mastery.

Over the years, pedagogical tools and methodologies have been created and used to varying successes. In recent years, they have been paired with emerging digital technologies to enhance learning outcomes and goals (van den Berghe et al, 2018). This has resulted in various stand alone "solutions", or digital communication platforms. A good example of this is Duolingo, an application which has combined mobile gaming tools and classroom learning concepts to gamify language learning in and through an easily accessible web and mobile interface. (Ghazal and Singh, 2016). From the success of Duolingo and other similar products, it is clear that utilising new technologies- some in different domains - can facilitate successful learning environments and provide scope for further enhancements with future technologies. One particular emerging technology that may enhance the language learning space is augmented reality (AR).

Augmented reality sits within the reality-virtuality spectrum, central between real environments and virtual reality (Santos et al., 2014). As a form of mixed reality, augmented reality affords the user common benefits of virtual reality (VR), whilst still situating them in real life context. Language immersive experiences, whether that be through virtual or augmented realities, have been gaining interest in recent literature. Interestingly, as noted by Demetriou et al. (2020) a large number of studies using AR or VR for language learning "lack grounding". As noted by Marzouki et al. (2017) language learning has high success in context, where language learners are able to explore and interact with each other. Despite the importance of using mobile and social concepts and methodologies to guide language pedagogy, there are very few AR solutions created with these in mind.

Therefore, it is imperative to not only explore the use of augmented reality solutions in the language learning space, but to integrate successful social and mobile methodologies and concepts. As such, the question arises as to how existing social and mobile language pedagogies can be applied within augmented reality facilitated immersive learning environments.
From this, the aim of this study is to create a social and mobile application that uses AR to facilitate and investigate immersive language learning experiences. This will be focused primarily on a singular use case, using French as the initial language and catering towards individuals with little to intermediate previous knowledge of French vocabulary and culture. The findings of this can hopefully prove applicable to other languages (in particular, less documented and used

indigenous languages), revitalising their preservation and use. As such, the main contribution of this paper is an investigation on the suitability of combining existing work in the AR language domain and immersive language pedagogies.

## *Contribution*

The contribution of this project can be seen through the identification and evaluation of a new approach to language learning: creating solutions that are immersive and collaborative AR experiences. The aim of this project was also to present a novel prototype designed in collaboration with language teachers and learners to facilitate this learning approach with scope for further development. From this research, there is hope that it would provide beneficial for the language learning process for both well established and less documented and spoken indigenous languages, revitalising their preservation and use.

## *Scope*

To investigate and therefore understand the scope and impact of this contribution, close collaboration with language learners and language teachers themselves is imperative given they are central to this domain of research. Although "language learners" can be identified as the key stakeholder investigated, language teachers can also be considered relevant given their additional insights into language learners and experiences in creating and designing learning environments for them.

Therefore, the broader question leading this investigation is:

- What can we learn about language learners and also open-ended AR applications for language learning?

From this, a more specific question can be identified as:

- How can we design a socially immersive technology that facilitates French learning in Australia?

This project focuses primarily on the French language due to its popularity and accessibility. Given this language is highly documented and works well with current established language pedagogies, it was established as appropriate for this project. The availability and ease of access to French learners and teachers was also beneficial for the reach of this project. AR was chosen as the technology medium due to its effectiveness at creating immersive environments. Unlike other potential technology mediums, AR by nature automatically creates immersive environments by allowing users to make use of environments without taking them out of their own (unlike VR). Therefore, this medium allows the research questions to be answered the most effectively.

## *Objectives/ Statement of Purpose*

With this scope in mind, the purpose of this study was to investigate immersive and collaborative language pedagogies using Augmented Reality and how they can be used to

facilitate effective and engaging language learning environments. This was achieved by creating an immersive social application for French learning in Australia. To do this, this thesis investigated current literature around methodologies for language learning – particularly those built on social and mobile techniques. Both language learners and teachers were engaged to understand the domain and identify stakeholder opinions and needs. The predominate focus of this was to gather anecdotal data for informing design and future method recommendations. A prototype application was created based off initial findings, and a method to evaluate the prototype for further findings and insights was included in the scope of this project. The objective of this process was to centralise the environment that the prototype helped to facilitate and the learnings gained from this rather than the specific the features and fidelity of the prototype created.

## *Thesis Structure*

This paper aims to present the key findings linked to the creation of an immersive language environment, paying particular focus to the supporting research, implementation and suitability of relevant design and evaluation methodologies as well as presenting novel findings. The structure of this thesis can be seen as follows:

Chapter 2: Literature Survey

- Initially, this thesis provided a review of the current literature within the broader language learning domain.

Chapter 3: Methods and Approach

- This chapter briefly mentioned the current domain state, presented research findings on different language and even learning pedagogies (including social and mobile theories), investigated literature on language technology (including AR) and investigated current existing solutions.

- This research enabled identification of gaps within the current research domain and provided grounding and insights for the design, development and evaluation phases.

Chapter 4: Initial Interviews

- Supplementary to the initial research, both language learners and teachers were engaged as participants and initial interviews were conducted to inform future designs and get anecdotal finding direct from the key stakeholders.

Chapter 5: Prototype design (process, methods, results)

- Combining the research and interview findings, a prototype was created and evaluated based off recommended methodologies and the findings were presented.

Chapter 6: Discussion of Results

- This thesis concluded by discussing the results and providing further analysis on insights affirming/challenging background literature and assumptions as well as their relevance and supportive findings for the thesis guiding research questions.

- A critical review of the methods used, prototype implementation and findings themselves were also addressed, identifying limitations and affordances as well as recommended methodology/prototype improvements to be made.

- Following this, the outcomes, learnings, contribution of the thesis and future recommendations were presented.

# Chapter 2 – Literature Survey

### *Approach*

To begin investigating the proposed research questions, it was important to gain an in depth understanding on what was currently known within the domain and how to best investigate this question. This research approach investigated the broad domain of language learning as a whole, identifying specific, relevant and broadly recognized language pedagogies and design methodologies present within second language acquisition domain, as well as an overview of the research and findings of existing AR language learning solutions.

Throughout this approach, theories from other disciplines and "out of scope" domains were investigated with regards to their relevance and potential contribution to insights based on the research question. This included the inclusion of research into social and mobile design theories and how they can be integrated into language learning research as well as presentation of learnings from technologies than AR that contributed to the broader technology language learning domain. Relevant evaluation methodology and recommended design approaches also were acknowledged as to guide further approaches aiming to aid with answering the research question. Finally, lack of research coverage and the recommendations and future work from relevant works identified gaps and areas for novel research.

## History of Language Learning

There is such a long standing history of language acquisition following written, spoken and observations utilising various techniques, specific for different languages, different language audiences and more. As such, what is currently known from research into language learning is increasingly broadened by new pedagogies informed by design principles, language environments and technology advances.

Identified by Scarino et al (2016), learner demographics including linguistic and cultural profiles have a significant influence over learnings. To recognise this, second language learning is often classified (using French as the desired language) as: FSL (French as a second language) or FFL (French as a foreign language). FSL can be identified through learners of a second language within a location where it is readily spoken whereas FFL learners are outside a predominately French-speaking environment (Ghazal & Singh, 2016). The scope of this research (English speaking Australians learning French) can be identified as FFL as the stakeholders have much less access to authentic learning environments and therefore rely more heavily on effective language pedagogies and learning contexts.

## Language Pedagogy

Understanding language learning is to understand the concept of learning itself, given all learning processes are built on language learning foundations. Scarino et al. (2016) keenly points out that "In language learning, language is therefore both the subject matter of focus; that is, the substance of learning, and the medium for learning." As such, commonly known learning techniques can also apply to and be considered language learning techniques.

### *Language Pedagogy Design*

There is a significantly broad amount of literature discussing the benefits and shortcomings of various pedagogical methods for language learning in action. To understand effective Pedagogies is to understand the design considerations they are based on. Scarino et al. (2016) on behalf of the South Australian education department, recommended designing language pedagogies that are personalised, support experimental learning, share multiple learner perspectives and encourage accountability. Although these are useful insights, understanding the context behind design recommendations through analysis of various pedagogies in action were much more beneficial in providing greater depth.

By analysing school-based learning environments, Herrington & Ozverir (2011), argued that tasks that aren't authentic replications of real-life scenarios impact the development of students robust knowledge negatively. This conclusion was made from the observations that formal education systems often orient towards "abstract and decontextualised forms of teaching" heavily controlled and evaluated by teachers.

A study on supplemental, self-directed learning approaches undertaken by students outside classroom environments was investigated by Litzler & Bakieva (2017). They investigated how students addressed the main modalities for language learning; Speaking, listening, writing and reading, concluding the driving motivation for students to learn language skills for relevant course assignments meant that communicating meaning through language was sidelined by more formal aspects.

Trying to disrupt formal classroom-based activities, Ghazal & Singh (2016) investigated game-based language learning driven by a user centred pedagogy. In particular, game-based learning emphasised "playing", allowing users to create their own learning resources as active co-creators of knowledge learnt. Conclusions from this research emphasised strong belief in game-based learnings "flexibility, adaptability, and its potential to meet various curricular need".

## *Social and Mobile Theories*

Many pedagogies, like those previously identified, draw on theories from other disciplines. In particular, there is a small amount of literature and case studies that discuss and provide insight into the benefits and shortcomings of language immersion using pedagogies grounded in social and mobile design theory. Within immersive language environments, social and mobile concepts presented potential in informing decision making all the way from ideation to implementation. To investigate this, a number of papers were analysed, that contained various language pedagogies cantered around social and mobile design techniques.

Filali et al. (2017), conducted a review on the effects of social and mobile concepts on language learning as well as methods and design principles that aided in the development of such environments. The goal was to see if the introduction of mobile and social concepts resulted in increases on identified metrics in comparison to traditional learning methodologies. The construction of social environments was found to be crucial in the acquisition of knowledge through interaction with peers and teachers during learning tasks where students were actively learning. Through analysis of 24 empirical studies, Karacan & Akoğlu, (2021) notes a "positive effect of mobile learning on the knowledge acquisition, learners' achievements, attitudes and motivation despite the high cognitive load." The goal is to see if the introduction of mobile and social concepts results in increases on the given metrics in comparison to traditional learning methodologies



Similar research conducted by Clark et al., (2011) also presented the effect of similar concepts for informal language learning in Sweden. The report outlined that those new to Sweden often

struggle to tap into the most powerful learning resource available: everyday interactions with Swedish speakers. This comes from the understanding that the Swedish language itself is best learned in social contexts where social and cultural considerations facilitate and favour immersive environments outside of a typical classroom environment. Thus, it provided an understanding of language as a "pervasive phenomenon" more than just vocabulary, but rather as an extension of communication within natural environments.

A similar study conducted by Mehmet (2016) centred around developing and evaluating social and cooperative language learning strategies for teaching Turkish as a foreign language. The key social strategies outlined were "reaching clarity, confirmation of knowledge, establishing cooperation, cultural sensitivity". This qualitative research focused on the process of teaching, particularly understanding the traditional roles of teacher and student and how group learning could enable such strategies to be enhanced. With group responsibility, members in the language environment were also responsible for the learnings of the other members in the group, utilising social connections to increase motivation and encourage positive, natural interactions.

# Language and Technology

In addition, there is numerous literature on technologies designed as a supplemental or replacement approach to traditional language environments and teaching methods.

More specifically, in recent years the availability and use of mobile applications to aid in the language learning has grown. A study done by Guaqueta et al. (2018) evaluating the suitability of popular app Duolingo, found numerous benefits to using language apps in the classroom. This study noted that the medium encouraged more engagement with students and was easy for teachers to adapt to existing learning materials (Guaqueta et al., 2018). A major contribution of this study was to support technology being used in classroom practices and to introduce the potential that doing so might encourage gain strategies for future learning on their own (Guaqueta et al., 2018). To investigate the different types of applications available for learning English specifically, as well as their acceptance, Nami (2020) analysed a number of language apps, categorising them into Dictionary and non-dictionary apps. Categorising the types of applications gave insight into students change in attitudes depending on the application, indicating positive feedback for the usefulness of language applications if they are designed correctly (in conjunction with students, combining various language skills) (Nami, 2020).
The recommendations from this research also outlined support for multidisciplinary co-design approaches:

> "Educators, apps designers, and curriculum developers in any discipline, including language learning, should interact to design app content that is aligned with course content and its pedagogical objectives to enhance the appeal of mobile learning tools for students" (Nami, 2020)

Considering the integration of emerging technologies with social and mobile design theories, Van den Berghe et al., 2018 investigated social robotics as a tool for language learning by undertaking an analysis of the current literature in the robot-assisted language learning space.

This review encapsulated different learning environments as well as language skills separate to words, with findings confirming increases in motivation as well as positive attitude and engagement in learning processes and activities. From the research conducted by Kukulska-Hulme & Viberg (2018) similar, yet broader scope verifies this and identifies flexibility,

continuity, personalisation, active participation and timely feedback as additional affordances of social robotic integration. Both these studies identify the affordances technology may have on both individualised and collaborative learning processes for collaborative and mobile language learning. Despite this positive assurance, Van den Berghe et al., 2018 notes the potential "novelty effect" which can often be associated with new technologies or tools, which may lead to decreased motivation from participants over time.

The current research on existing technologies (including those combined with relevant design theories) within the language learning space shows support and insights into the promise more specific, AR based solution research might have.

# Augmented Reality

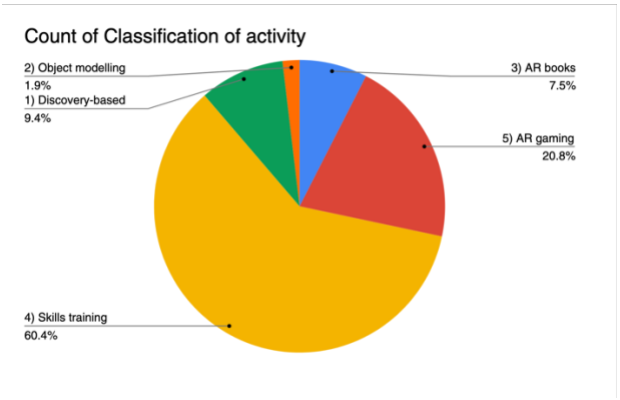
Recently, augmented reality learning technologies and articles have been produced, disrupting many pre-existing pedological approaches. Augmented reality itself is the "combination of virtual elements and real environment" (Santos et al., 2014).
Augmented reality solutions use one of two display metaphors; mirror: where the display is reflecting the user and the augmented information, or glass: where the user sees the normal plane of vision with the augmented environment "on top" like a glass (Santos et al., 2014). PokemonGo is an example of an AR application which was popularized for its contextualized learning approach. Building on this medium, many researchers and designers investigated the impact similar applications could have on future technical solutions within the language learning space.

# Existing Solutions

Karacan and Akoğlu, 2021 and Parmaxi and Demetriou, 2020 specifically conducted comprehensive reviews of such AR based language learning solutions, evaluating their approaches and conceptualized examples of this claim. These solutions vary between user goals, levels of education, languages used as well as the duration of activities. The figure outlines the classification of activities between the 54 publications analysed.

Karacan & Akoğlu, (2021) indicated that augmented reality language learning solutions provide authentic learning environments, increase learning motivation, are multimodal, and increase content retention and understanding. Many provide a review of affordances from both student and teaching perspectives.

Despite this, 46% of the solutions analysed in their paper did not have theoretical grounding, many of which did not cover out-of-classroom environmental or contextualised cultural considerations. Both papers identify the lack of research present using interdisciplinary teams and identify the need for the combination of virtual strategies with SLA (second language acquisition) principles.




Frameworks and methodologies for implementing such principles have been outlined and investigated within this space. A concise framework outlined in Karacan and Akoğlu (2021) was created by an interdisciplinary team that followed a questionnaire format for school learning. This framework evaluated the 'fit' that an AR pedagogical solution had on a given context and predominantly focused on being used by the enablers of pedagogical learning technologies: the creators of content, individuals or organisers funding such projects and the project initializers themselves. Contrastingly, Collins & Vaughan et al. (2019) identified that a design-based research methodology is best for measuring such impact. This followed a questionnaire and observation type format on the GaeltechVR for the VIVE pro. Following this method both the usability of the technology was observed as well as the impact of the solution on the identified metrics of motivation. This however, was using a VR rather than AR approach.

Considering the available literature using AR, VR and mixed reality in language learning, Li & Wong (2021) affirmingly noted that:

> "The use of technology alone will not suffice for improving learners' language proficiency, but the design of curricular and learning contents also plays an important role."

Thus indicating that affordances of AR, VR or mixed reality language technologies are inclusive and dependent on the contextual environment and the type of learning activities they are able to facilitate. Affirmingly, Santos et al., 2014 provided a guide for the design of effective AR content by using learning theories to establish the benefit such approaches can afford. They recommend choosing design strategies that enable exploration, promote collaboration, ensure immersion and that measure the effectiveness of the AR solution in isolation. These recommendations are complemented by Parmaxi et all (2017) who investigated the need for content that is easily created, accessible by those with a non- technical affinity or background and location and collaboratively founded.

# Conclusions/Gap

This investigative analysis on current literature theories, solutions and recommendations provided beneficial supporting information and directive for the design approach and direction of this thesis. Evaluating gaps in the current literature, there is a lack of interdisciplinary teams contributing to the design of AR language solutions as well as inadequate coverage of evaluations of these solutions by both language learners and teachers alike. Moreover, there is a gap for AR solutions used in conjunction with content that is grounded in AR-adaptable, engaging and effective language pedagogical design considerations. Thus, highlighting a need for further research into AR language learning approaches with theoretical grounding, with an out of classroom, contextualized approach. In particular, investigations on AR language solutions that utilise social and mobile theories to create immersive, collaborative learning environments.

# Chapter 3 –Methods and Approach

Determining the thesis approach and methodology selection included an evaluation of combined/ alternative approaches and their suitability at not only addressing the aforementioned gap but also in achieving the goals outlined in the initial research questions. Before determining the necessary methodology and approach of this thesis, it was important to identify the key information needed. As identified in the previous literature, the suitability of an immersive AR experience grounded in language pedagogies for language learners needed investigating. As such, information gained by this process was to provide an insight into the usefulness of creating an immersive language learning environment, through feedback from language learners and language teachers respectively. In conjunction to this, it was important to define an overall investigative approach as well as methodologies that would help answer the research question.

Similar to many papers addressed, concepts such as motivation, collaboration, accessibility, technology acceptance and language pedagogy preferences for language learners needed to be investigated to cover this scope effectively. Therefore, it was important to cover the main research questions by focusing on language learners' experiences, preferences and ideas as well as the experiences and views of language teachers. Of course, it was identified that the prototype scope would need to cover experience, usability and functionality design assurances to be able to give an insight on how to design within this space. As this scope leans towards a more qualitative data gathering approach, it was hoped that the presentation of aligned concepts, outcomes and theme implications would demonstrate the significance of the learnings.

## Ethics Application

Before engaging with prospective participants and conducting research activities, an ethics application was submitted. For the ethics approval, this thesis project was considered as part of a larger research project at UQ that is looking at developing and evaluating pedagogical (language learning) design tools and therefore the ethics application was amended to include this project alongside the others. After submission, the proposal was approved from the school of Information Technology and Electrical Engineering (ITEE) on the 15$^{th}$ of June, 2022. This allowed the recruitment of participants to begin. Following the approval, a participant information sheet (See appendix 1) was shown to all participants and an informed consent form (Appendix 2) was used and filled out by all participants before data was collected.

## Participant Recruitment

For this project, two main stakeholders were identified as French language learners and language teachers respectively. As such, these stakeholders were targeted as required participants. Prospective French language learner participants were identified from personal and professional networks, and Dr Ben Matthews and Dr Janet Wiles assisted in identifying a former French language teacher (now researcher in the same domain). In particular, the prospective language learners identified had varying French knowledge and learning environments, however all were learning or had previously learnt French in Australia.
These prospective participants were then contacted to gauge their interest in participating in this study. Those that confirmed their willingness to participate were then sent both the

Participant Information Sheet and Informed Consent Form electronically. After reading the forms and confirming the scope and domain of the project, the participants wanting to continue returned their signed forms and were ready to take part in the study.

# Design Process

This process was broadly guided by an iterative, human-centred co-design process. This was chosen given creating technology in this space was recommended to benefit greater from multidisciplinary inputs and efforts (Guaqueta et al., 2018). As such taking inspiration from co design principles – participatory, relationship oriented and shared power - allowed for participants (both language learners and teachers alike) to engage in domain identification, problem exploration as well as solution ideation. In particular, this method guidance aligns most with the research questions, learning directly from language learners themselves to present anecdotal information, reflections and to facilitate design insights. Therefore, this broad approach allowed for method flexibility, continual feedback and close stakeholder collaboration.

## Methodology

More specifically, it was decided that the approach most aligned with this guidance, was a qualitative focused, mixed method approach. This was informed by the research through design approach (See Figure 1). This approach conducts research and design concurrently, conducting research as a part of informing design, and designing as method of conducting research (Stappers & Giaccardi, 2022). This supported the thesis objective, as it not only allowed for broad research to be conducted but also for the creation of an informed prototype-hypothesis that supported further insights into designing in this space.

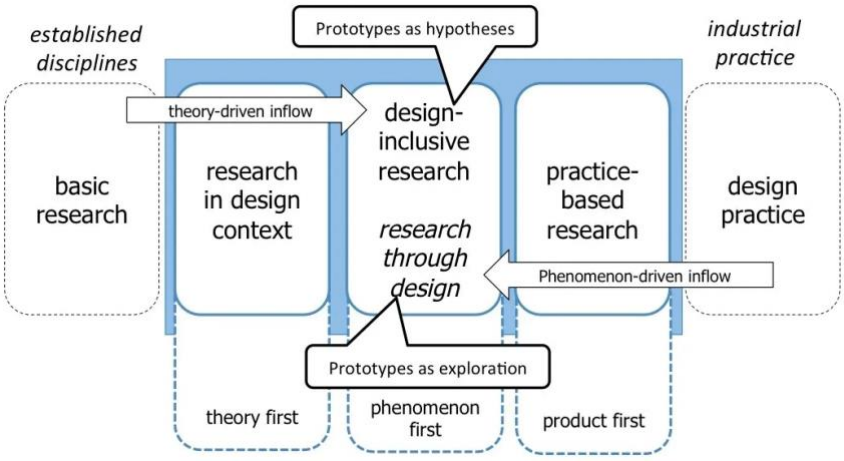



*Figure 1- Research Through Design Approach (Stappers & Giaccardi,, 2022)*

## Research through Design Process

The project process combined this approach with the interaction design life cycle providing a new adaptative method flow as identified in the Figure 2.

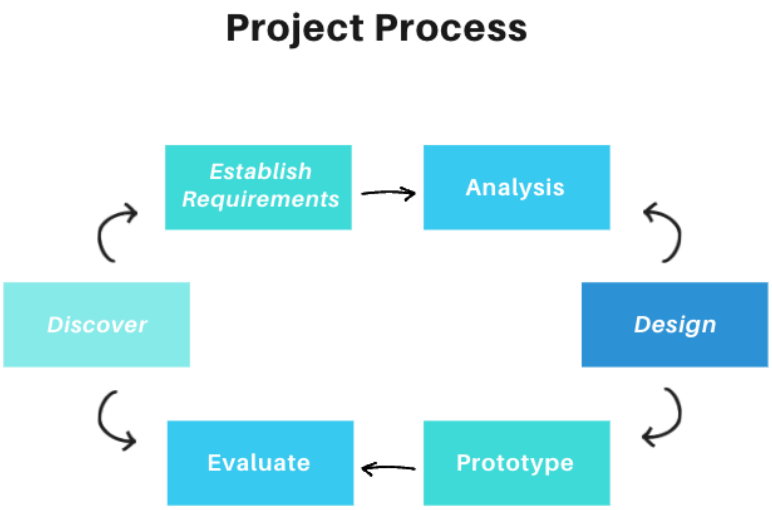



*Figure 2- Project Process*

From this, the main methods for obtaining useful data will be through interviews and evaluations. Ideally, the goal was to achieve as much user feedback as possible using common, easily understandable and accepted practises.

Keeping this methodology and design guidelines in mind the design process for this project was as follows:

Discover:

- Conducted a broad literature review, establishing what was and wasn't known in the domain.

Establish requirements:

- Engaged with relevant stakeholders to initialise the co-design process, facilitating qualitative research findings and guidance on stakeholder design requirements.

Analysis and Design:

- Evaluated and incorporated requirement feedback, informing design recommendations.

Prototype:

- Created a prototype based on design recommendations, and ability to enable further learnings.

Evaluate

- Evaluated the research and design learnings gathered from the prototype through user testing an, identifying further recommendations for further design/research.

# Chapter 4 – Initial Interviews

## Methodology Adopted

Following the research through design process, the initial contribution of research for this project came in the form of initial interviews. The purpose of these interviews was to create qualitative research results that would consolidate or challenge findings initially found through research alone. These interviews were also conducted to inform the design of a subsequent protype through familiarising the research and stakeholders in context and initialising the collaborative and co-design process.

Semi-structured interview methodology informed the interview design, through discussions with the researcher and participants guided by initial open ended questions which were able to be supplemented with follow-up questions, probes and comments.

The full list of questions can be seen in Appendix 3, which were arranged into the following categories:

- Demographic Questions
- Language Learning specifics
- Tools/Technology literacy
- Social and Mobile Interactions
- Opinions/Self evaluation (language contextualised)

These questions (created as an expansion of the main research questions) were generated to further understand the participants background, language learning experience and environment, as well as demographic factors impacting potential design approaches. The contribution of final category facilitated direct co-designing for the next stage of research – prototype design.

It is important to note that the questions presented to the language teacher were almost identical, with slight modifications made for personalization (e.g “how do your students learn best?” instead of “how do you learn best?”).

## Interview Data

For these initial interviews, 3 participants – 1 professor and 2 language learners- were engaged separately through Zoom for approximately 20minutes each. The results of this are displayed below.

| Findings | Quotes | Analysis | Prototype guidance |
|---|---|---|---|
| Difficulty of the Language | **"**Not at all. It's a very hard language to learn." (Language Learner 1)<br>"I can probably pick up on 30% of the language when I hear it in everyday context, and a bit more when it's structured more to a learning context" (Language Learner 2) | Both French learners identified that despite their experiences learning the language, they hardly felt "confident" in the language. This may speak to the complexity of the language itself, the complexity of learning a language in general or even a lack of self confidence in the learning methodologies they follow to adequately teach them the language. Language Teacher 1 however, expressed a high degree of confidence – this may be attributed to their 35+ years of experience teaching the language. | - Ensure Prototype can encompass students of all language levels.<br>- Must have language support and guidance opportunities integrated into evaluations. |
| Motivations for learning/teaching French | "I've always been interested in language learning. And I've always wanted to have that skill in my little repertoire." (Language Learner 2)<br>"I liked it and just kept going… it's just the one that I turned out to be better at than other things" (Language Teacher 1) | The motivations of the participants varied greatly, demonstrating that many learners/teachers may have different goals and reasons for learning. | - Consider all use case scenarios by keeping prototype open ended |
| Resources/ Learning Environment | "So I mainly do it [language learning using the app Duolingo] at home, because I'd like to write down the phrases and things because it's just easier for me when I do that to learn. So, if it's a particularly hard exercise, I | The learning environments and resources used were quite varied across those Interviewed. From classroom learning to using apps like Duolingo in the home environment and even blended learning environments (consuming French social media and media as a learning tool). | - The prototype should be mobile: able to be used in various locations and contexts. |

| | | | |
|---|---|---|---|
| | write it down. So then I can practice, you know, later" (Language Learner 1)<br><br>"So social media, and kind of streaming services like YouTube and Netflix, just things where I can absorb more of the language and the culture." (Language Learner 2)<br>"When I was using apps like Duolingo, having the reminders every day and having, like scrolling on social media and seeing something I know just something to have your brain kind of restructured and re focus back to it was helpful for me. So yeah, definitely learning all the time, rather than just in your in my kind of scheduled timetable" (Language Learner 2)<br>"Not everyone has super confidence. So you've got to have resources that allow students to hear the language to see the language. But it's about engagement. So it's about getting kids excited about, about learning and making them feel | Interestingly, Language Learner 2noted that the use of digital tools allowed them to be constantly reminded or immersed in the language was beneficial part of the learning environment they created outside of the classroom.<br>Language Teacher 1 also identified the concept of multimedia "resources" to supplement classroom environments for engagement purposes. | - Create an engaging interface and concept: so users are "excited" to use the prototype<br><br>- Available to be used in everyday scenarios/contexts |

| | | | |
|---|---|---|---|
| | comfortable that they can do it" (Language Learner 2) | | |
| Language Pedagogies | "I think the way I've found most success in it is using it, using it and trying to learn it in a conversational way. Picking it up from native French speakers. Rather than just trying to study it on my own. Or at least having a lot of support or being in an environment. There's a lot of feedback on whether I'm doing it or letting it says successfully." (Language Learner 2)<br>"Underpinning it all is the communicative approach….But obviously, when you're teaching in a school, you've got to teach all four skills [writing, reading, listening, speaking]" (Language Teacher 1) | Conversational style and communicative approaches to learning were identified as the most beneficial language pedagogies mentioned by Language Learner 2 and Language Teacher 1. Thus indicating support for approaches that rely heavily on the environment and interaction with other French speakers.<br>Language Teacher 1 also noted that the main 4 language learning shills are imperative . | - Develop communicative style Prototype that can facilitate or encourage conversational interactions<br>- Ensure the prototype or activities using the prototype can build upon the 4 main language learning skills mentioned. |
| Tools | **"**I think like apps are really useful things on your phone, are very useful. Rather than sort of having like a CD or having a textbook, I think having something on your phone that you're using that device every single day anyway, is very useful. And I think that apps are a lot more modernised and catered to, | Online resources were mentioned by all participants. Language Learner 1 mentioned that they often used their computer to access resources like Google whereas Language Teacher 1 mentioned that they often used tools like virtual tours, design sites etc. | - Prototype medium can be technology agnostic. Therefore the scope of this project (using an AR medium) fits well within the |

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| | like the modern day person, rather than like having CD tapes might not be as like, user friendly or like, relevant anymore" (Language Learner 2) | Language Learner 2 also mentioned the use of learning applications and media as other main tools to help supplement learning.<br>This broad spectrum of learning resources and tools is a testament to the how digitally agnostic language learning resources can be. More specifically, it comes down to personal preference and the digital literacy of the tool users. | stakeholders comfortability. |
| Language Sociality | **"**I think social interaction in a learning context is crucial, if not like the most important thing, because I think language is, is social like that's like the point of language. So being able to speak it socially, going back and forth, listening as well as speaking is so important" (Language Learner 2)<br>"I think is hugely important role between the, you know, the relationship between teacher and students, but also between students themselves and being able to feel comfortable to interact?" (Language Teacher 1) | All participants noted the major importance social interaction as well as in context interactions.<br>Language Teacher 1 noted that their students benefitted most greatly by visiting France – and being surrounded by culture.<br>For learners that aren't able to be in culture, it is seemly important to facilitate simulated environments and interactions for authenticity. | - Create a social environment where users can converse and interact with each other and/or a French professional/teacher |
| Challenges/Improvements to current Learning Environment | **"**it's sort of really hard to know if what I'm learning is correct if what I'm practising is correct. So outside of class times, I don't have anyone to run that by so I | Language Learner 1 mentioned the upkeep of the language was very difficult, the fact that with vocabulary exercises, if they are not consistent daily they loose progress. This is difficult as the motivation and availability for learners to be active daily is an unachievable expectation. | - Ensure prototype encourages motivation and continuity |

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| | think that's a big challenge for me" (Language Learner 2)<br>"So I've always taught within topic areas, and so try to contextualise the language with phrases that you use, so vocabulary, grammar, etc, that's going to be useful;" (Language Teacher 1) | Contextualization and the availability of social interactions and feedback is a major challenge identified by both Language Learner 2 and Language Teacher 1. The importance of this has been noted by many researchers, however becomes difficult in EFL(English as a Foreign Language) scenarios. | - Ensuring the prototype is contextualized or able to be used within multiple contexts |
| Co-design recommendations | "People spend a lot of money and it sits in a cupboard most of the time because people don't find ways to integrate it into their teaching." (Language Teacher 1)<br>""I think that having someone who has a very strong grasp of the native language, and like the local language and how it's spoken is important." (Language Learner 2)<br>"I could back up with what I've learned on Duolingo, with a class like a, you know, with other people.. even if you could create virtual classrooms, that could be cool." (Language Learner 2) | Language Teacher 1 noted that any preposed tool would have to be useful and easy to integrate with current language environments. This was verified by Language Learner 1 who believed that they would benefit more from supplementary (rather than replacement tool). This is interesting for the future development and understanding of this research as it identifies the potential scope – an addition to language learning rather than a replacement.<br>Language Learner 2 also noted that they would design a tool/methodology that would have an expert opinion and feedback focus. | - Prototype must be supplementary to current learning environments<br>- Feedback must be integrated + received by users. |

*In Summary:*

- Traditional classroom learning does not incorporate a contextualized or mobile environments.
- Existing apps aren't collaborative, or social
- Engagement and feedback is important for longevity of knowledge

# Chapter 5 – Prototype Design – process, methods, results

## Goals

The second part of this research through design process involved guidance from initial research and interviews informing the development and design of an AR prototype. Thus, allowing for a grounded, stakeholder involved design to be created- capable of producing the type of insights most beneficial for thesis objective and research question alignment.

## Proposed Design

### *Design*

As such, an AR application was developed allowing users to annotate the world around them by adding sticky notes with French words or phrases on them and virtually "placing" them on objects within their environment, with scope to move them as they saw fit (Figure 3). This application had a multiuser feature allowing other users in the same vicinity to have a shared world and view the sticky notes of others. Thus, allowing participants to share learnings by writing on and placing their sticky notes on objects around the room.


*Figure 3- Prototype In Action*

### *Technology*

This AR application was built using UIKit and SwiftUI for the interface, RealityKit and ARKit for the augmented reality based world tracking, object anchoring and placement and most importantly, Multipeer Connect (IOS) for connecting and syncing multiple users to create a shared world. The foundations of this application was grounded in the Swift language and was specifically developed for IOS Mobile phones and/or tablets. This technology stack and medium allowed for the creation of a protype aimed at meeting the aforementioned design goals.

### *Underpinning social and mobile theories*

Some social and mobile catered design techniques were also included in the AR development design. Social patterns such as social comparisons guided the design of shareability – enabling participants to also view the notes of others. The functionality and feature implementation was heavily guided by the physical space and social interaction framework (Hornecker & Buur, 2006). The considerations of this framework - tangible manipulation, spatial interaction, embodied facilitation, expressive representation- encompassed the design methodology suitably due to its social and immersive relevancy. The designing for location dependence

framework also heavily influenced the design process. This framework supported the creation of designs that are playful, interactive, “experience” creating, location-aware and location-specific. – all directly linked to recommended design conclusions found in the prior research of this project.(Viller, et al.) These design frameworks and patterns were all followed as their guidance comes from condensation of many previous research findings. Thus designs following these guidance’s came with a level of assurance given their effectiveness for similar designs.

### *Justification of Design*

This prototype design was grounded both in previous research findings and recommendations as well as relevant design principles. The lack of pre-defined learning content within the application allowed for the potential for multiple scenarios and pedagogies to fit. Thus, the application was more flexible and able to support teachers and various learning environments alike (Hulme & Viberg , 2018). The content was specifically chosen to be generated by the users (with scope for teach contributions as well) to allow for participant lead learning directions, engagement and accountability (Scarino et al., 2016). This design was specifically simple and interactive, suitable to all literacy types (Heuristic design principles) whilst still facilitating collaboration, movement and location dependence. Finally, this solution was designed to be open ended and language agnostic as to generate a solution with potential to answer the broader research questions.

## Prototype Evaluation

Although the prototype was designed with many underpinning pedagogical design considerations, as noted in prior research, the way in which the affordance of the prototype is used is a major determinant on its evaluated effectiveness and acceptance, and therefore ability to entice new or supporting evidences (Nami, 2020). As such, designing methods and/or learning objectives at this stage were considered both as a presentation of complementary research grounded pedagogy as well as a method that enabled prototype evaluation. It was also determined that findings also needed to be supplemented with experience, usability and functionality assurances of the AR technology proposed.

### *Methodology Adopted*

#### Methodology guidance:

Before creating an evaluation methodology, it was important to investigate potential research guidance as well as defining the type of received information desired. In alignment with the overarching thesis methodology, this evaluation was aimed to be open ended, allowing for observations, qualitative data and stakeholder feedback.

Guidance for evaluation methodologies from the previously found research and findings identified the need for a methodology that included:

- Gamified and/or task based approaches (Ghazal & Singh, 2016)
- Location based activities gathering data collection and measurable outcomes (Parmaxi et all., 2017)



- The collaboration, mobility and sociality of language learning (Filali et al., 2017)

- Shared learning where participants can ask questions interact with each other (Mehmet, 2016)

## Expert Feedback

Keeping these methodologies in mind, as part of the co-design process, Language Teacher 1 was shown the protype not only for suitability feedback but also to give insight into pedagogies, scenarios and activities that believed could be used most effectively in conjunction with this prototype. Language Teacher 1 identified this as following:

These insights guided the understanding of suitable language pedagogies for the proposed AR application and aided in the development of the evaluation method to investigate this.

"I could imagine this resource being used in a number of ways:

- Year 7 students typically study a topic including household objects. This resource could allow students to personalise learning by practising (writing and perhaps also saying) vocabulary in their own home context. This would also apply to vocabulary for other topics eg sports
- A teacher could also create visual vocabulary lists in different topics for their students or learners could create their own and share
- learners could write short phrases to describe their house (or other) eg this is my desk. There is a white lamp on it. My chair is … etc (again this could be recorded)
- This could also be used as an assessment tool ie students name / describe a context and then send it to their teacher." (Language Teacher 1)

## Chosen methodology

Following this guidance, two task based activities were defined allowing participants to identity items around them in French, and collaborate with other leaners to determine correct language practices. This was followed with an open discussion loosely guided by probing questions. These activities were designed to place participants in the same environment and location, giving them the availability to interact together or focus individually. This methodology was designed to be held within an isolated familiarised environment (e.g living room, office etc).

To design the AR prototype specific activities, existing learning activities (pedagogy grounded) were investigated and adapted to suit the outlined methodology needs (Cambridge, 2009).

The 2 designed activities were outlined as follows:

Activity 1:

- Participants were asked to place 5 different sticky notes containing the associated French words of objects (an iPad was available for participants to access if they did not know the English to French translations) on the table in a random, central location for sorting.

- Once everyone had placed their sticky notes, each individual was tasked with taking unsorted sticky notes and placing them on the individual objects they believed each one represented.
- This was followed by a discussion and justification of sticky note placement. For each sticky note, the initial creator informed the "correctness" of placements made by the other participants.

Activity 2:

- To consolidate and build on the language learnings in the initial activity, Activity 2 was designed as a "flipped spelling bee"
- For this activity, the researcher presented a French word for which the participants were tasked with writing the correct spelling on a sticky note.
- Once completed, participants were each asked to read their words and chosen spellings aloud, receiving feedback from other participants and accuracy confirmation from the researcher.
- This fostered a subsequent prompt for users to discuss the associated english word and relevance.

In particular, these activities were designed to cover the foundational language learning modalities: Reading (looking at eachothers sticky notes), writing (creating the sticky notes), speaking (repeating the sticky note contents aloud) and listening (paying attention to the given spelling words) (Litzler & Bakieva, 2017).

The application of previous recommendations and research were integrated, through the incorporation of these guidelines:

- Sharing of knowledge: Sticky notes were added to objects within the space as a sharing of information, and participant-to-participant feedback.
- Collaborative and communicative : Participants collaborated on creating a combined annotated world, fostering discussions with others.
- Investigative gamification: Participants aimed at improving language skills and contextual understanding by interacting with visual items and auditory cues.

Most importantly, before conducting the evaluation process, the participants were informed of methodology aim: to evaluate the learning affordances associated with the introduction immersive environments using AR technology. This was to ensure feedback and recommendations centred around the thesis objectives rather than the technology specific features.

## *Interviews*

Following this prototype design creation, an evaluation was undergone to produce further research findings building upon and challenging the learnings from research and initial interviews. This followed a semi-structured approach to the initial interviews. However, the questions were left open ended and were more dependent on the evaluation observations of the researcher and encouraging conversation flow. In particular, this method provided supplemental insights into the evaluation observations, confirming the thoughts and opinions of the participants throughout.

This method was chosen due to its flexibility at identifying information found, particularly creating a more casual environment, allowing for more honest and natural interview findings.

The contribution of these methodologies for supplementing and evaluating the proposed AR aligned best with the desired contribution of the thesis: creating insights into a new kind of pedagogical supported immersive and collaborative AR language learning experience.

Moreover, in comparison to other possible evaluation techniques such as SUS and TAM, this combined method allowed for qualitative, experience-specific evaluations.

# Evaluation Results

## *Process*

For these prototype evaluations, 3 French language learners were engaged all together in an authentic living room environment located by the research team. Participants each had a phone with the application loaded in, and were guided by various household objects placed on a table before them. The activities were outlined, guided by the researcher, using the available environments. This activity process took approximately 25 minutes with a 15 minute follow up interview.

## *Results*

The results of this process are displayed below.

| Concept | Findings | Quotes |
|---|---|---|
| Potential Learning Environment and Context | Alongside co-design activity feedback, Language Teacher 1 also discussed their analysis of the prototype medium and the benefits/ short comings of the language environment it facilitates. The simplicity was identified as useful for language learners of all types and the medium is beneficial for many learning contexts. Despite this, Language Teacher 1 noted the limitations of this prototype and language approach as it mainly | **"**I really like this app – very simple but would I think be really useful to language learners both in schools and adult learners. In revitalisation contexts especially learners are keen to label and learn household objects." (Language Teacher 1)<br>**"**This resource focuses on writing and reading (rather than speaking and listening) but these are skills that are important in school language programs but not necessarily a goal for adult learners, particularly in a revitalisation context. Having said that I could think of ways that a teacher or learner might include speaking at least." (Language Teacher 1) |
| Collaboration | Collaboration was a key theme identified by the participants. Creating a shared knowledge between the participants allowed them to both learn from their peers and build each others learnings. In the domain of "sociality" within language learning spaces, this was the main insight commented on. It was observed that there was a light comradery between the participants, and they were able to laugh with each other when they were wrong and seemed to enjoy racing each other to say the right answers. | "labelling certain objects is cool and it prompts more discussion about what an object actually is, which I think is really good for remembering those kinds of things." (Language Learner 4)<br>"In the collaboration space, I think, seeing other people's work makes that so much easier….. you don't really have a lot of ways to have peer review" (Language Learner 2)<br>"My experiences have been very much just me at home doing work around the house repeating stuff to myself and crazy person. But this approach is collaborative. It actually surprisingly like the way being able to bounce off each other and see how other people approach it really does also just kind of add a certain element to it that you just don't get when you're by yourself." (Language Learner 3) |
| Task based approach | The use of a task based pedagogy to supplement the AR immersive environment was well accepted by the participants. | "I do think that this type of approach is useful. I think that like, having task based learning, like I think helps stick things in the memory" (Language Learner 4) |

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| | Grounding the approach through the physical world rather than traditional approaches was a major stand out.<br>Language Learner 2 also noted the accountability associated with placing sticky notes – how it forced users to really think about the correctness of their results as it is viewed by their peers. | "My experience with language learning has always been very audio focus and a lot of the time kind of learning language can be very abstract to just hearing it….This approach means that it's more grounded and I can kind of see and directly correlate and make those connections in the physical world as opposed to just in my head" (Language Learner 3) |
| Comparison to current Learning environments/ pedagogies | The identified visual associations of objects, within contextualised and physical spaces was identified by Language Learner 3 as a major difference from their current/previous learning environments.<br>Similar to previously identified by Language Teacher 1, Language Learner 4 noted the opportunity for this approach to supplement rather than replace their current learning approach. Using this tool in conjunction to classroom style environments as an activity facilitation to create an alternative and affirmative language learning approach. Interestingly, participants who utilized other tools like language learning applications were more open-ended about the role they saw this approach taking. | **"**I use Duolingo. Right. So this is much more collaborative. And I think you've [Language Learner 2] actually made a really good point about it being kind of like, the physical, you can actually form associations with real world objects versus drawings of those objects. And sometimes they don't even present drawings of objects, they just like tell you, or say what to feel prompted to just write, for example." (Language Learner 4)<br>**"**I have experience in like classroom based French learning. And I think that it's a good accompaniment to a lesson where you're like learning the content. And then I feel like tape is always trying to think of activities or way to really cement that or other ways to experience the content. I think this could replace some of those activities or stand for an activity where you're in practice." (Language Learner 2) |
| Pain points/future advice | All of the participants noted their positivity acceptance of the prototype and the immersive environment centered around it and that reccomendations and improvements would only enhance the outcomes and benefits of such approach.<br>Instant and instructor feedback was a major pain point for participants, through addressing a need to ensure they were learning correctly throughout the process rather that at the end. | "I love the instant feedback. So I think like if you can somehow do object detection…then feed the detected object through, like translation algorithm. So when you actually do place a card on it, they can tell you whether or not what you did was correct" (Language Learner 4)<br>"Make it situational. So like everyday situations, like asking for a train ticket or asking something like that, where you really get put into a situation, it makes it more tangible to you" (Language Learner 3) |

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| | Both Language Learner 2 and 3 recommended an improvement to this methodology is to make it more situational and contextualized even further – something that could be paired with a lesson or more specific contexts/learning topics.<br>Further gamifying the experience was also brought up, with potential changes to the prototype separate to the learning environment.<br>Like Language Teacher 1, Language Learner 2 also noted that encompassing the main 4 language learning modalities would also be beneficial as they identified a lack of support for speaking and listening activities in the presented prototype alone. | "You use the app as a gun, and you shoot the target, the virtual object that someone actually audibly says, yeah, that'd be kind of fun." (Language Learner 4)<br>"I don't know if I would like change it. But maybe I think if we could expand upon it and hit aspects that aren't just writing, like maybe if you could incorporate some like audio activities and yeah, maybe just like to expand to hit upon like, in this activity, you're getting all the all the required, like near the writing and the speaking and listening, it'd be cool if it was all environment replacement." (Language Learner 2) |
| Language Pedagogies | Language Teacher 1 also Identified scenarios or ways in which they envisioned the immersive prototype could be used. | "I could imagine this resource being used in a number of ways:<br>- Year 7 students typically study a topic including household objects. This resource could allow students to personalise learning by practising (writing and perhaps also saying) vocabulary in their own home context. This would also apply to vocabulary for other topics eg sports<br>- A teacher could also create visual vocabulary lists in different topics for their students or learners could create their own and share<br>- This could also be used as an assessment tool ie students name / describe a context and then send it to their teacher. |

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| | | - Multi-user: Is this synchronous or asynchronous or both? I could imagine the students creating a little video for their pen pal in the target country describing their house/family etc.<br><br>- If synchronous, perhaps they could ask each other about eg house and the partner could reply." (Language Teacher 1) |

# Chapter 6 –Result Discussion and Critical Review

To evaluate the usefulness and contribution of this thesis, a discussion on the method findings enabled further analysis on research and designing insights within this chosen domain, affirming and/or challenging background literature and assumptions as well as identifying their relevance and alignment with the guiding thesis research questions.

## *Encompassing Language Pedagogies:*

When evaluating the prototype design alone Language Teacher 1, noted a limitation of the prototype as it only covered writing and reading modalities. This feedback was important given the large amount of research implicating that the combination of all four modalities are essential to develop comprehensive skills and understandings in language learners (Litzler & Bakieva, 2017).This finding highlighted the importance of language techniques that rely on all 4 modalities of language learning, supporting other literature in this domain.

From this evaluation alone, it could be perceived that the protype in isolation favors reading and writing affordances, however as outlined in Chapter 5, the contribution of methods integrated with this prototype had the opportunity to encompass more speaking and listening methodologies (similar to prototype evaluation Activity 2). This is exemplified by the lack of confirmation for this evidence from the participants evaluating the protype and learning methodology together. Thus, for this project, the prototype was best evaluated with supportive methodologies that had supplementary, effective pedagogical groundings. This presents the idea that comorbidity of the prototype and a supplementary methodology can best represent the design considerations of “immersive language learning” solutions and provide insight on how they might be evaluated together to receive the most effective results.

Interestingly, this can potentially provide insight to another discussed phenomenon of the importance of perceived technology affordances. In particular, this is identified by Language Teacher 1, who commented on the frequency of technology to not be used because it often did not fit into the classroom environment seamlessly and/or was not an additive contribution to the learning process. This supports a recommendation that future technologies aimed at creating immersive environments must be easily integrated into learning contexts and environments, and should present multiple opportunities for language teaching customization. This goes further than simply evaluating a technologies’ “ease of use” but rather the need for it to have a purpose that supplements and aids language learners and teachers themselves, enhancing their learning experience beyond current practices. A learning from this shows that the acceptance and usefulness of using AR (and potentially other technologies) to create immersive language learning may also be heavily reliant on the perception of its usefulness to language teachers and learners on whether it

can successfully supplement or enhance their current language pedagogies and learning environments.

## *Motivation and technology longevity:*

A key consideration for the successfulness of language learners identified in initial research was motivation (Litzler & Bakieva, 2017 ). This was also supported in the interviews, with Language Teacher 1 noting that the French language in particular needed dedication and regular upkeep as it is a hard language to learn. This observation provided insight into the need for motivation in language learners to pursue self-directed or "out of classroom experiences".

In particular, the success of new language learning facilitative technologies is known to cause excitement and entertainment value due to their novel like nature. However, the longevity of such motivating causes are often shortened through familiarisation (Van den Berghe et al., 2018). Interestingly the responses from the final protype analysis and subsequent interviews provided evaluations on applicability of this consideration within this project. As identified in the previous section, the technology usage in this approach acted as a medium for creating an a immersive environment (not just a stand-alone technology but a technology that facilitates a customisable pedagogies). The combination of this approach supported a minimisation of the "impact" potential associated novelty might have. As identified in the final interviews, majority of the feedback centred around technology improvements that would improve the learning experience rather than just to make the technology medium itself "cooler". Given the age demographics of the testers (within the 18-25) this may be attributed to a broader awareness and exposure to similar technologies.

## *Collaboration*

Initial research indicated a multitude of support for language pedagogies grounded in collaborative and social environments (Parmaxi et al., 2017). However, from the initial interviews, collaboration itself was barely mentioned or recommended as a design aspect, and thus it was assumed that the collaborative protype and method design would have mixed opinions. Given this, unexpected findings of the prototype evaluation process indicated participants desire and positive acceptance of collaboration through the immersive experiences. The initial assumption was that participants would focus more internally whilst conducting the tasks individually, however instead participants helped each other to create shared knowledge. This indicated that the creation of immersive environments through technology may have scope and potential to create positive collaborative experiences.

## *Positive acceptance*

The comradery and ease of interaction between participants in the final evaluation showed the positivity of such approach. The ability for users to "laugh" throughout the process is a testament to the safe space such approach creates, thus positively supporting users' acceptance and excitement when following this method. The participants "racing each other" to complete tasks – although not originally expected or directed, provides an insight into the

mindset of language learners and creative potential of this technology-enhanced pedagogy. This, combined with collaboration and sharing of knowledge, supports collaborative motivations as participants not only learnt from each other, but were able to push each other further, bringing drive and excitement to the approach. This unexpected insight only came to fruition by bringing participants together for observation.

## *Gamification/Tasked based approach*

From the literature review, approaches to language learning benefited from gamification. Although a more task-based approach with undertaken with the methodology and evaluation design, the initial protype was designed to be explorative and open-ended to be able to facilitate gamification concepts such as "playfulness" (Ghazal & Singh, 2016). As seen by the adaptability of the participants, how the tasked based approach was utilised was also dependent on the protype flexibility to create gamified interactions. The flexibility of this can hopefully provide insight into the scope of possibilities for interaction that immersive language environments using AR can bring.

Following this approach, the accountability of placing the sticky notes for all to see – promoted more "active" learning – where participants felt more accountable and therefore more assured of their learnings for each sticky note that was put down. The benefit of this can be seen as not only a physical reminder of the learnings and knowledge of each student, but also as assurance of the level of confidence a student may have on each note. This method of creating an immersive environment indicates a suitability for displaying the development and confidence of students to language teachers.

## *Comparison to current approaches*

Solutions and pedagogies in this domain cover a multitude of different contexts (level of autonomy, language completeness, in- classroom, out-of-classroom etc) (Li & Wong, 2021). Not defined in the scope, was the role and context immersive language experiences had within the language learning domain. This was due to the initial, limited understanding of the potential affordances and suitability. The flexibility of the application and the immersive approach it presents was mostly considered as a supplementary resource and approach to language learning for those in traditional classroom environments, given participant insights. Although, there is also support from research and interview findings for learners outside of classroom environments given their ability to use various resources concurrently and their acceptance and adaptability in relation to new language learning processes. It is understandable to assume that such a technology based immersive pedagogy would not completely be able to replace such a solidified, longstanding system (at least not in its currently scoped form). Thus, the initial support of this research identified the role and scope this methodology can have within the current state of language learning environments.

## *Instant feedback*

Although literature-based research and initial interviews all noted the importance of expert feedback, participant reviews on the final immersive design noted that it failed to provide such feedback. This was puzzling as in the prototype and methodology evaluation, participants were able to access resources for the first task and were given the correct answers in the second task. For this, an assumption could be made that participants preferred feedback that would be instantaneous. This speaks to the nature that the prototype - or the scenarios in which the prototype was used - did not adequately address this need. This also highlighted the importance of this concept within this domain and how potentially useful rapid feedback may be for designing immersive language learning experiences.

# Critical Review

The limitations and affordances of the methods used, prototype implementation and findings themselves were addressed in the critical review as follows.

## *Method Analysis*

Overall, the co-design approach helped inform design rationales throughout the process and fostered stronger partnerships and stakeholders for in-depth discoveries. The research through design the interaction design life cycle combined methodology can be well considered well suited for the project in producing the desired type of outcomes and learnings (aligning with research questions and thesis goals).

Both interviews gained novel information, presenting the individuality of stakeholder insights rather stakeholder considerations as summarised generalisations. The semi structured interviews allowed for open-ended driven unexpected research insights and non-researcher influenced findings, whilst providing enough guidance to ensure the direction and goals for insights meet the research questions. The final interview in particular allowed participants to "bounce off" each other, confirming or rejecting statements made by other participants.

The evaluated prototype methodology, although beneficial to foster discussions in the interviews, had some individual limitations. Only two language tasks were given, limiting the result of such findings to be contextualised to the pedagogical implications of those tasks, rather than a varied amount of other incorporated activities or language pedagogies. This methodology also did not allow for predominately teacher-scaffolded activities and assumed the technical literacy of participants as well as their access to mobile phones.

## *Limitations*

In conjunction to method design and implementations, other limitations of this project were identified. This included:

- The small amount of participants engaged

- The undetermined applicability to more complex language learning environment and tailoring

- The prototype lo-fidelity and resultant small scope potentially impacted changes and recommendations made by the research

- The long term results or findings were not evaluated.

Following the analysis of research findings and critical review, the outcomes, learnings and contribution of the thesis and future recommendations are presented.

# Outcomes/Learnings

This project was guided by the broader and more specific research questions of: “What we can learn about language learners and also open ended AR applications for language learning?” and “How can we design an socially immersive technology that facilitates French learning in Australia?.”

This project has produced greater understanding of the immersive language learning domain through insights focused around these questions. From this, a number of significant outcomes were produced, as the thesis:

- Built upon existing literature on language pedagogies in combination with emerging technologies

- Utilized and evaluated social and mobile methodologies within an immersive language learning context

- Considered and therefore spotlighted the needs and goals of language learners and teachers in learning pedagogy design

- Hypothesized a novel approach to language learning using immersive technology and methodology

The created prototype demonstrated that there are promising ways of supporting collaborative ways of language learning given that they are: immersive, social, environment based, open-ended, gamified and allowing for user generated content and peer learning.

# Contribution

This project provides a good introduction to working within this space, providing initial support for this new immersive language learning approach whilst still addressing potential limitations and present gaps.

As identified initially, the contribution of this project is an investigation into the suitability of immersive, collaborative language learning environments. The main contribution has been to demonstrate initial support, engagement and feedback for this proposed methodology, as well as creating scope for further research to help address the gaps present in current literature. Additionally, the specificity of the domain and scope contributes targeted research– with potential application for simar approaches to be adapted for other languages and contexts.

This project also presented a novel prototype designed in collaboration with language teachers and learners to facilitate this learning approach also with scope for further enhancement, in line with recommendations.

# Recommendations and Future Work

As identified through the analysis of interviews and prototype results, as well as direct recommendations from participants themselves, there are a number of recommendations that can be made.

Recommendations for future work within the immersive language learning space from this project include:

- Supporting the use of AR to create real world annotations in language learning context
- Investigating the usefulness gamified, task based activities incorporating instant feedback.
- Facilitating collaborative, social and mobile processes in language immersion
- Further contextualization's and personability of learning environments and content to understand the role of this research
- Broadening the scope to include more language learners than just FFL learners in Australia

In conjunction with this, more research supporting the research outcomes and learnings identified above would also be beneficial.

Alongside these findings, this project also produced a prototype application that evaluates and facilitates such learning objectives. Future work may benefit from modifying and enhancing this prototype for further insights into this domain.

# Chapter 7 - Conclusions

This project investigated a new environment and process for language learning on FFL learners in Australia, thus identifying a new approach to language pedagogies that include immersive, collaborative and gamified AR experiences. This was investigated to cover research gaps and learnings presented in the literature review, and was evaluated as a co-design process with key stakeholders (language learners and teachers). Although research and stakeholder feedback was addressed through the prototype design, the subsequent evaluation also provided insight into potential recommendations and future work. This project has also presented a novel prototype designed in collaboration with language teachers and learners to facilitate this learning approach with scope for further development.

# Bibliography


Alce, G., Wallergård, M., & Hermodsson, K. (2015). Wozard: A wizard of oz method for wearable augmented reality interaction—a pilot study. Advances in Human-Computer Interaction, 2015, e271231. https://doi.org/10.1155/2015/271231

Billinghurst, M., & Duenser, A. (2012). Augmented reality in the classroom. Computer, 45(7), 56–63. https://doi.org/10.1109/MC.2012.111

Bug, T. S. (2020, July 25). How duolingo made education exciting. https://thesuccessbug.com/how-duolingo-made-education-exciting/

Cambridge English. (2009). TKT Module 1: Types of activities and tasks for language and skills development – Teacher's Notes. Cambridge English. https://www.cambridgeenglish.org/images/168888-tkt-module-1-types-of-activities-and-tasks-for-language-and-skills-development.pdf

Clark, B., Wagner, J., Lindemalm, K., & Bendt, O. (2011). Språkskap: Supporting second language learning "in the wild." https://doi.org/10.13140/RG.2.1.3564.8489

Collins, N., Vaughan, B., Cullen, C., & Gardner, K. (2019). Gaeltechvr: Measuring the impact of an immersive virtual environment to promote situated identity in irish language learning. Journal For Virtual Worlds Research, 12(3). https://doi.org/10.4101/jvwr.v12i3.7356

Viller, S., Macdonald, L., Matthews, B. (n.d.). Designing for location dependence—Experience overview. Retrieved November 11, 2022, from http://designforlocation.org/overview.html

Filali Marzouki, O., Khalidi Idrissi, M., & Bennani, S. (2017). Effects of social constructivist mobile learning environments on knowledge acquisition: A meta-analysis. International Journal of Interactive Mobile Technologies (IJIM), 11(1), 18. https://doi.org/10.3991/ijim.v11i1.5982

Geison, C. (2019, August 20). What in the ux is "wizard of oz testing"? Enterprise UX Research Agency, User Research and Usability. https://www.answerlab.com/insights/wizard-of-oz-testing

Ghazal, S., & Singh, S. (2016). Game-Based Language Learning: Activities for ESL Classes with Limited Access to Technology. ELT Voices - International Journal for Teachers of English, 6, 1–8. https://www.researchgate.net/publication/307885410_Game-Based_Language_Learning_Activities_for_ESL_Classes_with_Lim-_ited_Access_to_Technology

Guaqueta, C. A., & Castro-Garces, A. Y. (2018). The use of language learning apps as a didactic tool for efl vocabulary building. English Language Teaching, 11(2), 61–71. https://eric.ed.gov/?id=EJ1166513

Herrington, J., & Ozverir, I. (2011). Authentic activities in language learning: Bringing real world relevance to classroom activities. https://www.researchgate.net/publication/267828593_Authentic_activities_in_language_learning_Bringing_real_world_relevance_to_classroom_activities

Hornecker, E., & Buur, J. (2006). Getting a grip on tangible interaction: A framework on physical space and social interaction. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 437–446. https://doi.org/10.1145/1124772.1124838

Karacan, C. G., & Akoğlu, K. (2021). Educational augmented reality technology for language learning and teaching: A comprehensive review. Shanlax International Journal of Education, 9(2), 68–79. https://doi.org/10.34293/education.v9i2.3715

Kukulska-Hulme, A., & Viberg, O. (2018). Mobile collaborative language learning: State of the art: Mobile collaborative language learning. British Journal of Educational Technology, 49(2), 207–218. https://doi.org/10.1111/bjet.12580

Li, K. C., & Wong, B. T. M. (2021). A literature review of augmented reality, virtual reality, and mixed reality in language learning. International Journal of Mobile Learning and Organisation, 15(2), 164. https://doi.org/10.1504/IJMLO.2021.114516

Litzler, M. F., & Bakieva, M. (2017). Students' Out-of-Class Activities for Practicing English as a Foreign Language: A Log Study. International Journal of Scientific Study. https://www.researchgate.net/publication/321184692_Students'_Out-of-Class_Activities_for_Practicing_English_as_a_Foreign_Language_A_Log_Study

Mehmet, C. V. (2016). The importance of strategies of social language learning and cooperative learning in the process of teaching Turkish as a foreign language. Educational Research and Reviews, 11(10), 981–986. https://doi.org/10.5897/ERR2016.2630

Möller, M., & Sörbris, P. (2012). Implementing a Wizard of Oz Tool for Augmented Reality [Lund University]. https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=3242939&fileOId=3242940

Nami, F. (2020). Educational smartphone apps for language learning in higher education: Students' choices and perceptions. Australasian Journal of Educational Technology, 36(4), 82–95. https://doi.org/10.14742/ajet.5350

Osterweil, S., Shah, P., Allen, S., Groff, J., Kodidala, S. P., & Schoenfeld, I. (2016). Reports from cite "educational technologies evaluation in india." https://dspace.mit.edu/handle/1721.1/115340

Parmaxi, A., & Demetriou, A. A. (2020). Augmented reality in language learning: A state-of-the-art review of 2014–2019. Journal of Computer Assisted Learning, 36(6), 861–875. https://doi.org/10.1111/jcal.12486

Research through Design. (n.d.). Retrieved November 11, 2022, from https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design

Santos, M. E. C., Chen, A., Taketomi, T., Yamamoto, G., Miyazaki, J., & Kato, H. (2014). Augmented reality learning experiences: Survey of prototype design and evaluation. IEEE Transactions on Learning Technologies, 7(1), 38–56. https://doi.org/10.1109/TLT.2013.37

Scarino, A., Kohler, M., & Benedetti, A. (2016.). Investigating Pedagogies for Language-and-Culture Learning. University of South Australia. https://www.education.sa.gov.au/sites/default/files/languages_pedagogies_report_final.pdf?v=1466990807?acsf_files_redirect

The difference between structured, unstructured & semi-structured interviews. (n.d.). Oliver Parks Consulting LLC - Technology Sector Recruitment Experts. Retrieved November 11, 2022, from https://www.oliverparks.com/blog-news/the-difference-between-structured-unstructured-amp-semi-structured-interviews

van den Berghe, R., Verhagen, J., Oudgenoeg-Paz, O., van der Ven, S., & Leseman, P. (2019). Social robots for language learning: A review. Review of Educational Research, 89(2), 259–295. https://doi.org/10.3102/0034654318821286

Wen, Y. (2021). Augmented reality enhanced cognitive engagement: Designing classroom-based collaborative learning activities for young language learners. Educational Technology Research and Development, 69(2), 843–860. https://doi.org/10.1007/s11423-020-09893-z