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INSTITUTE OF GRADUATE STUDIES

Ph.D. THESIS

LEARNERS' REFLECTIONS ON EXPERIENCING AUGMENTED REALITY IN THE ENGLISH CLASSROOM AT TERTIARY LEVEL

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This thesis titled **"Learners' Reflections on Experiencing Augmented Reality in the English Classroom at Tertiary Level"**, prepared by **Ozan VARLI** under the supervision of **Assist. Prof. Dr. Özlem ETUŞ** , was accepted as a **Ph.D. Thesis** after being **consensus** approved by our jury as a result of the exam held on **24/06/2022**.

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DECLARATION

I hereby declare that this thesis is my own work, I have not had engaged in any unethical behavior at any of the stages from planning to the writing of the thesis, I have obtained all the information in this thesis within the limits of the academic and scientific ethical rules, I have cited all the information and comments being obtained in this thesis study, and I have included these references in the list of references. During the analysis and writing stages of this thesis, I accept that I have abided by the patent and copyright rights and therefore I myself take all kinds of legal responsibility.

Ozan VARLI

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To my father, in loving memory …

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LIST OF ABBREVIATIONS

Abbreviations	Description
2D	: two dimensional
3D	: three dimensional
3G	: third generation of wireless mobile telecommunications technology
4G	: fourth generation of wireless mobile telecommunications technology
AR	: augmented reality
CALL	: computer assisted language learning
CG	: control group, non-AR group
CMC	: computer mediated communication
EFL	: English as a Foreign Language
EG	: experimental group, AR group
GPS	: Global Positioning System
GUI	: graphical user interface, a form of user interface that allows users to interact with electronic devices through graphical icons and audio indicators
HCI	: human-computer interaction, researches the design and use of computer technology, focused on the interfaces between users and computers
HHD	: hand-held display, a mobile VST display device fits in a user's hand
HMD	: head-mounted display, a wearable VST display device worn on the head or as part of the visor of a helmet
HUD	: head-up or heads-up display, a display technology which does not require the user to change his viewpoint but look at a fixed point
MR	: mixed reality, merging of real and virtual worlds to produce new environments and visualizations, where physical and digital objects co-exist and interact in real time
OS	: operating system, computer system software that manages the hardware and software of a computer
OST	: optical see-through, a display technology which shows the real world directly through optical elements
SDK	: software development kit, a collection of software development tools in one installable package, which ease the creation of applications
UI	: user interface, the space where interactions between humans and computers occur

UX : user experience, a person's emotions and attitudes about using a particular product, system or service, including perceptions of system aspects such as utility, ease of use and efficiency

VR : virtual reality is a simulated experience that can be similar to or completely different from the real world

VST : video see-through, a display technology which shows the image of the real world as fed from a built-in camera on a device or head mounted display

XR : extended reality, all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables, i.e., augmented reality, virtual reality, and mixed reality

GENİŞLETİLMİŞ ÖZET

[DOKTORA TEZİ]

[YÜKSEKÖĞRENİM DÜZEYİNDE İNGİLİZCE SINIFINDA ARTIRILMIŞ GERÇEKLİK DENEYİMLERİNE YÖNELİK ÖĞRENCİ YANSITMALARI]

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[Bilişim teknolojilerindeki yeniliklerin hemen her alanda olduğu gibi dil öğretimi alanında da getirdiği katkıların bu alanda olumlu yönde bir değişime ve dönüşüme öncülük ettiği son yıllarda yapılan araştırmalarda sıklıkla vurgulanmaktadır. Bu yenilikler arasında adından sıkça söz ettiren Artırılmış Gerçeklik (AG), kullanıcılarının çeşitli araçlar ve uygulamalar vasıtasıyla fiziksel ve sanal dünyalardaki kavramları ve nesneleri bir araya getirebilmelerini mümkün kılmakta ve öğretmenlerin ve öğrencilerin geleneksel ders içeriklerini ve etkinliklerini daha farklı deneyimlemelerini sağlayan bir yenilik olarak karşımıza çıkmaktadır.

Bu çalışma, geniş bir çerçeveden bakıldığında, son yıllarda pek çok alanda gerçekleşen dijitalleşme süreçlerinin gerekli kıldığı eğitimde dönüşümden kaynaklanan sorunları ele almak için bir yükseköğretim düzeyinde zorunlu dil eğitim hazırlık programında geleneksel öğrenme materyallerine ek olarak AG'nin potansiyelini keşfetmeyi amaçlamaktadır. Ancak daha ayrıntılı bakıldığında, AG'nin söz konusu bağlamda öğrencilerin dil öğrenme deneyimini nasıl etkilediğini ve geleneksel tekniklerle birlikte kullanıldığında sınıftaki öğrenme kültürüne nasıl katkıda bulunduğunu ortaya çıkarmayı amaçlamaktadır. AG üzerine yapılan çalışmalar dikkate alındığında, daha fazla sayıda katılımcıyı içeren, daha uzun uygulama sürelerini kapsayan, daha gerçekçi öğrenme senaryolarındaki kullanıcı deneyimine dayalı, çoklu

modalitelere sahip güncel AG sistemlerinin kullanıldığı, karma yöntem araştırma modelleriyle desteklenmiş daha detaylı çalışmalara ihtiyaç olduğu görülmektedir. Bu nedenle, bu çalışma, AG'nin eğitimdeki, özellikle dil öğretimindeki, mevcut uygulamaları nasıl etkileyebileceği konusunda daha derin bir anlayış kazanabilmek için katılımcılarının deneyimlerine yönelik bilgi toplamayı amaçlamaktadır. Ayrıca, bir yükseköğretim kurumunun hazırlık dil programında yabancı dil olarak İngilizce sınıfında öğrencilerin alıcı (receptive) ve üretici (productive) becerilerin etkin kullanımına odaklanan, bir dönem süresince AG temelli bir öğretim modelinin uygulanma sürecinin ayrıntılı bir açıklamasını sunmaktadır.

Nitel ağırlıklı karma yöntem araştırma modelinin benimsendiği bu çalışmada, AG yeni bir öğrenme teknolojisi olarak sınıf içi öğrenmeye dahil edilmiştir ve yüksek öğrenim düzeyindeki İngilizce hazırlık sınıfı öğrencilerinin bunu nasıl deneyimlediği araştırılarak AG'nin bir öğrenme aracı olarak öğrencilerin yansıtımları çerçevesinde sınırlılıkları ve olasılıkları araştırılmıştır. Bu karma yöntem araştırmanın nicel boyutu, nitel alana yerleştirilerek katılımcıların teknolojik farkındalıkları ve yeni teknolojileri kullanmaları ile yeni teknolojilerle dil öğrenmeye yönelik tutumları istatistiksel olarak da araştırılmıştır. Bu nicel boyut, nitel bulguları destekleyici bir görüş sağlamakla birlikte, aynı zamanda araştırma katılımcılarının genel profilini daha nesnel bir şekilde tanımlamaya yardımcı olmuş, deney grubu (n=18) ile kontrol grubunun (n=18) performanslarını kıyaslama imkânı sunmuştur. Nitel boyut ise, araştırma sorularına daha kapsamlı bir düzeyde bütüncül bir yorum getirebilmek için, katılımcıların AG ile dil öğrenme deneyimini, yine onların bireysel yorumları ve gözlemlenen davranışları üzerinden betimlemeyi amaçlamaktadır.

AG grubundaki katılımcıların ilk elden deneyimlerini analiz etmek için, aynı zamanda dersin okutmanı olan araştırmacı tarafından, birbirinden farklı AG öğrenme görevleri geliştirilmiş ve bir dönem boyunca öğretilecek şekilde Orta Düzey Öncesi (Pre-Intermediate) Dinleme ve Konuşma ders müfredatına aktarılmıştır. 14 haftalık uygulama sürecinde katılımcılar, arka planda kurumsal öğrenme yönetim sistemi Moodle tarafından desteklenen Aurasma mobil AG uygulaması üzerinde geliştirilmiş öğrenme arayüzünü kullanarak bahsi geçen öğrenme görevlerine ve içeriğine erişerek AG ile öğrenmeyi deneyimlemişlerdir.

Veri toplama süreci, nitel düzeyde 14 haftalık katılımcı gözlemi, iki tur yarı yapılandırılmış mülakatlar ve öğrenme günlükleri, nicel düzeyde ise ön ve son testli anketler ve başarı testleri dahil olmak üzere farklı veri toplama araçlarını içermektedir. Uygulama süresinin sonunda

nitel veriler iki döngü in vivo ve desen (pattern) kodlamasından sonra NVivo üzerinde Tematik Analiz ile analiz edilirken, nicel veriler SPSS üzerinde parametrik olmayan testler ile analiz edilmiştir. Yani deney grubunda (n=18), anket ve başarı testinin ön ve son testlerinin sonuçları Wilcoxon Signed Rank Test (ilgili iki örneklem) ile analiz edilirken, deney ve kontrol grupları arasında (n=36), sonuçlar Mann-Whitney U Testi (iki bağımsız numune) ile her iki grubu istatistiksel olarak anlamlı bir fark açısından karşılaştırarak analiz edilmiştir.

Nitel bulgular, dört ana kategori etrafında düzenlenmiştir. İlk kategori, öğrenme deneyimi, öğrencilerin deneyimlerine doğrudan referanslarla bir eğitim aracı olarak AG'nin potansiyelinin açıklayıcı bir açıklamasını sunmayı amaçlarken, ikinci kategori, dil ile etkileşim, yani dil pedagojisi ile ilgili temel konuların yanı sıra öğrencilerin yabancı dil öğrenimindeki bireysel gelişimleri ile ilgili konulara açıklık getirmektedir. Üçüncü kategori olan teknik değerler ve yükümlülükler, AG ile öğrenmenin mevcut altyapı, dağıtım ve uygulama çerçevesindeki teknik süreçler, prosedürler ve zorluklar kadar katılımcıların beklentileri ve endişeleri ile ilgili bulguları sunmaktadır. Son olarak, dördüncü kategori olan öğretim değerleri ve yükümlülükleri, AG ile öğrenme ve öğretme ile ilgili öğretim konularına özgü bulguları paylaşmaktadır.

Dil ile etkileşim kategorisindeki nitel bulgular, AG tarafından en uygun ve desteklenen beceriler olarak dinleme ve konuşma becerilerini öne çıkarırken, yeterli odak ve dikkat verilmesi halinde okuma ve yazma becerilerinin de geliştirilebileceğini göstermektedir. Benzer şekilde nicel bulgular, deney grubundaki katılımcıların mobil cihazlarını kontrol grubuna göre yorum yazma, dinlerken not alma ve çevrimiçi ses/video klipleri dinleme/izleme için önemli ölçüde daha fazla kullandığını ortaya koymuştur. Katılımcılar arasında çalışmada kullanılan AG ile öğrenme modelinin dilbilgisi öğrenimine direkt bir katkısı olmadığı görüşü baskınken, belirli form ve ifadelerin modellenerek dolaylı yoldan edinimini sağlayan ve aynı zamanda dilin yapısı ile ilgili farkındalık artıran etkinliklerin bu bağlamda faydalı olabileceği öngörülmüştür. Sözcük bilgisi etkinlikleri en çok tercih edilen AG etkinlikleri olmalarının yanı sıra katılımcılar tarafından en etkili ve ilgi çekici görevler arasında derecelendirilmekte ve bu tür görevlerin dil ile yüksek düzeyde etkileşim sağladığı düşünülmektedir. AG'nin daha esnek olan yeni bir arayüz sağladığı ve öğretimin farklı aşamalarında yer alan teknik ve pedagojik zorluklara pratik çözümler sunduğu iddia edilebilir. Katılımcılar, doğal konuşma dilinin farklı seviyelerde nasıl kullanıldığına dair daha büyük bir farkındalık geliştirirken, dilin konuşulan özelliklerinin yazılı özelliklerinden nasıl farklı olduğunu anlayabilme fırsatı

bulmuşlardır. Bu tür bağlamlarda ve seviyelerde doğal konuşmayı keşfetmeleri, onlara iletişimin günlük hayatta nasıl gerçekleştiğine dair daha kapsamlı bir anlayış sağlamakla kalmamış kendi performansları üzerinde düşünmelerine de yardımcı olmuştur.

Nicel bulgular, deney grubu ve kontrol grubunun, yeni teknolojilerin kullanımına ilişkin farkındalık düzeyleri ve görüşleri ile ilgili benzer geçmişleri ve deneyimleri paylaştığını göstermektedir. Her iki grubun ön test puanları Mann-Whitney U Testi kullanılarak karşılaştırıldığında aralarında anlamlı bir fark bulunamamıştır. Bu durum, uygulamanın başlangıcında her iki grubun farkındalık ve kullanım düzeylerinin hemen hemen aynı olduğunu göstermektedir. Ancak her iki grubun son test puanları incelendiğinde üç maddenin istatistiksel olarak anlamlı olduğu görülmektedir. Bu anlamlı bulgulara göre öncelikle öğrencilerin sınıf içi deneyimleri, cihaz kullanma becerilerine ve farkındalık seviyelerine olumlu katkılar sağlamıştır. AG görevlerini yerine getirmek için sınıfta akıllı cihazların yoğun kullanımı nedeniyle, deney grubu katılımcıları donanım veya yazılımdan kaynaklanan zorluklarla başa çıkmak için farklı stratejiler geliştirebilmiştir. Benzer şekilde, AG ile öğrenme, katılımcıları aynı zamanda kontrol grubuna kıyasla daha özerk hale getirerek yeni teknolojileri kullanmalarını teşvik etmiştir. Son olarak, AG ile öğrenme deneyimine sahip katılımcıların, yeni teknoloji edinimi söz konusu olduğunda kendi kararlarını verebilme özgüvenini gösterebildikleri anlaşılmaktadır.

Her iki grubun son test puanlarının karşılaştırılmasında ortaya çıkan üç anlamlı maddenin yanı sıra, deney grubunda son test puanlarının da arttığı görülmektedir. Bireysel puanlardaki artış istatistiksel olarak önemli görünmese de, analizde bir madde anlamlı olarak işaretlenmiştir. Katılımcıların, uygulamanın başlangıcından sonuna kadar geliştirilen yeni teknolojileri kullanma konusundaki farkındalıkları ve bilgileri, AG ile öğrenme prosedürleri hakkında daha özerk ve bilinçli hissettikleri anlaşılmaktadır. Deney grubu, sınıfta mobil cihazlarını sadece sesli materyalleri dinlemek ve özgün videolar izlemek gibi alıcı (receptive) etkinlikler için değil, aynı zamanda tartışma forumlarında yazma ve dinlerken not alma gibi üretken (productive) etkinlikler için de kullanma alışkanlığı geliştirmişlerdir. Bu sonuçlar, AG ile öğrenmenin katılımcılar açısından dijital yetkinliğin öğrenim amaçlı kullanım becerisini artırdığı, katılımcılara hedef dilde daha fazla uygulama ve üretim yapma fırsatları tanıdığı ve onların sınıf içinde ve dışında fikirlerini ve görüşlerini ifade etmeleri için yeni bir dizi etkileşimli araç sağladığı bulgulanmıştır. Son olarak, deney grubunun son test puanlarındaki anlamlı değişimi tanımlayıcı ve destekleyici nitelikte bir başka bulgu ise katılımcıların

gelecekteki öğrenmelerinde yeni teknolojileri daha verimli ve daha özerk bir şekilde kullanabilecekleri yönündeki görüşlerini olumlu olarak önemli ölçüde değiştirmiş olmalarıdır.

Başarı testi sonuçları hem ön test hem de son test puanları parametrik olmayan Mann-Whitney U Testi ile analiz edildiğinde gruplar arasında istatistiksel olarak anlamlı bir fark olmadığı görülmüştür. Bu sonuç deney grubundaki öğrencilerin AG kullanmanın dil öğrenme deneyimlerini iyileştirdiğini düşünmelerine veya buna inanmalarına rağmen, kontrol grubuna kıyasla sınav performanslarının farklı olmadığını göstermektedir. Neticede öğrencilerin yeni teknolojiler, özellikle de AG hakkında olumlu görüşlere sahip olmasının tek başına sınavlarda daha yüksek puanlar sağlamaya yetmeyeceği ve bunun sonucunda öğrenmede direkt başarıya dönüşemeyeceği göz önünde bulundurulmalıdır.

Sonuç itibarıyla, bu çalışma öğrencilerin öğrenme deneyimlerine ilişkin yansıtmalarını temel alarak dil sınıfında AG'nin potansiyelini keşfetmeyi ve sergilemeyi, yenilikçi öğrenme araçları ve tekniklerinin tasarımı ve geliştirilmesi için gereken öngörüleri elde etmeyi ve alandaki mevcut araştırma çabalarına katkıda bulunmayı amaçlamıştır. Aynı zamanda, bu araştırma AG'nin öğrenciler tarafından nasıl algılandığı ve tanımlandığı, belirli dil öğrenme bağlamlarında nasıl deneyimlendiği, kullanımıyla ilgili bazı teknik ve eğitsel özelliklerin neler olduğu ve son olarak öğrencilere bir eğitim aracı olarak neler sunduğu hakkında ayrıntılı bir açıklama sağlamıştır. Bunu yaparken dil sınıfındaki geleneksel uygulamalara eleştirel bir bakış sağlayarak öğrenme içeriği sunmanın alternatif yollarını tanıtmış, katılım ve etkileşimi teşvik etme potansiyeli yüksek mobil tabanlı bir AG öğrenme arayüzü ile teknoloji entegrasyonunun sınırlarını genişletmiştir.]

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Anahtar kelimeler: [Artırılmış Gerçeklik, Yabancı Dil Öğrenimi, Öğretim Teknolojileri]

ABSTRACT

Ph.D. THESIS

LEARNERS' REFLECTIONS ON EXPERIENCING AUGMENTED REALITY IN THE ENGLISH CLASSROOM AT TERTIARY LEVEL

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The contributions of the recent innovations in the world of information technologies have driven an ongoing transition and transformation in the field of language education, as in any particular field, and this change has often been referred to as improving the quality of educational experience in the recent literature. Among these innovations, Augmented Reality (AR) particularly stands out as it enables its users to bring together the concepts and objects in the physical and virtual worlds through specific tools and applications, and allows teachers and learners experience the traditional course content and activities in an exceptional way. This study, in a wider sense, aims to explore the potential of AR as a supplement to the traditional instructional materials in a higher education language support program in order to address the issues arising from the educational transformation as a consequence of ongoing digitalization in many aspects of life. However, in a more detailed perspective, it aims to find out about how AR impacts the language learning experience of learners within the given context and contributes to the learning culture in the classroom when utilized along with traditional techniques.

By adopting a qualitatively driven mixed method research frame, this study incorporates AR as a novel learning technology into classroom learning and explores its potential by investigating how preparatory year English learners at tertiary level experience it. The quantitative strand of this mixed methods research is embedded into the qualitative strand and aims to provide insights to the qualitative findings by statistically investigating the participants' technological awareness and use of new technologies and their attitudes towards language learning with new technologies and tries to compare the performances of the experimental group and control group participants within and across in order to portray the general profile of the research participants in a more objective manner. The qualitative strand, on the other hand, intends to find out about the participants' language learning experiences with AR along with their opinions on new technologies, through their individual remarks and observed behavior, in order to bring about a holistic interpretation of the situation at a broader level.

To analyze the first-hand experiences of EFL learners in the AR group, various AR tasks have been developed and incorporated into a semester-long Pre-Intermediate Listening and Speaking course by the researcher who was also the instructor of the course. During the 14-week implementation period, the participants have experienced AR by accessing the AR learning content via the custom AR learning interface based on the mobile AR app, Aurasma, supported by the institutional learning management system, Moodle. The data collection procedures involved a variety of instruments including 14-week participant observation, two sets of semi-structured interviews, and weekly learning journals in the qualitative strand as well as pre and post questionnaires and achievement tests in the quantitative strand. At the end of the implementation period, the qualitative data was analyzed with Thematic Analysis on NVivo after two cycles of in vivo and pattern coding, while the quantitative data was analyzed with non-parametric tests on SPSS. That is, within the AR group (n=18), the results of the pre and post tests of the questionnaire and achievement test were analyzed with Wilcoxon Signed Rank Test (two related samples), whereas between the experimental group and control group (n=36), the results were analyzed with Mann-Whitney U Test (two independent samples) in order to compare both groups for any statistically significant difference.

The qualitative findings are presented in four main categories. While the first category, learning experience, presents a descriptive account of AR's potential as an educational tool

with direct references to the learners' experiences, the second category, engagement with language, highlights specific matters relevant to the linguistic progress of the individual learners as well as trending topics related with language pedagogy. The third category, technical assets and liabilities, introduces findings regarding the participants' expectations and concerns as well as technical processes, procedures, and challenges within the existing infrastructure, deployment, and implementation frame of the AR learning. Finally, the fourth category, instructional assets and liabilities, presents further themes that are peculiar to instructional matters with regards to learning and teaching via AR.

The quantitative findings suggest that the experimental group and control group share similar backgrounds and experiences regarding their awareness levels and opinions on the use of new technologies. When the pre-test scores of both groups are compared using Mann-Whitney U Test, no significant difference was found. This indicates that both groups were almost identical in their awareness and usage levels at the beginning of the implementation. However, when the post-test scores of both groups are analyzed, three items are found to be statistically significant. First of all, the in-class experience of the participants in the experimental group contributed positively to their device using skills and their awareness levels. Due to the intensive use of smart devices in class to perform the AR tasks, the participants seem to have developed the strategies to cope with challenges posed by hardware or software. Second, AR learning encouraged the participants' use of new technologies by making them more autonomous at the same time. Finally, the participants' AR learning experience must have contributed to their self-confidence and self-esteem in a positive way that they can make their own decisions when it comes to new technology ownership.

In addition to the three significant items from the comparison of the post-test scores of the two groups, within the experimental group, it can be seen that post-test scores have also increased. Although the increase in the individual scores do not stand out as statistically substantial, one item has been marked significant in the analysis. The participants' awareness and knowledge in using new technologies improved from the beginning of the implementation until the end. They developed the habit of using their mobile devices in class not only for receptive activities such as listening to audio materials and watching more authentic videos, but also for productive activities such as posting in discussion forums and taking notes. These results may suggest that AR learning made them gain new skills, expanded participants' opportunities for more practice and production in the target language,

and provided them with a new set of interactive tools to get involved and express their ideas and opinions in and outside class. Likewise, in the post test of "Attitudes Towards Language Learning with New Technologies", the participants significantly changed their opinion in favor of the new technologies and indicated that you could continue learning by themselves with the help of new technologies in the future.

There is statistically no significant difference between the groups when their achievement test scores, both pre-test and post-test scores, were analyzed with the non-parametric Mann-Whitney U Test. This might indicate that while the learners in the experimental group think or believe that using AR improved their language learning experience, their test performance did not differ. This may suggest that learners' holding positive opinions of new technologies, AR in particular, does not on its own ensure higher scores in tests and as a result translate into success in learning.

In conclusion, the study has explored and showcased the potential of Augmented Reality in the language classroom via learners' reflections on their learning experience, derived insights for the design and development of innovative learning tools and techniques, and contributed to the existing research efforts in the field. It has provided a detailed account of how AR is perceived and defined by learners, how it is experienced in specific language learning contexts, what some technical and instructional considerations are regarding its use, and finally what it offers as an educational tool to learners. In doing so, this study has also challenged conventional practices in the language classroom, introduced alternative ways of delivering learning content, fostered engagement and interaction, and expanded the boundaries of technology integration via a mobile-based Augmented Reality learning interface.]

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1. INTRODUCTION

Innovations in the field of information technologies have led to significant changes in most areas of everyday life. Thanks to smart solutions, we live in an interconnected world in which restrictions of the physical world are no longer of concern to many while accessing and delivering information. Gaining knowledge, skills, and expertise through interactions with computers, tablets, smart phones, and most recently wearable technologies is becoming increasingly integral in our daily routines. These technologies, in the same way, have altered the educational landscape and have long been debated to revolutionize the traditional learning environments by equipping teachers and learners with diverse tools and therefore contributing to the transformation of the traditional classroom learning.

However, one thing that is so critical about this process of transformation is that it becomes more and more complicated to explore these new technologies thoroughly and in-depth due to their rapid emergence and adoption rates. Let us consider the fact that there were no iPhones, iPads, or Android devices on this planet back in 2006, yet in less than ten years, they have become a reality in many aspects of our everyday lives, not to mention their popularity in educational settings. Recent practices in the educational research literature, accordingly, indicate diverse ways in which these digital technologies can be used to promote an individual's learning. Again, in recent years, there have been lots of international events, workshops, and conferences being organized not only to understand how these technologies work, but also to share the best practices to promote the deployment and use of these new technologies in and outside the classroom. So far, there has already been a fair amount of agreement among the tech-enthusiast educators to claim that these emerging technologies empower learners by helping them make use of available electronic resources and tools that suit best to their individual learning needs.

Standing out as an innovative concept among these new technologies, Augmented Reality, seems to have great potential in challenging the traditional ways of accessing/delivering information, assisting us while carrying out complex tasks, and ultimately improving the ways we perceive the physical world by augmenting it with virtual

annotations. In an effort to understand this phenomenon in the context of education, particularly in English teaching, this current study aims to (1) investigate the innovative educational practices enabled by Augmented Reality (hereafter AR), in tertiary level English language classes, (2) inform those who would like to further explore its potential in language teaching, (3) provide additional insights into the broader implementation of new technologies in language learning environments by taking the experiences and reflections of its users into consideration, and (4) while gaining deeper insight to learners' reflections as users of AR in language learning, utilizing the experiential dimension of research to gain a comparative perspective on its potential impact on language learning.

Thanks to the capabilities of today's mobile devices and the improvements in software development for mobile platforms, AR is slowly becoming more prevalent and a growing phenomenon in marketing, advertising, entertainment, and education. Although the definition of AR has been evolving as the variety and capability of smart devices increase, the most up-to-date definition could be viewing/interacting with audio/visual or somewhat tactile virtual information, which has already been overlaid on physical objects or space in real world by another party, through a device featuring the proper processing hardware and software, such as smart phones, tablets, goggles, glasses/contact lenses, heads-up displays (HUD) or head-mounted displays (HMD). The principal functionality of AR is, therefore, to augment or supplement an individual's existing understanding and perception of reality through interaction with virtual input as part of his actual physical experience.

The idea of bridging the gap between the real and virtual worlds in order to enhance and expand the user experience sounds promising, and indeed, it is not far from reality and no longer a privilege for the majority of middle-class consumers. That being said, there are several simple AR applications designed for the handheld devices that are either free or highly affordable; and accessing AR content through these devices is not a challenging task at all. By investing in mid-range consumer technologies for personal use, individuals also equip themselves with the required tools to experience AR without having to pay further. Therefore, the convenience and potential of AR to this end has also enabled leading technology firms in Silicon Valley to move towards this direction and started developing auxiliary hardware and software in addition to whatever is currently available on smartphones. They find AR exciting and profound as well as promising massive long-term growth in the future. According to IDC (International Data Corporation), worldwide revenues for augmented and virtual reality is

forecast to reach $162 billion in 2020 (https://www.idc.com/getdoc.jsp?containerId=prUS41676216., Accessed: 31 October 2017). This means that the trend for AR is likely to keep moving upwards in the upcoming years.

Looking at the investment figures above, one can easily see that AR has piqued great interest among the leading tech investors, yet how does it echo in the realms of education? Are educational administrators ready to invest in AR tools and content? Are teachers ready to bring this technology into the classroom, and are the learners willing to utilize it while learning? Appearing in the New Media Consortium's Horizon Report for Higher Education twice under the "Time-to-Adoption Horizon: Two to Three Years" (Johnson et al., 2011, 2012, 2016), AR is recognized as a "game-changer" and claimed to be contributing to the migration from desktop computers to mobile devices while accessing information and therefore creating more opportunities for learning. Among some of the promising aspects in terms of its relevance for teaching, learning, research, or creative inquiry are as the following:

- AR offers visual and highly interactive forms of learning by helping users overlay data onto the real world as easily as it simulates dynamic processes. Its ability to respond to user input makes it interactive and provides great potential for learning and assessment.
- Unlike traditional technologies that usually allow one-way delivery only, AR is active, allows users to construct new concepts through interactions with virtual objects, and therefore, aligns with more constructive approaches to learning.
- Certain processes and objects which are impossible to be brought into a learner's physical learning environment can easily be handled and worked with at various scales and in various forms, which eventually leads to better learning outcomes.
- AR aligns with the concept of situated learning as learners can make connections between their real-life experiences and education by transferring learning from one context to another through contextual layers enabled by this technology. Therefore, the acquisition of linguistic content and the realization of tasks are merged into everyday life tasks, and as a result, learners are surrounded by and exposed to rich content as it is available on demand, which also characterizes contextual learning.
- AR is mostly accessible through mobile devices, and therefore, it repurposes these devices not only for social interactions but also for learning. The ubiquity of this technology removes the boundaries of the physical world, introduces virtuality into reality, leading to just-in-time learning and exploration, which extends the learning

experience outside the traditional classroom, making learning more autonomous and self-driven.

The potential of most common AR applications depends on a set of features that already come with almost all of the off-the-shelf smart phones. The main function of these apps is, as mentioned above in the definition, to display audio and/or visual content about specific places or objects by retrieving from a remote server on the Internet. Therefore, they have great potential for on-site, situated, and multimodal learning and are being favorably implemented in places like libraries, museums, art galleries, and exhibitions nowadays. For instance, visitors are given handheld devices, such as iPads and tablets, with rear cameras, and once they hold the camera to those delicate objects behind the secure displays, they can seamlessly interact with the virtual versions of those objects. Visitors can also get extra information as pop-up virtual annotations, watch interactive videos that are overlaid on real sites and artefacts. With the integration of GPS and geo-tagging features, users can receive information about a historical building or landmark that has been formerly placed, and they can even travel in time by overlaying the related media content of what once used to be there at some point in the past.

Similarly, AR books are coming of age, too. The idea is again similar to the one mentioned above. When certain markers, or images on a page are scanned through a device, 3D characters pop up and start interacting with the reader. One of the first examples of such books is the MagicBook, a typical children's storybook featuring AR and developed by the Human Interface Technology Laboratory New Zealand (Billinghurst et al., 2001). Grasset et al. (2007, p. 2) presented the book as "an interface with a seamless integration of different modalities, while keeping the intrinsic value of the physical values of the book." Although it was a prototype, they pointed to its potential as an educational tool which put visual and audio elements together to support learners with different modalities and collaboration among them. There are similar examples of AR textbooks emerging in higher education contexts, such as medicine, chemistry, and biology to make complex processes clearer and easier to explain. All in all, it appears that, like hyperlinking in e-texts, AR has enabled seamless connectivity, referencing, and annotating of print materials in a more multimodal and interactive fashion, and has moved the existing text-reader relationship one step further by improving an existing interaction paradigm. Therefore, the notion of literacy is being redefined as learners have already started moving away from traditional readers and writers towards multiliterate

individuals (Selber, 2004; Jenkins et al., 2006; Borsheim et al., 2008; Cope and Kalantzis, 2013). AR supports this notion as it allows recognition of language as a multimodal and semiotic source, fosters engagement in real and virtual communication, and assigns multiple roles as reader, writer, and designer due to increased interactivity it provides.

As for instant support for languages, the leading AR applications focus on real-time translation of texts, mostly at word or phrase level. In 2010, Quest Visual introduced Word Lens, a text translation app using optical character recognition technology to instantly retrieve translations of words from its built-in dictionary. The company was acquired by Google, and later in 2014, Google integrated the same AR technology into its most popular, free translation app Google Translate. Users simply hold the cameras of their smart devices on a text that is in a language that they cannot speak, and the app overlays translated equivalents, in about 20 languages, on top of the selected text instantly. Such apps are used by travelers and are reported to be extremely helpful while understanding important street signs, food labels, or restaurant menus, especially in languages that use specific alphabets.

When it comes to language education, although there is no dedicated language learning application yet, there are several AR viewer applications, such as Aurasma, Layar, Daqri, Junaio, and Augment, which can be repurposed and used by language educators, in and outside the classroom, to provide access to authentic materials, increase the amount of linguistic input, and supplement the learning experience through multimodal interfaces. These apps use image recognition technology which allows the users to scan special markers and trigger images to view the AR content that has already been overlaid by a content creator.

On the one hand, the majority of these apps unfortunately lack customization in their interfaces and do not provide much flexibility for content creation and interaction. In other words, they have a fixed content library, and one has to choose among whatever is available in it. It is, then, very restricting and time-consuming to find content, and most of the time, one cannot locate the exact content he/she has been searching for in these built-in repositories. When found, however, the only possible action is to view, which is nothing but passive reception of the content as in listening and reading, and there is no ground for active participation and production as in writing and speaking, on the users' end.

On the other hand, a teacher with the essential skills and interest in educational technologies can still modify these apps to a certain extent, and upload 3D virtual objects,

audio/video/text annotations or guiding instructions/images from an outside resource to link to the markers. As soon as learners scan these fixed markers, they are able to interact with this special content that has already been uploaded by their teacher. Yet again, it is limited and lacking productivity. With the introduction of new AR frameworks recently, such as the ARKit by Apple (https://developer.apple.com/arkit., Accessed: 12 July 2019) or ARCore by Google (see https://developers.google.com/ar/., Accessed: 12 July 2019), nowadays software companies or individual developers are continuously being invited to develop newer apps for the actual needs of the market, including the education sector, which will hopefully find solutions to the problems and constraints mentioned above and help eliminate them.

After several pilot attempts with the aforementioned applications, Aurasma (HP Reveal) was chosen specifically as the only AR content viewer thanks to its free Developer Studio account for educators. This account gave the researcher the opportunity to create a content library for the course and start a private channel to publish the content for the learners through subscription. However, the main advantage of the application was indeed the feature that enabled certain gestures, i.e., tapping (single or double) on the AR content for further actions in order to start/pause the audio/video content or direct the user to a preset URL as a follow-up activity. The latter feature provided a lot of flexibility and transformed almost all the AR tasks into productive activities once the URLs were linked with specific tools on the learning management system and helped the researcher log student data which would be impossible otherwise.

To sum up, although AR has the potential to bring a great deal of excitement to the field of language teaching, it appears that current applications or devices still have some serious limitations mostly regarding their availability, adoption, design, interactivity, and use issues. However, this does not mean that current applications are completely useless and incompetent. As discussed above, educators can devise these apps to work with other auxiliary platforms so that they can customize their teaching practices, create unique learning opportunities that are interactive and better cater to the needs of their learners. Such efforts may also expand the capacities of these apps in registering and storing user input. The ambiguity of the current situation shows us that there needs to be new future trajectories for AR in language education so that it becomes a more effective and efficient resource/tool for language learners. This study, therefore, aims to implement AR learning as an integral component of a semester long EFL course at the tertiary level, and investigate and portray the

learning experiences of the learners who used their personal technologies to fulfill the assigned AR tasks. By referring to various data sources, it also seeks answers to the potential of AR as an educational tool both from technical and instructional perspectives. Moreover, the AR learning scheme as well as the AR learning interface developed and deployed in this study provide insights to the field by suggesting an implementation model and introducing new ways of incorporating AR by combining multiple skills that allow practicing the target language at receptive and productive levels. Therefore, it can be regarded as an example of the efforts to test AR's potential in a language classroom with respect to the experiences and reflections of English learners.

1.1. STATEMENT OF THE PROBLEM

One of the pressing needs of today's educational planning is to design and deliver the content. Traditional approaches are being challenged due to the increasing amount of free and technologically-rich educational content, tools, and services that are a lot more accessible than ever before. Standardized educational systems and processes lack the elements and features which are required to meet the needs of today's learners, and it seems that there are several internal and external factors that contribute to this condition. The print educational content, for instance, cannot catch up with the current pace of life and reflect constant updates. The role of learners has evolved from passive receipients of information to active producers of content on multimedia. The role of the teacher, likewise, has been reshaped and redefined by emerging conditions and developments. Although the idea of a physical environment called "school" is still valid and well-embraced, the schooling concept has been forced to adjust these changes in recent years, and incorporating new technologies as well as new media into education has become inevitable. To provide learners with uninterrupted instruction, educators as well as other stakeholders have witnessed a great exodus towards virtual realms.

Until the recent global pandemic, virtual learning tools and environments had still been considered somewhat optional, if not mandatory, for most educators. As soon as the number of infected people hit a peak and the severity of the Covid-19 required lockdowns and quarantines as a result, the circumstances started changing in favor of e-learning scenarios. Teachers and learners all around the world found themselves being forced into avoiding physcial contact yet keeping online and connected to carry on educational activities. All educational institutions where nationwide lockdowns were executed by laws had to switch

from face-to-face learning to distant learning in such a short time that in most cases there were no prior preparations, staff training or even digital infrastructure available. Teachers were looking for tools and resources to be able to digitize their content in order to deliver their courses in the most convenient way possible while learners were investing in new technologies to attend online classes so as not to be left behind. Those who had had some prior e-learning experience and access to an established digital infrastructure via their schools were considered lucky and could continue teaching and learning. Although some institutions supported their learners by distributing laptops or tablets they had in their inventories, many a learner had to suffer due to lack of networked devices or broadband internet connection at home. This unfortunately reflected negatively on their learning performance and test scores as there were serious interruptions.

The factors compelling the change in the educational landscape date back to the transition from the industrial age to the information age towards the end of the 20th century, which required hard labor to be replaced with knowledge work and soft skills. As a result, processing knowledge has become more paying than processing natural resources, and easy, quick, and constant access to information, therefore, plays a critical role in this process. Such a shift, as one may claim, has also forced education to become lifelong and more self-paced. Learners in the 21st century are expected to learn the skills to stay fresh, keep up-to-date, and continuously improve themselves to be fit in global economies. However, the goals and objectives of the national curricula do no longer reflect the best interest of learners. Therefore, this transition has to be represented in the existing educational practices, and the educational experience as of 21st century has to be readjusted respectively.

More and more people today live in global communities that are connected to each other through social, virtual networks. Interaction and information exchange, therefore, have become two major actions in most, if not all, aspects of life. Thinking about education out of this context is out of question. Although access to education may still seem to be a major issue in some parts of the globe, there has been an ever-increasing interest in improving the quality and relevance of educational experience in the developed world. Parallel to the advancements in technology and modern educational approaches, educators do their best to spread these efforts all around the globe by equipping learners with the precise skills to make them members of a global yet interconnected classroom. The more interactive and connected the educational experience is, the more successful the learners are likely to become.

Similar to the changes above, learning approaches have been evolving from individual and behavioristic to those that are more communicative, interactive, social, and contextual. Therefore, constructivist and dialogic approaches, encouraging learners to use higher-order thinking skills, are far more important and prevalent in the educational literature. Problem-based, task-based, or situated learning are among the most highlighted approaches. Problem-solving and critical thinking skills have become the core skills in the educational programs designed with those approaches in mind, while rote learning and memorization of factual information and procedures have no value anymore. Learners are expected to have the skills to find and use relevant information when needed by effectively using communication and information technologies.

Recent technological improvements in communication and information technologies have also changed the definition of literacy skills (The New London Group, 1996; Cope and Kalantzis, 2000). Surrounded by various emerging forms of media in their everyday lives, individuals are constantly challenged with the ability to digest the content they are exposed to on these new forms of media along with the urge to acquire the skill sets to produce content in these environments. According to Jenkins et al. (2006), the following media literacy skills are vital to participate in the modern day information society: play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgement, transmedia navigation, networking, negotiation, and visualization. Promoting these skills is highly important for today's educational institutions in order to prepare their learners for the jobs that do not exist yet. This is possible by redefining the pedagogies behind the design and delivery of learning content. At the present stage, new technologies offer educators new solutions to provide novel learning experiences.

As the traditional educational systems transform due to the factors mentioned above, the definition of learning a language in the 21st century has been evolving as well. The ideal language learning experience, for instance, involves the interplay of a series of conditions that are directly and/or indirectly related with the internal capacities and capabilities of an individual, as well as the external factors that are present in the environment. In order to support an individual's linguistic progress in terms of learning and/or acquiring a language, the following conditions are considered helpful:

- exposure to authentic and comprehensible language input to recognize and differentiate patterns at phonological, syntactic, semantic, and pragmatic levels,
- contextualized language to understand, make connections with, and build upon previous experiences,
- interaction with highly competent language users to practice, collaborate in, and perform real-life tasks for real-life situations,
- active participation and engagement in challenging and meaningful tasks to internalize the language and learn by doing,
- increased motivation and a positive attitude to invest internal and external resources into learning, overcome challenges and obstacles, and not fear risks,
- autonomy to be an active and independent learner, have a say in own learning experience, and take initiative in making critical decisions,
- continuous support and reinforcement for precise and accurate progress in linguistic production,
- critical content to activate higher-order thinking skills and trigger argument production for self-expression
- multimodal content to help long term retention and recalling of language patterns
- individualized learning experiences addressing the specific needs of individual learners
- reflective learning experiences by which learners can clarify and/or create meaning to change their perspective
- new/digital/multiple literacies by which learners can utilize various multimedia tools, resources, and spaces not only to access information but also to communicate
- opportunities to revise/recycle/extend learning through means that are not bound by time and place

Although several other items could be added to the list considering the specific needs of learners, it is certain that meeting these conditions is not a simple task and could be extremely challenging at times due to lack of finances, restrictions and limitations of physical locations, availability and accessibility of equipment, resources, and content, and last but not least, staffing. As far as the readines level of learners, their familiarity with diverse learning equipment and media, and their capacities and skills to use them for their learning are involved, the amount of challenge increases even more. Again, new technologies come to

rescue and offer solutions to help realize these aforementioned conditions by eliminating most of the concerns above.

Looking back at the historical evolution of Computer Assisted Language Learning (CALL hereafter), one could notice the dramatic increase in the incorporation of computers and smart devices into lesson plans with the intention that technology assists an individual's learning progress by providing access to rich, authentic, personalized, and situated linguistic and cultural content through multimedia interfaces on several alternative forms of new media, increasing opportunities for communication, interaction and collaboration among learners, encouraging and motivating while performing various tasks, and monitoring learning progress to give feedback to maximize the impact on language output. In their comprehensive overview of the field, Lomicka and Lord (2019) also point to the evolution of CALL in this respect and argue how certain technological developments drive the change in the practices of language teaching, learning, and research by suggesting the following periods:

- The emerging media period in the 1980s with the incorporation of multimedia, which was characterized by simulations, interactivity, and authenticity
- The mediating technology period in the 1990s with the expansion of computer-mediated communication (CMC), which investigated concepts like interaction, tasks, and authenticity in synchronous and asynchronous forms
- The participatory, social, and reflective period with the advances in Web 2.0 in the 2000s, which concentrated on active participation and collaboration of learners both individually and as members of learning communities
- The "Social Turn" (Otto, 2017, cited in Lomicka and Lord, 2019) period in the 2010s with the increasing appeal of technologies and concepts like mobile devices, online learning, social networks, and open resources

Considering the technological trends that define periods as mentioned above, it would not be too bold to claim that the 2020s will be defined by more immersive, shared, and persistent environments which arise between the blurring borders of reality and virtuality with the advances in extended realities (XR), such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) as well as the innovations in human-computer interaction (HCI), such as wearable technologies.

New technologies emerge, and as a result, the definitions, purposes, and meanings of the existing concepts and artefacts change. Sometimes, they are even forced to transform into new entities. Printing technology, for example, have revolutionized the way we approach education and enabled us, the humanity, to transfer our knowledge to the new generations through books in a much faster, more convenient, and cheaper way. Compared to handwritten works, print has democratized the delivery of information to a great extent and made it available to the masses, yet with the advent of the Internet and networked smart devices, the availability, accessiblity and spread of information has gained an even greater momentum, and almost replaced the good old print regarding the access to the most up-to-date information. Augmented Reality, at this point, opens up a new page by introducing a more immersive, engaging, and omnipresent delivery experience to its users by allowing them experience the outer world through added layers of virtuality. As a result of this revolutionary shift, the definition of learning is constantly being challenged as it is no longer the effort to acquire and posses knowledge to (or not to) use it; it is rather knowing how to search, access, and use specific knowledge when needed.

This study, in a wider sense, aims to explore the potential of Augmented Reality as a supplement to the traditional instructional materials in a higher education language support program in order to address the aforementioned issues arising from the educational transformation. However, in a more detailed frame, it aims to find out about how AR impacts the language learning experience of students within the given context, how students as learners relate to this experience by reflecting on its qualities, attributes, affordances, and constraints, and finally, how AR learning contributes to the culture in the classroom when utilized along with traditional techniques.

1.2. PURPOSE OF THE STUDY

The purpose of this qualitatively driven mixed methods research study is to explore and interpret the possible progressive changes in the data collected from a fourteen-week implementation of Augmented Reality in an English as a Foreign Language (EFL) classroom. While the quantitative aspect of the study aims to find out whether there is any significant difference between the means of two independent and identically distributed groups when exposed to the same learning content through different media, i.e., AR-aided instruction vs. traditional coursebook-based instruction, the qualitative aspect focuses on the depth and

breadth of individuals' experiences while learning with AR tasks supplementing the print content. Although it is very difficult to observe a solid change in the learning outcomes and therefore give credit to the technology in use due to the complex nature of the learning processes as well as other internal and external factors, it is aimed that the findings will shed light on our understanding of how Augmented Reality is experienced by language learners in a classroom setting, what kind of an understanding they form of AR-based tasks and exercises in a language learning context, and affordances AR presents to them. In a broader scope, the present study aims to contribute to a deeper understanding of language learners' opinions to technology-assisted language learning with specific reference to AR applications in the language learning process, derive insights for the development of innovative teaching and learning tools and techniques, and inspire like-minded educators to design and conduct more future studies.

Since the beginning of 2010s, especially appearing in the most renowned technology adoption reports, e.g. Horizon Report (Johnson et al., 2011, p. 16) under the "Time-to-Adoption Horizon: Two to Three Years" category, Augmented Reality has been attracting a great deal of attention. Especially within the last couple of years, one can easily notice the number of new AR software applications along with dedicated devices, i.e., Google Glass or Microsoft HoloLens, introduced by the lead manufacturers of the IT industry. End consumers started investing in these technologies at affordable prices in order to view commercial and/or non-commercial content for marketing, social or entertainment purposes. Although the number of applications that enable AR for education is still low compared to AR for marketing or entertainment, incorporating AR learning into everyday teaching is not far from reality. With basic IT literacy skills, one can easily repurpose some of the already existing applications for specific learning scenarios and utilize its combining virtuality with reality potential in and outside the classroom.

Being so novel and state-of-the-art, AR is a very fresh item in the agenda of educational debate and needs to be explored and experimented further in order to gain a wholistic understanding of the phenomenon. With this in mind, there are some early adopter educators who testify and argue AR's great potential in their teaching, yet the amount of peer-reviewed research, which showcases the actual impact of AR in the field of education, is slowly growing and the majority of these studies are linked with either science education or technical education. When the use of AR in language teaching is considered, the number of

research studies are still limited. The Thesis Center of the Council of Higher Education in Turkey (https://tez.yok.gov.tr/., Accessed: 16 February 2022), for instance, lists 200 theses, at both master's and doctorate level, under the title of Augmented Reality across all the disciplines, covering the period between 2009 and 2022. Of all the theses, only 78 are tagged with education and training, submitted between the years 2014 and 2022. However, the bulk of these studies concentrate on science and technical education with 11 doctoral dissertations and 32 master's theses, which is followed by studies in social sciences and educational sciences with seven doctoral dissertations and 20 master's theses. The last group of studies within education and training is language education with eight master's theses submitted from 2016 until 2021. These studies feature the following issues within the context of language learning and teaching:

- effectiveness of AR supported materials on EFL vocabulary teaching (Dogan, 2016);
- effect of AR-aided course book on EFL learners' achievement and attitudes (Cinar, 2017);
- effect of AR in improving English grammar and vocabulary in elementary education (Buyukuygur, 2018);
- effectiveness of ARCS based instructional materials in the teaching of ESP vocabulary and motivation via AR (Tandogan, 2019);
- effects of AR based EFL teaching on the success of primary level students (Bahadir, 2019);
- impact of mobile AR enhanced materials on EFL learners' motivation, attitude level, and reflections in academic writing classes (Pozharina, 2019);
- contribution of AR supported vocabulary teaching to the academic success of A1 level students learning Turkish as a foreign language (Kanal, 2020);
- pre-service EFL teachers' perceptions of AR and self-efficacy level in considering AR in their teaching (Okumus, 2021).

Similarly, ProQuest Dissertations and Theses Global (http://search.proquest.com/pqdtglobal/., Accessed: 25 May 2017) lists 159 results which are indexed under augmented reality and language learning. When sorted by relevance, only the top 15 results include the key phrase augmented reality either in their titles or in their abstracts. Although these studies do not necessarily involve language learning and teaching directly, they focus on the following themes:

- reading motivation in elementary education
- mobile augmented reality games for teaching
- learner outcomes in engineering courses
- vocabulary acquisition in special education
- learner perceptions of emerging technologies
- generational differences of learner-interface interaction
- cognitive modeling in art education

As for the peer-reviewed articles, book chapters, and conference proceedings, Google Scholar lists 4360 results which include the key phrases augmented reality and language teaching (https://scholar.google.com.tr/scholar?hl=en&as_sdt=0%2C5&q=%22augmented+reality%22+AND+%22language+teaching%22&btnG= ., Accessed: 16 February 2022). However, when the article abstracts, sorted by relevance, are scanned through, it seems that only a very small number of them primarily focus on augmented reality in language education. The majority of the publications only mention the potential of augmented reality in language teaching under the heading of mobile learning or computer-assisted language learning (CALL).

Finally, systematic reviews of publications (Dey et al., 2018) show that earlier studies of AR, especially before 2011, were mostly conducted with head mounted displays (HMDs) featuring hardware and software with limited capacities in laboratory environments and provisioning and overlaying information as their main function (Ke and Hsu, 2015). These pilot studies did not focus on real world usage scenarios, either. Instead, they were testing the potential of new prototypes developed by computer scientists and covered only very short periods of time. The most popular data collection technique was questionnaires, and they were filled out after a short exposure to a specific aspect of AR.

Considering the studies above, it seems that there is need for further detailed studies which utilize more up-to-date AR systems featuring multiple modalities, focus on more realistic and holistic learning scenarios, integrate multiple skills, are more contextualized in scope and based on user experience in a reflective frame, include more participants, cover longer implementation periods, and collect data using diverse research instruments. This present study, therefore, aims to gather information with reference to the experiences of its participants to gain deeper insights on how Augmented Reality may possibly impact current

practices in education, language teaching in particular. It also provides a detailed account of a semester-long AR-based teaching model, focusing on the active use of receptive and productive skills, in an English as a Foreign Language classroom in the preparatory language program of a higher education institution.

With these in mind, the study addresses the following research questions as its basis of investigation:

1. How do learners describe their language learning experience with AR?
2. What do learners think about the role of AR in learning/practicing language skills (listening, speaking, reading, and writing) and aspects (grammar and vocabulary)?
3. What are learners' reflections on:
    a. the technical and instructional assets and liabilities AR holds in language learning?
    b. AR as an educational tool to language learners?
4. Is there a significant difference between the experimental (AR) group and the control (non-AR) group in terms of:
    a. technological awareness and use of new technologies?
    b. attitudes towards language learning with new technologies?
    c. achievement in language proficiency?

1.3. LIMITATIONS OF THE STUDY

The qualitative and quantitative components of this study were conducted with 36 participants (18 in the experimental group and 18 in the control group) in Pre-Intermediate level Listening and Speaking course students in the Spring of 2015 at the preparatory language program of a foundation university in Turkey, and it reflects the diverse dynamics of the setting and its participants.

The implementation process lasted 14 weeks (a semester), and therefore, the data collection procedures covered the participants' experience limited to this time period.

This course was a mandatory course; therefore, the fact that it was mandatory might have influenced s' overall motivation towards the course, interest in the course content, and participation in the sessions.

The interview, questionnaire, and achievement test had been designed by the researcher and were limited to their own capacity and capability to measure and assess the participants' language learning experience with AR, their awareness levels, attitudes, and views on learning languages using new technologies, and their achievement based on the concepts taught via AR.

1.4. DEFINITIONS OF KEY TERMS AND CONCEPTS

The terminology used in this study is discussed in detail in the following chapters, yet below is a brief list of the definitions of key terms and concepts in order to provide a clearer frame of the study as well as avoid any confusion:

Application or App: A specific program designed for smart devices, especially smart phones, in order to perform a specific task

AR Feed Channel: The AR feed that allows the experimental group to display the virtual items developed in the Aurasma Studio platform

Augmented Reality (AR): The name of the technology that enables overlaying real time, virtual information (audio, visual, and/or textual) on the objects in the physcial world with the help of smart devices

Aura: The term for overlaid virtual content used by Aurasma

Aurasma: An AR application for mobile platforms (Android and iOS) which makes use of image recognition technology and allows a certain degree of interactivity with the virtual objects

Loading: The moment when the application is trying to retrieve the information from the AR channel feed.

Location-based AR: The kind of AR in which the virtual content is triggered by a previously defined location in the physical world.

Marker-based AR: The kind of AR in which the virtual content is triggered by the recognition of a previously defined, i.e., anchored, marker image in the physical world and the content is simultanesouly overlaid onto it to be viewed by the user.

Markerless AR: The kind of AR in which the virtual content is not attached to any physical object, rather available on the interface and can be manipulated and overlaid onto any surface as viewed by the user on display.

Computer Assisted Language Learning (CALL): Levy (1997, p. 1) defines it as "the search for and study of applications of the computer in language teaching and learning."

AR Overlay: The dynamic, virtual content that is overlaid on the static, print content when the mobile AR interface recognizes the *trigger image*.

Reflection: Costa and Kallick (2008, p. 233) defines it as "the habit of reflecting on own actions and constructing meaning from those experiences."

Scanning: The act of holding the smart device to the physical image and waiting for the virtual content to display without moving the device away

Tapping: After displaying the virtual content, tapping on the screen to proceed to the next activity, predefined by the researcher

Trigger Image: The static, print content that gets recognized by the mobile AR interface when scanned with a smart device

2. CONCEPTUAL FRAMEWORK

Digitalization in higher education institutions has gained a strong momentum, particularly during the past two years due to the recent global pandemic. Transforming their educational content, investing more and more in new hardware and software resources, and training faculty members to utilize digital tools and resources, universities are trying to incorporate new technologies into their traditional curricula in the hope that they can improve the overall quality of teaching and learning, create possibilities to attract and reach out to more s, and address the needs of multiliterate individuals by fulfilling the requirements of the 21st century skills. Although the leading educational institutions take a top-down approach, that is, following a more controlled path by setting short- and long-term goals and objectives, and develop strict policies and strategies while adopting new technologies, there are still a great number of schools which either struggle to catch up or wait until these technologies come of age and penetrate into classrooms via learners and teachers in a more bottom-up fashion. In other words, these technologies have become so widespread that ingorance or avoidance does not appear to be a viable option. The majority of the students at tertiary level come to class having at least one of the following devices in their possession: laptops, tablets, smart phones, or wearable technology of some sort, and even if these technologies are not purposefully integrated into lessons, students still find a way to integrate and make the most of them in their learning, without being necessarily told to do so by their instructors. The current picture, in fact, shows us that digitalization or digital transformation in education as well as other fields has been driven by the latest trends in technology and inevitably become one of the core items in the agenda of educational institutions, especially in the last decade, thanks to the faster and more seamless wireless internet connection supporting more flexible and highly responsive applications along with the boom in affordable personal, mobile, and smart devices. Hence, this chapter aims to lay the groundwork before investigating the potential of Augmented Reality (AR) as a learning tool in a language classroom, and intends to provide a detailed account of it by (1) describing and defining what AR is and providing a technical background on the available forms of AR, (2) presenting a brief report on the emergence and progress of Augmented Reality as a technological concept until now, (3)

reviewing the initial attempts of incorporating AR into teaching and learning both at international and domestic levels, (4) making connections to the most recent practices in the field of education as well as information and communication technologies (ICT), and finally (5) discussing its link and relevance to the latest theoretical paradigms of multimedia use in language teaching.

2.1. WHAT IS AUGMENTED REALITY?

Augmented Reality (AR) is the name of the interactive experience that involves overlaying virtual objects, data, and information onto the objects or spaces in the real world so that it appears as if the virtual input is present in the actual perceived physical space. By doing so, it blends the virtual and physical worlds together and constructs a new form of reality which is more enhanced and enriched, or as its name refers “augmented”. Although there are several other terms referring to blending virtual and real worlds through similar interactive experiences and are somehow described or defined as features of one specific type of reality within a hierarchical order, such as Extended Reality (XR), Mixed Reality (MR), or Virtual Reality (VR), Augmented Reality (AR) stands out to be the most agreed upon term so far in the research literature.

According to Milgram et al. (1995, p. 284), Augmented Reality, in its broadest definition, is "augmenting natural feedback to the operator with simulated cues" and is situated somewhere between pure reality, i.e., “Real environment”, and pure virtuality, i.e., “Virtual environment”, in a reality-virtuality (RV) continuum (Figure 2.1):

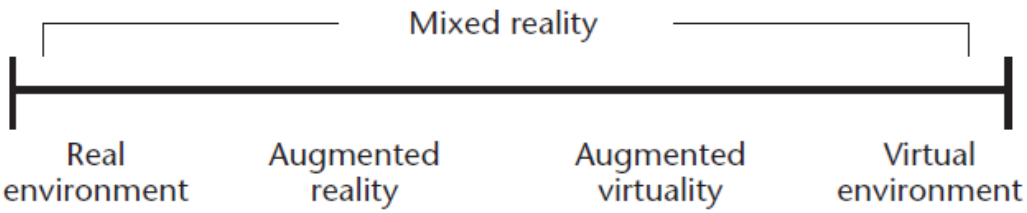

Figure 2.1: Milgram’s reality-virtuality continuum (Milgram and Kishino, 1994, p. 284)

As a special concept under a larger class technology, i.e., Mixed Reality (MR), AR stands closer to the real environment because its aim is to enhance an individual’s real-world experience by providing real-time interactive virtual input in order to augment his perception.

In Augmented Virtuality (AV), however, real world objects are placed in a virtual environment, in other words, a synthetic, computerized, simulatory world which may not necessarily represent the reality we know of, and the focus is to enhance the virtual experience of an individual rather than his real-life experience (Milgram et al., 1995).

Although the most common definitions and depictions of AR in the literature involve display technologies through dedicated goggles and headsets, there are several counterarguments that this definition is rather limiting the potential of AR to the sense of sight only with the purposes of supplementing extra information about a place, guiding users on how to perform a specific task, or provide further explanations through audiovisual media. For Azuma et al. (2001), this is just one specific form of AR, and the concept of AR covers not only sight, but also other senses including hearing, touch and smell, and ideally augments human perception through all the available channels of sensory input. Along the same lines, Carmigniani and Furht (2011, p. 3) note that AR can even be used to augment or replace impaired senses "by sensory substitution, such as augmenting the sight of blind users or users with poor vision by the use of audio cues, or augmenting hearing for deaf users by the use of visual cues." Therefore, Klopfer (2008, p. 92) argues that it is very constraining to define AR as a form of technology which involves an "immersive" environment that is experienced through a "head- or eye-mounted display which is always in the visual field". Instead, it should be approached in a much broader sense and referred to as "technologies that merge real and virtual information in any location-specific way, where both real and virtual information play significant roles" (Klopfer, 2008, p. 92).

These diverse definitions of AR in the literature of computer science and instructional technology could be due to the emergence of AR five decades ago in the form of a head-mounted display, connected to an importable terminal. However, today's smart and wearable devices feature all the required hardware and software resources that allow viewing high quality 3D virtual content in a more flexible way, without having to swerve from natural physical postures and gestures. However, there is still some division in the way researchers perceive the term AR and define it. In their meta-analysis study, Wu et al. (2013) note that while some researchers refer to AR as a technology aspect and describe it by referring to its features and characteristics, such as Azuma's (1997) aforementioned definition, some others prefer concentrating on AR at a broader and more conceptual level, as in Milgram et al.'s (1995) aforementioned definition, which expands the definition of AR beyond a device and

amalgamates the technology that comes with. At this point, it can be concluded that a broader definition would benefit educators and designers more as it would take into account a range of devices and platforms that are capable of housing AR. Therefore, a specific form of technology should not play a restricting role for AR; instead, AR should appear in many different forms for seamless exposure in order to enhance user experience at maximum levels.

2.1.1. Types of Augmented Reality

As mentioned above, AR systems today, come in very many different types and forms thanks to the advances in new technologies. The smaller the components get, the more compact and portable the devices become. The size and processing capacity and power of these devices contribute a lot to the user experience and enable users to experience AR in a more intuitive way. Although the earlier systems lacked the hardware and software today's systems have, there seems to be a consensus in the three fundamental conceptual characteristics that an AR system should possess. These are, according to Azuma et al. (2001, p. 34), as follows:

- combining real and virtual objects in a real environment,
- running interactively in real time,
- registering (aligning) real and virtual objects with each other.

These characteristics cover all the possible aspects of AR, that is, they do not restrict AR to particular display technologies nor senses, such as head-mounted displays (HMDs) which AR systems were initially introduced with and AR interfaces that augment user experience through the sense of sight only. Similarly, *diminished* or *mediated reality* systems, which remove the real objects from the perceived world, should also be considered a subset of AR because the rationale behind these systems is again blending real and virtual information to diversify user experience (Azuma et al., 2001).

The characteristics and features of AR systems are quite clear in theory; however, they differ a lot in practice. On a more specific and technical account, Carmigniani et al. (2011) discuss that AR systems could be divided into five different categories based on the device, component and interface technologies used. These categories are fixed indoor systems, fixed outdoor systems, mobile indoor systems, mobile outdoor systems, and mobile indoor and outdoor systems. Each system features a different configuration in terms of what the main

focus of the AR experience is and possesses different specifications. For instance, while mobile systems require user movement and geospatial object-registration by utilizing GPS-trackers and compasses, fixed systems use visual-markers and require digital cameras, so it seems very difficult to talk about a unique AR system or the default features of an AR system from a technical point of view due to the diverse purposes AR systems serve.

Although there are several different interpretations of AR systems, there are four common components that are used in the AR systems, according to Carmigniani et al. (2011). These are as follows:

1. Display technologies: Head mounted displays (HMD), handheld displays and spatial displays are the forms that are available at the moment. The first two technologies are the most common ones and feature either video-see-through (VST), in which the virtual content is seen on the camera view of the real world on a video display as in smartphones and tablets, or optical-see-through (OST), which allows seeing through a lens that has the capacity to overlay the virtual content, i.e., smart glasses. Although VST and OST have been acknowledged to be the available technologies to date (Botella et al., 2005; Juan et al., 2005, 2007, Cipresso et al., 2018), there are also spatial displays which feature special projectors reflecting the virtual content directly onto the surfaces of physical objects, and retinal displays, which are worn onto the retina of the human eye and provide a wider viewing angle compared to the VST (Bimber and Raskar, 2005).
1. Input technologies: There are gloves, wireless wristbands, or smartphone touchscreens as pointing devices, markers etc. which could be used to register input in an AR system. More recently, more natural input forms have been introduced. Users can use hand gestures, gaze or blinking eyes to control objects or get in interaction. The input devices and methods that were once suggested, such as sticks or computer mice (Rekimoto, 1998), are being replaced with more familiar, more organic input methods. In the most recent prototypes, users can interact with virtual content almost as they would with real, physical content.
2. Tracking technologies: Digital cameras and other optical sensors, GPS, accelerometers, solid state compasses, wireless sensors, etc. have so far been used in AR systems. Now that there are faster and more precise sensors, embedded into smart and mobile devices, particularly cameras with high resolution, virtual content can be conveyed into the

physical world with great accuracy. Most applications available in the market nowadays deploy marker- or image-based tracking technologies, in which a built-in digital camera recognizes the preset marker or image pattern and then the system matches the recognized pattern with the one in its database and seamlessly overlays the virtual content onto the marker or image. However, as mentioned in Cheng and Tsai (2013), there are also location-based AR applications, in which GPS sensors recognize the coordinates of a virtual content that has been previously placed, and when triggered, the content is delivered it to the user. In such applications, horizontal and vertical accuracy becomes an issue to consider as current GPS sensors cannot provide high precision positioning data and accessing the virtual content could be quite challenging in smaller spaces.

3. Computer technologies: These technologies include stationary systems, desktop computers, a laptop in a backpack, smartphones, and tablets, etc. Except for few kiosk applications or smartboard applications, stationary systems are not as common as mobile systems. There has been a tendency in moving towards more portable, even wearable technologies to interact with virtual content in a more realistic way. AR is best experienced on mobile devices (Henrysson et al., 2005), and smartphones made AR more accessible and available (Broll et al., 2008).

As these components improve, AR systems become easier to deploy, more mobile, more intuitive, and more interactive. However, it is not only the hardware which is vital for a successful implementation of AR. The user interface (UI) is equally important and plays a significant role in user experience (UX). So far, Carmigniani et al. (2011) classify four main ways of interaction in AR applications, which are tangible AR interfaces, collaborative AR interfaces, hybrid AR interfaces, and the emerging multimodal interfaces:

1. Tangible interfaces involve direct interaction with the virtual content by using tangible objects or tools, such as cards, sticks, paddles, or boxes. These interfaces are quite intuitive and make AR deployment a lot easier among those who do not have any prior technical background or computer literacy, such as elderly people or children. Billinghurst et al. (2001) introduce three tangible interfaces, the Shared Space, a collaborative AR game; AR PRISM, an AR application used for geospatial visualization; and Tiles, an AR prototyping application. They conclude that these

interfaces can be used to “naturally support face-to-face collaboration and spatial data manipulation” (Billinghurst et al., 2001, p. 5).

2. Collaborative interfaces feature a shared AR workspace in which multiple users can collaborate on the same virtual content. Users may even connect from remote destinations to modify the shared virtual content. Kato and Billinghurst (1999) describe one of the first examples of AR conferencing applications in which virtual monitors via markers represent remote users who can view and interact with the same virtual content and collaborate on a shared virtual whiteboard.
3. Hybrid interfaces combine different interfaces that are available through different devices for interaction with virtual content. For instance, in addition to the see-through content, audio content can also be integrated, and users are then supported with feedback that is received from different interfaces. Bichlmeier et al. (2007) discuss a hybrid medical AR system which could blend the 3D medical imaging data of patients with their actual VST images during an examination and help the physicians perceive their patients’ anatomy in context and interact in a more intuitive and multisensory way.
4. Multimodal interfaces enhance real object input with natural speech, hand gestures, gaze or blink in different modalities for ideal human-computer interaction, allowing the user to interact with virtual content in multiple modes and enabling immediate switching between input forms and modalities. These interfaces are said to be the future of AR systems. Grasset et al. (2005) and Billinghurst et al. (2005) introduce an AR prototype, the AR Mask, which combine several input technologies, i.e., gaze, pad, and two-hand selection, and VST display technology in one device in order to support traditional interaction techniques.

All in all, the interface technologies focus on one central idea: creating the most appropriate experience for the most intuitive interaction between the user and virtual content. Once this has been achieved, AR systems offer their maximum potential.

2.1.2. Augmented Reality Hardware and Software

As discussed above, Augmented Reality requires sophisticated hardware configurations. To date, dedicated AR devices have been very low in number or remained as prototypes designed for specific research scenarios. Early examples of AR hardware include mostly HMDs, handheld displays or larger displays connected to stationary computers.

Having mobility in mind, handheld displays connected to backpack computers were configured to run AR applications. These systems were expensive, limited, and required specific technical knowledge and expertise for users to operate. With the advance of mobile devices, however, there has been a boost in the number of applications that enabled end users to experience AR via personal devices for mostly entertainment purposes. Although there were special AR applications developed for color display mobile phones before, AR started attracting more attention after smart devices, i.e., phones and tablets, featured faster processors, bigger touch screens, more capable sensors, i.e., high-resolution video cameras, digital compasses, GPS etc. Thanks to more advanced mobile operating systems (OS) that are capable of executing more complex programs, such as Android and iOS, smartphones and tablets became ideal pieces of hardware for affordable AR implementations. These devices were followed up by smart glasses, AR/VR goggles, and AR/VR headsets, such as Google Glass, HoloLens, Occulus Quest, or Magic Leap, but they have not gained the same popularity and deployment rates as smartphones and tablets yet due to their high prices and limited number of applications available in their platforms. The future of AR hardware, however, moves toward smaller and more compact solutions, such as contact lenses. A very recent project in the Optics Department at IMT Atlantique (https://www.imt-atlantique.fr/en/the-school/news/first-stand-alone-contact-lens-flexible-micro-battery., Accessed: 12 July 2019) achieved to create "the first autonomous contact lens incorporating a flexible micro-battery". This breakthrough innovation will soon enable the integration of other significant functions, such as wireless communication modules as well as newer input and display technologies, and AR systems and applications will gain a new momentum.

Parallel to the innovations in the AR hardware field, particularly in the last decade, there has been some substantial progress in the AR software field. Being one of the pioneering, cross-platform, open source AR software development kit (SDK), AR Toolkit (http://www.hitl.washington.edu/artoolkit/., Accessed: 12 July 2019) by Kato and Billinghurst (1999) has been used extensively for the initial versions of mobile AR applications in Symbian, iOS and Android OS. Similar to AR Toolkit, Google's AR Core (https://developers.google.com/ar/., Accessed: 12 July 2019) has also become a popular open source SDK since 2018, supporting mobile AR applications, especially on Android OS. AR Core's counterpart in the iOS realm is ARKit (https://developer.apple.com/documentation/arkit., Accessed: 12 July 2019) launched by

Apple in 2017. In addition to these, some of the canonical AR SDKs worth mentioning are DAQRI (https://daqri.com/., Accessed: 12 July 2019), Vuforia (https://developer.vuforia.com/., Accessed: 12 July 2019), Wikitude (http://www.wikitude.com/products/wikitude-sdk/., Accessed: 12 July 2019), AR.js (https://aframe.io/blog/arjs/., Accessed: 12 July 2019), and MAXST (https://developer.maxst.com/., Accessed: 12 July 2019). Now that the leading tech companies, such as Google, Apple and Facebook, have been investing more and more in AR, current applications appear to provide more accurate, seamless and smoother experience on powerful and personal devices.

Besides the independent SDKs as mentioned above, there are also end-to-end branded app solutions such as Aurasma (now HP Reveal), Augment, Layar and Blippar. These solutions, following a software as a service model, have their own studio developer accounts allowing high-end users to deploy AR tasks without any prior programming knowledge on a graphical user interface (GUI). These users can build their public or private AR content libraries and stream their content via a dedicated application to their subscribers. These applications are available on multiple platforms and basic functionalities, i.e., viewing AR content, are free of charge. However, to create and stream content, a developer studio account is needed, and such accounts may require paid subscription. It appears that these solutions have so far been the quickest and most efficient AR applications to deploy.

2.2. ADVANCES ON AUGMENTED REALITY: A CHRONOLOGICAL PERSPECTIVE

The fantasy of augmenting the capacity of human senses has been considered an unworldly yet such an astonishing practice that these special powers have been attributed to either superheroes or supernatural entities in literary works. A noteworthy example of this imagination, i.e., the possibility of viewing special labels on people or objects, appears in L. Frank Baum's 1901 novel The Master Key. In his work, Baum depicts Character Marker, a special kind of glasses which show how good or evil people are by marking them with the letters G and E when worn. Although Baum's explanation of the working principle of such a technology differs a bit, thanks to his vision, human beings have pushed the limits of technology so far that speaking about augmented senses, as of today, does not sound as fantastic as it once used to be. Six decades after, in 1965, the earliest known example of AR,

the Ultimate Display, was launched by Ivan Sutherland at Harvard University. It was an optical, see-through head-mounted display (HMD) featuring interactive 3D graphics (Figure 2.2):

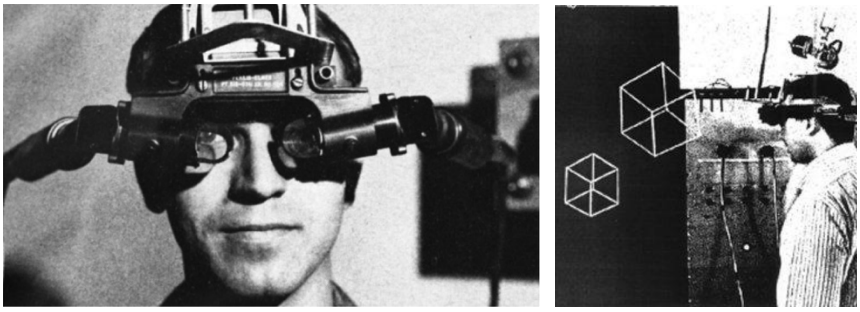

Figure 2.2: Ivan Sutherland and the Ultimate Display and the Sword of Damocles, Harvard University

Sutherland (1965, p. 1) presented his vision of augmenting real-world experience with virtual information with his historical quote, "A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland." His revolutionary Sketchpad (Sutherland, 1963) and The Sword of Damocles (Sutherland, 1968) are considered to be the very first examples of human-computer interaction (HCI) via a graphical interface and a VR HMD. Although the first prototype of an AR system was officially introduced and technically present, the concept was first coined as Augmented Reality by Tom Caudell and David Mizell (1992) in their study describing the design and prototyping steps of a video see-through heads-up display (HUD). This VST HUD, called Magic Glasses, featured head position sensing and a real-world registration system (Figure 2.3):

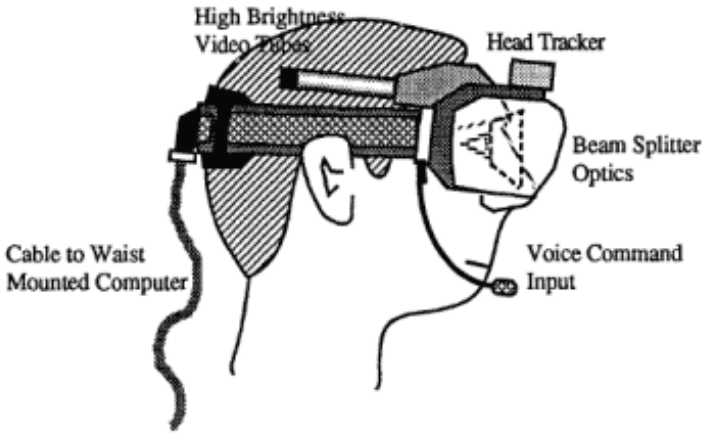

Figure 2.3: Caudell and Mizell's (1992) AR HUDset

With this unique AR HUDset, Caudell and Mizell could superimpose computerized diagrams on real world objects as well as stabilize their positions. Working at Boeing at the time, they could implement this technology in order to improve the manufacturing processes of aircrafts by assisting technicians in assembling wires and cables.

Being in the focus of a limited number of researchers in the early 1990s, AR could not go beyond laboratory experiments until the emergence of affordable consumer technologies as discussed earlier. With the introduction and availability of laptop computers, handheld devices, GPS receivers, portable cameras, cellular phones, smart phones and tablets, the evolution of AR has gained rapid acceleration, and one can easily trace down its progress by looking at some of the early studies and projects in the literature.

Loomis et al. (1994) developed a prototype of an outdoor navigation system (Figure 4) which aimed to guide the visually impaired with virtual sounds based on their actual physical location. Although they did not specifically name this personal guidance system as AR, the system augmented a blind person's traveling experience and informed him of his current position and orientation with respect to the environment being navigated, provided information about the immediate surroundings, and assisted in route planning.

Figure 2.4: Loomis et al. (1994, p. 86) depicting a blind traveler navigation system

Rekimoto (1996) introduced TransVision which appeared to be one of the first successful examples of portable, hand-held, and shared AR systems. Multiple users could collaborate in the same augmented space, interact with a 3D model of a design item superimposed on the real-world view (Figure 2.5):

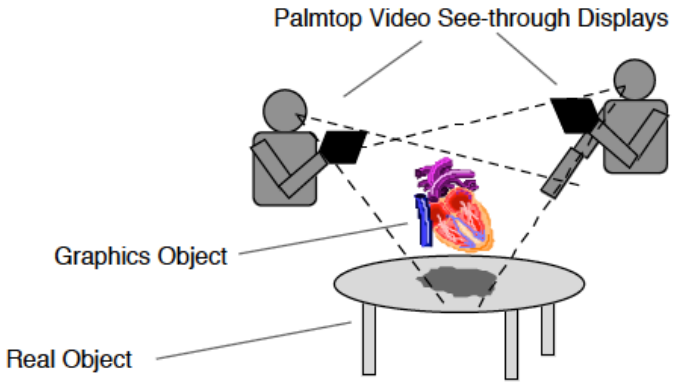

Figure 2.5: Rekimoto's (1996, p. 2) shared augmented space

In order to find a permanent solution to the object recognition and stabilization problems, Rekimoto (1998) introduced "2D Matrix Markers", square shaped barcodes, as a method for real-time object identification and registration (Figure 2.6). This method enabled scanning and recognizing markers instead of objects and allowed overlaying virtual objects over them simultaneously. Most AR applications that are available today still use this form of AR:

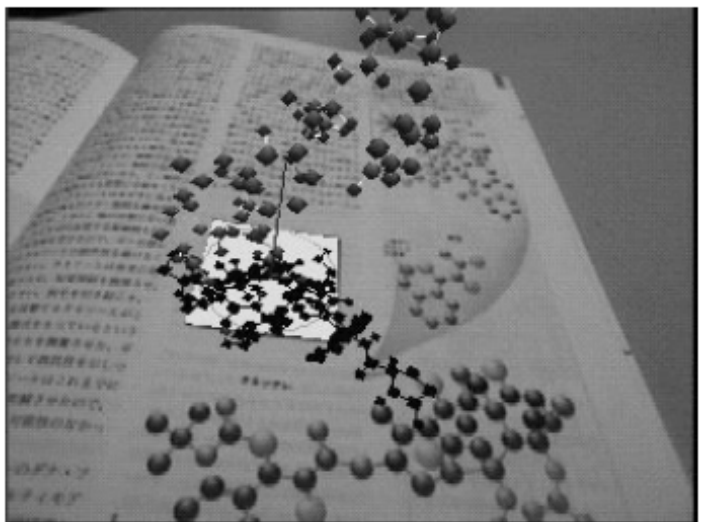

Figure 2.6: "A 3D molecular model pops-up from the book" (Rekimoto, 1998, p. 5)

Azuma (1997) introduced the mostly acknowledged definition of AR and addressed potential problems in the implementation of AR after studying several AR applications used in medical, manufacturing, visualization, robot path planning, entertainment and military contexts. He noted that errors regarding registration and sensing were two of the biggest problems in building effective augmented reality systems.

Feiner et al. (1997), Thomas et al. (1998, 2000), and Hoellerer et al. (1999) introduced several AR system prototypes, such as MARS (Mobile AR System) or ARQuake (AR version of the video game Quake), which aimed to make possible wearable computer systems that could support users in their everyday interactions with the world. These prototypes were part of an effort to make the AR technology more portable and integrated into daily tasks.

Kato and Billinghurst (1999) released ARToolKit, an open source pose tracking library, and introduced a video-based AR conferencing system which allowed interaction between people through an AR interface. ARToolKit has been a very widely used tracking library (http://www.hitl.washington.edu/artoolkit/ ., Accessed: 13 July 2019) and helped developers be able to produce specific AR applications on various platforms. One of the biggest contributions of ARToolKit was to address the viewpoint tracking problem. Thanks to its capacity in calculating the real camera position and orientation relative to physical markers in real time, the kit enabled the easy development of various AR applications.

After 2000, AR devices evolved to be smaller and more portable, as did most mobile devices, and AR applications featured multiple users, collaborative interfaces (Reitmayr and Schmalstieg, 2004), and internet integration (Kooper and Macintyre, 2003). When consumer cell phones with built-in cameras and color displays came of age, Moehring et al. (2004) presented the first video see-through AR tracking 3D markers (Figure 2.7):

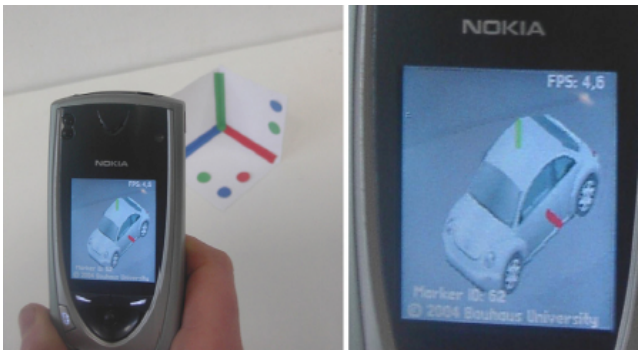

Figure 2.7: Moehring et al. (2004, p. 2) introducing video see-through on a consumer cellphone

However, the most significant enhancements in mobile AR systems appeared when cell phones were equipped with built-in sensors, such as accelerometers, compasses, and GPS technologies. Nokia (https://research.nokia.com/page/219., Accessed: 13 July 2019) introduced the MARA (Mobile Augmented Reality Applications) project to explore sensor-based, video see-through mobile augmented reality applications (Figure 2.8):

Figure 2.8: View of a restaurant on a Nokia 6680 fitted to run MARA

In 2007, AR appeared in MIT Technology Review's 10 Breakthrough Technologies (Jonietz, 2007) and was referred to as one of the most significant emerging technologies at that time. According to the report, mobile augmented reality was nearly ready for the market despite the financial challenge of convincing carriers that customers would pay for augmented-reality services.

From 2007 on, most cell phones have featured built-in rear cameras, GPS devices, accelerometers, and gyroscopes along with more capable mobile operating systems, such as Symbian, Android, and iOS, and therefore, video see-through AR applications have become more and more accessible for end users. In the following years, with the emergence of larger touch screen smart phones and tablets, display and audio processing speeds and virtual content quality have remarkably improved. Parallel to the advances in the hardware world, mobile AR applications and platforms have become more and more prevalent.

2008 marks the coming of age of several pioneering mobile AR applications that were publicly available and could be deployed effortlessly in everyday contexts by tech-savvy users who already owned a smart device. Among these applications are Wikitude (2008), Layar (2009), Junaio (2009), and Aurasma (2011). These applications were very innovative in

terms of making use of the 3G and 4G mobile networks for high-speed internet connection as well as built-in sensors, i.e., camera, GPS, accelerometer, and compass, for the best AR experience. After all, most of the issues concerning AR developers have been partially resolved, and improvements on positioning, image recognition and tracking, 3D model rendering, and video overlay have no longer posed serious limitations, rather borne more accurate, precise, and faster results in the AR implementations. Several successful and publicly available AR applications have become available since then, such as interactive advertisements, museum guides, multiplayer games, live maps featuring AR (Figure 2.9):

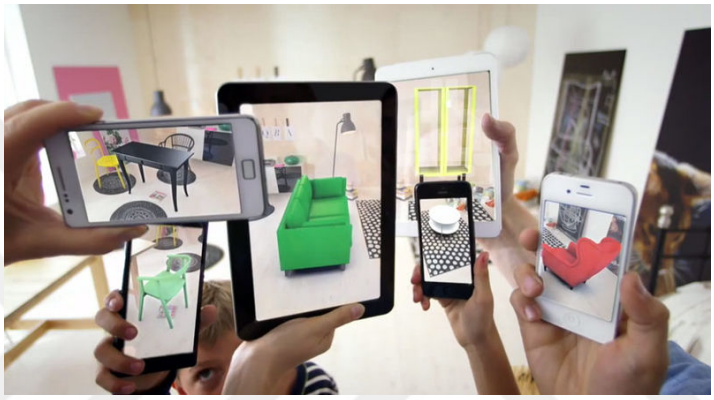

Figure 2.9: Retailers advertising 1:1 3D models of their products through AR applications

In 2012, Google introduced the Project Glass (Figure 2.10), an optical HMD, running with Android operating system. It was still the Explorer edition, only available to those who used it for testing and developing purposes. Google later announced that within 2014 there would be a new version, much more affordable and offering a variety of applications. The Glass had a price tag of $1,500 at that time. However, in early 2015, the production of this version was discontinued, and Google allegedly started working on a new version of the Glass (http://time.com/4163067/google-glass-2-photos-2015/., Accessed: 13 July 2019) at the end of 2015.

Figure 2.10: Google Glass

Shortly after Google, Microsoft announced HoloLens (Figure 2.11), a pair of head-mounted smart glasses running a relatively more complicated operating system, Windows 10, in contrast to its predecessors. Providing a collection of AR applications as well as developer tools, HoloLens seems to be so far the best AR goggle that is available in the market as of 2017.

Figure 2.11: Microsoft HoloLens

After a three-decade journey, AR has finally attracted a great deal of attention that there is more investment and funding on research projects as well as commercial, enterprise products. According to a recent report by Digi-Capital (2019), we are currently experiencing AR 1.0, which started with the acquisition of AR/VR startups by tech giants in 2014, such as Facebook's buying Oculus or Google's buying Magic Leap. Although these acquisitions stimulated some entrepreneurs, corporates, and investors to build early-stage AR hardware and software, it has not created a mass market yet. Mobile AR reached a revenue over $3 billion globally, driven by app store revenues such as Pokémon Go, the most popular mobile AR game to date, released in 2016 by Niantic and Nintendo; adspend, and eCommerce sales. However, the report adds that there were no breakout mobile AR apps in the last couple of years and claims that this is due to the fact that developers are still figuring out what works best for mobile AR. Currently, the top ten most popular mobile AR application categories in the application markets are games, social, photo/video, entertainment, navigation, medical, education, lifestyle, travel/transport, music, and business.

In order to move towards AR 2.0, which refers to the next generation AR hardware and software, the Digi-Capital (2019) report suggests that the following changes need to take place in the current practices:

1. The installation, user experience (UX) and user interface (UI) of the available AR applications vary greatly, and there are several different interpretations of AR as a concept. To avoid the high friction, there needs to be high quality, standalone, dedicated AR devices designed by renowned tech companies, and mobile AR developers should introduce more innovative features.
2. The current AR experience impresses the users at the beginning; however, because there are no meaningful and critical tasks performed through AR yet, the positive impression wears out very fast, and it becomes repetitive and monotonous. There should be more critical use cases that justify the use of AR on a regular basis.
3. There are several standalone AR apps in the market, yet they cannot achieve the high adoption rates and commercial success of those everyday apps that have AR features incorporated into their interface, e.g., Google Maps AR navigation or Snapchat Lens Studio.
4. The current technologies involving dedicated AR/VR goggles or headsets are too expensive, ranging between $200 to $3,000. Unlike those, the free mobile AR apps offer relatively better value, but functional apps still come at high costs. Therefore, the next generation AR needs to be more affordable for the end consumers and offer greater value at a much lower price.
5. Most AR apps have been focusing on the entertainment sector, i.e., games and video. The new generation apps should focus on specific problems and create their own functional ecosystem.
6. The investment on current AR technologies is somewhat high; however, the return on investment is remarkably low, limited to the wow effect. For AR 2.0, the return has to be more than what is available today, and users need to receive higher returns on their AR investments.
7. AR 1.0 is still mostly about pilot projects except for few instances that were fully implemented. When big companies move towards bigger AR integrations, the current status of AR will change and become more integral.

8. Currently, there are still debates on defining, describing, and distinguishing AR, VR, MR, XR, and spatial computing in the AR/VR industry, which is of no concern to the end consumers and enterprises except for some early adopters. For the actual users of AR, what matters most is the critical use cases with a clearer focus, which will then be realized with AR 2.0.
9. There are several platforms for AR applications at present and this causes fragmentations in AR 1.0. However, current trends show that specific platforms, such as ARKit of Apple and ARCore of Google, have been recently standing out and slowly dominating the market as the development platform of choice.
10. There is not enough data shared by AR 1.0 companies to further develop roadmaps, rollouts, investments, and valuations in AR industry. However, the market is slowly becoming more data driven as a result of the efforts of the data analytics platforms, which will clarify the gray areas relating to the usage and further development of AR 1.0 and lead to AR 2.0.
11. Although the first AR companies were funded by venture capitalists, it seems that the next generation AR companies will have to run on smaller budgets and money making will become more important. The investment on AR/VR startups has been in decline, and some pioneering AR companies had to exit the market in 2018 due to lack of funds.
12. AR 2.0 will come true when a major tech company, such as Apple, launches a specific AR device and a mass consumer market is initiated after this product. However, it might still take at least five years after a release to create a long-term mass consumer market.

There have been big expectations in the IT field that every new year is claimed or announced to be the year of AR/VR; however, a sense of cautious optimism seems to be the determining factor in how the next stages of the AR market will look like. Nevertheless, a recent explainer report appearing in the Chronicle of Higher Education (Pelletier, 2018) argues that although some experts still question if AR and MR will ever receive the attraction that has been attributed to these concepts so far and become widespread in the educational realms, others speak more confidently and speculate that around 60 percent of higher education institutions will adopt VR in different capacities by 2021.

2.3. AUGMENTED REALITY IN EDUCATION AND RESEARCH

The use of AR for both formal and informal education dates back to the early 2000s. The first attempts stand out as prototypical examples, and they concentrate on showcasing AR's limited features in the teaching of specific concepts at the time yet speculating about its potential in the future of education to attract more attention and call for development. These prototypes, in the majority of the cases, supplement face-to-face teaching in order to enrich the traditional learning experience delivered through books or other print materials in a typical classroom setting through 3D learning content. Therefore, their most outstanding promises appear to be AR's ability to make the invisible visible via superimposed graphics, such as showing molecules and particles at nanoscale on a physical surface (Dunleavy et al., 2009), or to simulate particular tasks which would be either too dangerous or too difficult (or even impossible) to perform otherwise by providing a sense of virtual immersion, such as chemistry experiments with explosives or dissection tasks in a science class. Learners are taught a segment of a class via specially designed or repurposed AR devices and applications, mostly in science and technology classes, and through experimental research designs, AR's impact on learning performance, success, comprehension, motivation, engagement, interaction, and collaboration have been investigated. Although some of these studies have mentioned serious limitations regarding technical, instructional, and cognitive issues, the great majority of the literature agrees that AR has a considerable potential for teaching and learning, offers several new opportunities as a distinct form of media, but needs more attention, investment, and improvement to be implemented more successfully in educational settings (Bitter and Corral, 2014; Fernandez, 2017; Papanastasiou et al., 2019).

In these veins, the studies that have been published from 2000 until now reveal some common patterns, i.e., defining AR in general, introducing most recent technical advances, and discussing new potential usage areas, and focus on the big picture of AR in education research (Yuen et al., 2011; Wu et al., 2013; Bacca et al., 2014; Radu, 2014; Diegmann et al., 2015; Chen et al., 2017; Akcayir and Akcayir, 2016; Sommerauer and Mueller, 2018). Although there is consensus upon the idea that AR offers great opportunities for teaching and learning, those studies also draw attention to various issues that need to be considered before implementing AR in educational settings.

First of all, one of major concerns is that the AR in education research is still in its early stage compared to the research on other forms of new technologies; therefore, it is difficult to see the impact of AR in teaching and learning as it is not clearly evident yet. The attributed potential of AR is, in fact, mostly due to effectiveness and contribution of older forms of technologies on the learning outcomes, i.e., multimedia or web-based learning environments, as the literature on the use of computers and the Internet in education suggest (Wu et al., 2013). However, some studies mark the years between 2009 (Bacca et al. 2014) and 2013 (Chen et al. 2017) the coming of age of the AR research in education as the number of publications in renowned journals increase.

Next, the research literature so far heavily relies on empirical studies. These studies have been published in the most reputable indexes and databases, such as SSCI, ProQuest, EBSCOHost and ERIC, and adopt various designs, including mostly mixed methods, quantitative methods, with short term, experimental, and cross-sectional designs, yet very few qualitative methods with longitudinal, case studies have been reported. The data collection tools are questionnaires, interviews, observations, and surveys. Samples range between 30 and 200, and mostly in formal education, from higher education, particularly undergraduate level students, followed by primary and secondary level students. However, the early childhood education, vocational training, and special education seem not to have been explored as much (Wu et al., 2013; Bacca et al., 2014; Diegmann et al., 2015; Chen et al., 2017).

These studies mainly concentrate on subjects regarding design, development, usability, and implementation of the AR systems (Wu et al., 2013), which serve the purpose of explaining specific topics and present additional information to the user. In addition to the subjects above, applications, games and laboratory simulations are also becoming popular (Bacca et al., 2014). Parallel to the technological developments, marker-based AR is favored over location-based AR, yet they are both applied in several studies due to the availability of built-in sensors in mobile devices. Object tracking is still an issue; therefore, marker-less AR needs some more software development to be used (Wu et al., 2013).

The reported advantages and effectiveness of these systems are increasing “learning gains, motivation, interaction, and collaboration” (Bacca et al., 2014, p. 141) opportunities along with “better learning performance, deeper learner engagement, improving perceived

enjoyment, and forming positive attitudes" (Chen et al., 2017, p. 16), while the constraints are listed as "difficulties maintaining superimposed information, paying too much attention to virtual information, and the consideration of AR as an intrusive technology (Bacca et al., 2014, p. 142)." However, these evaluations predominantly rely on the participants' self-reflections regarding the usability, preference, and efficiency of the systems they used (Wu et al., 2013).

AR implementations have been quite popular in Science Education (40.6%) and Arts and Humanities (21.9%) compared to Health and Welfare (3.1%), Educational Sciences (0%), and Agriculture (0%) (Bacca et al., 2014, p. 139). Similarly, a more recent study (Chen et al., 2017, p. 15) also reveals that science education (40%) is still the dominating field in which AR in education research have been carried out. According to the same source, it is followed by Social Sciences (16.36%), particularly language teaching and visual art and painting appreciation. However, health (7.27%) and service (7.27%) seem to have the lowest number of studies. The implementations are predominantly from classroom settings, followed by museums, libraries, and rarely field trips. Tablets and smartphones seem to have become the standard AR devices. Dey et al. (2018, p. 6) report that there has been a steady increase in the number of studies using hand-held displays (HHDs) in contrast to head mounted displays (HMDs) since 2011.

These conclusions above reveal the big picture regarding the current status of AR in education and are quite similar in terms of the benefits and constraints of the implementations; however, as pointed out by some studies (Radu, 2014; Diegmann et al., 2015) each AR implementation is unique in its own way and these findings may not apply in different contexts. Therefore, after analyzing the above conclusions carefully, one can conclude that there is need for more qualitative studies to portray the actual experience of users in detail to create a more vivid account of AR in education.

2.3.1. Affordances and Effectiveness of AR in Different Educational Disciplines

The affordances of AR in education have been endorsed to be quite exceptional in the studies that have been published so far. Although there are still several issues mentioned on deployment procedures, regarding the technical and instructional capacities of the hardware and software used, the majority of the studies on AR seem to refer to it as a unique experience in that its advantages and potential far outweigh such constraints and limitations (Lau and

Wen, 2021). When the implementations in the past 20 years are reviewed, the following affordances as well as claims could be drawn:

- AR contributes to learning performance and academic success in a positive way, increases learning gains, and helps better understanding of learning concepts.
- AR creates new learning opportunities.
- AR enhances motivation, increases engagement/involvement, reduces anxiety, and makes learning fun/interesting/appealing/non-traditional.
- AR enhances interaction (learner-learner, learner-teacher, learner-learning material/content.
- AR fosters the creation of learning communities and promotes collaboration while learning.
- AR blends formal and informal learning and extends learning outside the classroom.
- AR supports modern learning approaches.

To start with, the majority of the studies quote that AR contributes to learning performance and academic success in a positive way, increases learning gains and outcomes, and helps better understanding of learning concepts (Bacca et al., 2014; Radu, 2014; Diegmann et al. 2015; Akcayir and Akcayir, 2016; Chen et al., 2017). These claims are based on the fact that the AR learning systems combine the capacities and capabilities of several other forms of multimedia learning environments but offer a dissimilar experience due to its application principles. The 3D visualization of the learning content and its delivery via tangible, interactive, multimodal, and collaborative interfaces, specifically in the teaching of abstract concepts, provide greater advantage over conventional teaching methods in the acquisition and construction of new information, comprehension, retention and recalling of the previously taught subjects as well as building a variety of physical and cognitive skills both in formal and informal learning scenarios.

The delivery of the content in 3D format seems to be more effective compared to 2D print or text materials in the teaching of spatial constructs and leads to better understanding of the studied topics. Implementing *Construct3D*, a three-dimensional geometric construction tool, on their multi-user, shared AR interface called *Studierstube,* Kaufmann and Schmalstieg (2002) observed that viewing geometrical forms in 3D and interacting with them enhanced learners' grasp of mathematics and geometry and improved their spatial skills as these

learners benefited from experimenting with geometric constructions in 3D. Shelton and Hedley (2002) found similar results when they investigated the possibility of physically controlling the 3D virtual models via AR. Their aim was to minimize the effect of the cognitive filter that appears when learning spatially related content using 2D diagrams of Earth-Sun models in a science class. Based on the data collected from 28 students, they suggested that physical manipulation of the astronomical concepts via AR contributes to a more direct cognitive path for better understanding. Likewise, in an experimental study with 133 primary level students and three teachers in an astronomy class, Kerawalla et al. (2006) observed that the students who learned with 3D virtual objects and animations via AR had a relative advantage in understanding the astronomical concepts over the ones who only used traditional materials, i.e., print books, blackboard drawings, round objects etc. Sin and Zaman (2011) also compared the pre-test results of 40 secondary-level students to measure the effectiveness of an AR book called Live Solar System over the traditional textbook in an astronomy class. Students in the experimental group improved their scores by 46%, while those in the control group could improve by 17 % only. More recently, Lu and Liu (2015) conducted an experimental study with 51 primary school students in a marine education class, and the results showed that the AR learning program boosted the learning performance of the low academic achievers and helped the acquisition of learning concepts. These results indicate that 3D visualization of abstract concepts (or the objects that cannot be brought to the learning environment) and the interactive nature of AR learning experience contribute positively to subject learning.

Learning with AR also enhances comprehension, long-term retention and recalling of learning concepts. As Valimont et al. (2007) argue, thanks to the number and variety of modalities available, especially compared to other instructional forms, AR interfaces support human associative information processing and promote information integration by exploiting visuospatial, verbal, proprioceptive, and tactile memory while gaining knowledge, and as a result, increase the amount of elaboration on the subject studied. This means that when there are more memory channels available, the likelihood of encoding information accurately and retaining it in the long-term memory becomes higher, and this eventually impacts the effective and efficient retrieval of information while working on a real-world task. Macchiarella and Vincenzi (2004), in this regard, reported that AR-based learning had a significant impact on long term memory in their study with undergraduate students in an

aerospace maintenance training program. The results of an immediate recall test and a long-term retention recall test given one week after showed that the amount of information forgotten was reduced significantly when compared to the results of the students who were exposed to only video-based and print-based modes of learning. In a study by Dünser and Hornecker (2007), it was found out that AR storybooks had significant impact in story recall and reading comprehension and led to positive outcomes at early literacy education. By moving virtual characters and solving puzzles on an AR storybook, children, aged six to seven, were more likely to solve problems and had more chances of finding new solutions when they collaborated performing a task on an AR interface. Again, in a similar study, Billinghurst and Dünser (2012) compared the learning outcomes of two groups, one of which was taught using a print book on electromagnetism, while the other was taught with an AR book with interactive 3D models of electromagnetic concepts. At the end of the learning session, both groups were given an achievement test in which the AR group performed significantly higher, with a mean score of 72%, in contrast to the 60% of the non-AR group. After four weeks, both groups were given a retention test, and this time the AR group scored higher again, with a mean score of 55%, compared to 45% of the non-AR group.

Correspondingly in language teaching contexts, Chen et al. (2007) utilized an AR interface prototype in teaching Chinese phonetic alphabet to young learners at kindergarten level. Having compared 30 children who were divided into two groups as AR group versus book group, they found out that the AR group performed better in pronunciation and memorization by scoring higher in writing, reading and relationship memory exercises. In a similar context, Freitas and Campos (2008) used a PC-based AR system (SMART) to teach vocabulary on types of animals and means of transport to 52 primary level students in an English class at three different schools. They reported that AR learning experience had a much higher impact on the progress of the weak and average students compared to their traditional learning experience; however, the good students improved in either case, which could be due to the higher potential for improvement in low achievers as well as a tendency in physical movement as AR learning tasks required. More recently, Dogan (2016) implemented AR vocabulary tasks using an image-based mobile AR application with 40 EFL learners at higher education level. At the end of five weeks, he found out significant results in favor of the AR group in terms of learning and retention of the vocabulary items taught. These results

suggest that AR learning improves long-term retention and recall compared to other modes of learning.

The AR systems featuring tangible interfaces enhance the development of skills while performing manual tasks in practical courses. Allowing users to manipulate virtual objects and receive guiding information or immediate feedback, these interfaces have been successfully integrated into physical training sessions. In medical studies, for instance, Kotranza et al. (2009) designed an AR learning environment for medical school students to simultaneously support their psychomotor and cognitive skills building while teaching how to perform a clinical breast exam (CBE). Compared to the traditional CBE training, which require an extensive one-on-one interaction with a professional providing subjective feedback, the AR CBE interface was well-embraced by the students as well as expert clinicians and reported to be providing advantages over traditional approaches due to its on-demand applicability and relatively objective and detailed visual feedback. In military, Henderson and Feiner, (2011) developed a prototype AR application to provide mechanics assistance with the comprehension, localization, and execution of mechanical tasks in routine maintenance and repair of military vehicles. Based on the user data collected, they stated that the application reduced the time and head and neck movements spent on the tasks as the users could locate tasks and perform visual inspections more quickly than they would with conventional techniques. In automatics and robotics, Jara et al. (2011) used RobUALab, a virtual and remote lab application, to help the undergraduate students at a computer science program experiment with manual tasks as a follow up activity for their face-to-face classes. The results from the students' perception study show that the system was quite efficient and useful in their learning process, encouraged them to understand concepts and motivated them to learn more, gave them the opportunity to better analyze the physical phenomena, and enhanced their constructive and collaborative practical learning. It seems that AR applications with tangible interfaces back up learning via experimentation, as in learning by doing principles, deliver simulatory experiences in-situ and on-demand, and improve desired skill sets while conveying cognitive input through interaction with 3D virtual learning objects.

There are several advantages of incorporating representations of spatial information, i.e., location, during knowledge acquisition and AR systems provide great support in this regard. Valimont et al. (2007) argue that when students learn with AR, they have the opportunity to register new information with relevant spatial cues since the real world, the

physical space, is the actual learning environment and these cues serve as mnemonic devices while recalling information. This aspect of AR proves to be useful, particularly on tasks that involve outdoor activities, such as fieldtrips or treasure/scavenger hunt games. These applications, through context-sensitive information and location-aware field guides, allow learners associate spatial data with learning content and make ways of learning possible (Klopfer and Squire, 2008) alongside raising awareness of local environments the learners live in (Morrison et al., 2009). Therefore, when content understanding is linked to such spatial facilities, it becomes more likely to achieve better learning outcomes and longer knowledge retention.

In addition to the effectiveness and affordances above, AR provides new learning opportunities. One of the greatest characteristics of AR learning experience, as frequently endorsed in the literature, is that it is unique and does not resemble any other form of multimedia learning experience. Billinghurst (2002) argues that AR offers three significant properties that are unique in teaching and learning. First of all, AR supports seamless interaction between real and virtual spaces. For instance, in an AR interface, it is possible that learners can share a common workspace and collaborate with each other in a more naturalistic way, using communication cues such as gaze, gestures, and nonverbal behavior. However, when these learners work on computers, they sit side-by-side and focus on the desktop screen space and show different group communication patterns as they do not share a naturalistic interpersonal communication space at all. Second, AR offers a tangible interface metaphor to interact with objects. Because the relationship between the real and virtual is possible in AR interfaces, learners can manipulate virtual content by using physical objects in a quite intuitive manner. For instance, users can control 3D models by moving physical objects in the real world, i.e., cards or cubes. In this way, AR provides a very rich and interactive experience to learners, who may not even have the necessary computer literacy skills. Because there is no mouse or keyboard use required, young learners might also benefit from such rich educational experience. Finally, AR enables smooth transition between reality and virtuality. Billinghurst MagicBook interface, for instance, enables shifting between realities and transforms a real book in a way that it offers content at three different levels of reality, i.e., physical reality, augmented reality, and immersive virtual reality. A printed page, therefore, can become an animated interactive virtual environment and support new forms of

educational experience. It appears that as delivery of content takes a new form in AR teaching and learning, and access to information through integrated media provides serious advantages.

Another reported advantage of AR in education is that it enhances motivation, increases engagement and involvement, and makes content relatively more appealing while learning due to its highly interactive, game-like interface. In the majority of the studies, participants describe their experience in a positive way, express how enthusiastic, fascinated, entertained, and involved they were while using an AR application as a learning tool (Chen et al. 2007; Dünser, 2008; Martin-Gutierrez et al., 2010; Dünser et al., 2012; Chen and Tsai, 2012; Redondo et al., 2013; Iwata et al., 2013; Furio et al. 2013; Chang et al., 2014; Ferrer-Torregrosa et al., 2015; Munoz-Cristobal et al., 2015; Lu and Liu, 2015; Han et al., 2015). Kaufmann and Dünser (2007), in their usability evaluation of an AR application called Construct3D, quoted how highly satisfied users were and could focus their attention on tasks while learning dynamic 3D geometry. Sotiriou and Bogner (2008), in their CONNECT project aiming to bridge the gap between science classes at school and activities in a science museum via specially designed AR tasks, noted that students in the experimental group scored significantly higher in interest and enjoyment domains, and their AR experience increased their motivation and attitude towards learning.

Likewise, in the Handheld Augmented Reality Project (HARP) investigating the efficacy of AR in the math and language arts curricula at the middle school level via specially designed AR Learning Environments called Alien Contact! and Gray Anatomy, O'Shea et al. (2009) found out that AR increased engagement, involvement, and motivation by combining complex problem solving skills and collaborative skills in the teaching of science, math and language skills based on the data collected from observations, formal interviews, and web postings for two semesters. In the further stages of HARP, Dunleavy et al. (2009) conducted a follow up study on the impact of AR on the academic achievement and affect to particularly analyze how teachers and learners describe and understand how an AR learning experience helps or impedes teaching and learning. Based on the findings of the data collected from 80 students and six teachers at middle (sixth and seventh grade) and high school (tenth grade) levels, it was concluded that technology-mediated, narrative, interactive, situated, collaborative problem-solving aspects of AR simulations led to high levels of engagement among the s, including those who were previously disengaged and challenging the teachers both behaviorally and academically. Despite the difficulty of using an HMD, Juan et al.

(2010) reported that participants, 46 children aged 7 to 12, were much more in favor of the AR version of an educational game about endangered species than its non-AR version, describing their experience more fun and stating that they would like to play again.

In similar veins, in a high-school level English class, Liu and Chu (2010) investigated the effectiveness and motivational capacity of an AR learning environment called HELLO for listening and speaking tasks as part of a case study. To measure s' motivation and engagement levels, they designed learning tasks based on Keller's (1987) ARCS (attention, relevance, confidence, and satisfaction) motivation model. Their survey and interview data, collected from 64 students from three different high schools, revealed that using ubiquitous games in learning was effective in terms of not only leading to better learning outcomes, but also providing better motivation for learning. Students reported how interesting but at the same time useful the application was and how it helped them engage in listening and speaking tasks in an enjoyable way. Applying Keller's ARCS motivation model again, Di Serio et al. (2013) looked into the impact of an AR system on 69 middle-school students, aged between 13 and 16, in a visual arts course. Both the quantitative and qualitative results showed that AR learning experience was more interesting and easier to understand compared to the traditional presentation methods. The students were highly engaged in the tasks, concentrated while performing them, and deeply satisfied with the materials, delivery method, and autonomy as they were free to choose the content to explore and revise as much as they wanted via the AR application.

At this point, as Billinghurst and Dünser (2012) argue, the interactivity AR offers appears to play a key role in the involvement with the content. In their AR reading comprehension study, they reported that learners described their reading experience as playing games and told that they enjoyed the interactive parts best. As a result, they suggested that AR books could serve a valuable purpose in engaging students in traditional classroom settings and address the diverse learning preferences of students as an alternative to the good old textbook.

AR enhances interaction at several levels and directions, i.e., learner-learner (Kamarainen et al., 2013, Wang et al., 2014), learner-teacher (Zarraonandia et al., 2013), and learner-content (Chao and Chen, 2009). In an attempt to improve these interaction scenarios, Kaufmann and Schmalstieg (2003) set up one of the first augmented classrooms and used

specially designed AR kits consisting of hybrid hardware, such as HMDs with cameras, custom pinch gloves with sensors, and wearable backpack computers with batteries and wireless network cards while using Construct3D, an AR interface used in geometry education. Although some of these hardware components have evolved into micro computers that are built into smartphones or even glasses/goggles today, the AR kit still allowed high levels of interactivity and collaboration thanks to its portability and shared workspace interface. Upon the completion of tasks, students were walking around the 3D shapes they built together and explored them from different perspectives. Billinghurst and Dünser (2012) claim that when learners interact with the AR learning content, they are more likely to remember new information and transfer it easily when they encounter a problem compared to those who passively receive it. These interactions also push the learners to make an extra effort to understand the material they are working with, invest more interest in it, and eventually become more engaged in the content.

Research conducted with young learners also emphasizes how effectively children could interact with learning content through AR interfaces. Chen et al. (2007) reported that young learners at kindergarten level described the AR interaction and interface as friendlier because they enjoyed interacting with the virtual animal character in the app, and they claimed that it was this aspect of AR which led to more immersion. Similarly, Freitas and Campos (2008) observed how the AR system they used changed the way 2nd grade students interacted with learning content as well as their peers and reduced the distance between the learner and knowledge. Klopfer and Sheldon (2010) argue that such vivid interactions are due to the mobility aspect of AR simulations, that is, students can walk around, talk to each other and discuss, and at the same time, interact with the real environment and objects around them.

To improve the learner-teacher interaction, particularly in case of receiving instant and private feedback on the status of students at a university lecture, Zarraonandia et al. (2013) used a special AR system, ALF (Augmented Lecture Feedback), which allowed the lecturer view virtual signs on the students based on their status regarding the course content with the help of an HMD. By monitoring the students' states during the lecture, i.e., if they understood the topic being discussed or the example being given, the lecturer could either provide further explanation or speed up the pace without any interruption. The results from the study suggest that ALF improved the in-class communication and interaction between the students and the

lecturer and helped those who fear showing up in front of their classmates reflect themselves in an alternative way.

Another affordance of AR in education is that it promotes collaboration while introducing new learning concepts (Billinghurst and Kato, 2002; Kaufmann, 2003; Kaufmann and Schmalstieg 2003; Liarokapis, 2007; Liarokapis et al., 2009; Yoon et al., 2012; Ke and Hsu, 2015; Martin-Gutierrez et al., 2015). Because the virtual information is attached to the real-world objects, learners sharing the same physical learning environment can collaborate and communicate in a more natural and intuitive way using tangible interfaces (Billinghurst et al., 2001; Reitmayr and Schmalstieg, 2004; O'Shea et al. 2009; Dunleavy et al., 2009; Billinghurst and Dünser, 2012; Kamarainen et al., 2013). For instance, Morrison et al. (2009) found student collaboration to be more effective when mobile devices are used to view the AR content on paper maps compared to using the built-in digital maps. They observed that navigating with AR fostered the creation of shared spaces in which students could collaborate and negotiate shared meanings, while navigating with digital maps led to a more individualized experience among the participants. Bressler and Bodzin (2013) reported similar results in their study regarding the implementation of a mobile, vision-based AR science game with 68 students at middle school level. Their findings suggested that such games have the potential to teach collaboration skills to the students along with contributing to their flow experience and promote their interest towards science.

Besides its potential for collaboration via sharing the same physical setting through tangible interfaces, AR also makes remote collaboration possible. Because the information is stored in the virtual space, those who are not necessarily in that environment can participate in the tasks and work together via remote collaborative interfaces (Pemberton and Winter, 2009; Henderson, 2011; Henderson and Feiner, 2011). In a recent study, Pejoska-Laajola et al. (2017) explored the potential of AR video conversations featuring on-screen drawings on mobile devices via SoAR (Social Augmented Reality) app to promote informal learning activities as well as assisting, inspecting, and monitoring tasks between managers and workers in construction and facility maintenance services context. The remote participants could digitally annotate the physical objects during a video conference and share them live with the participants on site in order to provide further guidance on a given task. The results from the field studies and interviews suggested that AR video created a virtual workspace for collaboration and therefore contributed to informal workplace learning.

As is the case in the aforementioned SoAR study, AR blends formal and informal learning and extends learning outside formal teaching settings. Thanks to the rapid development of hardware and software of AR technologies, AR applications on handheld devices are becoming more and more customizable, and offering more accurate location-specific learning experiences (Klopfer and Squire, 2008). Especially with mobile AR in recent years, there are several opportunities to learn while playing outdoor games and continue learning outside the classroom (Klopfer, 2008; Squire and Jan, 2007). This provides students the ability to transfer or even transcend knowledge and skills acquired in traditional classrooms and enables them to learn anytime, anywhere while allowing teachers to draw connections between the learning content and learner experience. These new possibilities change the role of teachers, that is, make them responsible for bridging the gap between the formal and informal through AR, and therefore, add more value to the quality of learning experience in general. (Sotiriou and Bogner, 2008). Likewise, Kamarainen et al. (2013) argue that AR-integrated outdoor activities help students make connections between the abstract knowledge and situated knowledge applied in everyday life. In their project EcoMOBILE, for instance, they found out that students could significantly improve their knowledge on environmental topics by participating in AR field trips. In another study focusing on AR's potential for informal learning, Freitas and Campos (2008) reported the positive impact of SMART on the whole class collaboration as the system transformed the traditional learning environment into a unique and compelling quiz show setting in which all the students participated as contestants and worked in groups to compete while learning second grade concepts via 3D models. These studies reveal that learning with AR is a state-of-the-art pedagogical experience in that learners are positioned at the core of the learning experience and encouraged to utilize their higher-order thinking skills in order to reach more sophisticated learning outcomes (Kamarainen et al., 2013).

Regarding the promotion of higher-order thinking skills, a more sophisticated learning experience, and a -centered pedagogy, the research literature on AR in education also suggests that AR could be incorporated into modern learning approaches and support inquiry-based learning processes while making learners more autonomous and self-responsible for their own learning. According to Wu et al.'s (2013) systematic review, while designing AR learning environments, several instructional approaches are taken into consideration. These approaches, depending on the learning scenario and content, could be categorized in terms of

their emphasis on roles, locations, and tasks. Among the most common approaches are as the following: game-based learning in which learners learn by playing AR treasure/scavenger hunt games to reach the defined outcomes (Squire and Jan, 2007; Freitas and Campos, 2008; Rees, 2010; Liarokapis et al., 2009; Folta, 2010; Liu and Chu, 2010; Bressler and Bodzin, 2013; Wang et al., 2014) problem-based learning in which learners learn through their experience of solving a problem using their mobile AR devices (Squire et al., 2007; Squire and Klopfer, 2007; Liu et al., 2009); discovery learning (Ibanez et al., 2014) and inquiry-based learning in which learners are actively involved in asking questions and problems in the process of learning via an AR interface (Chiang et al., 2014); project/challenge-based learning in which learners gain knowledge and improve their skills through exploration of real-world challenges and problems (Luis et al., 2013); location/place-based/aware learning in which learners use their environment, augmented by virtual elements, as a resource for learning (Reitmayr and Schmalstieg, 2004; Rosenbaum et al., 2007; Squire et al., 2007; Klopfer, 2008; Klopfer and Squire, 2008; Morrison et al., 2009; Klopfer and Sheldon, 2010; Wolpers et al., 2011; De Lucia et al., 2012; Kamarainen et al., 2013; Lakarnchua and Reinders, 2014; Zhang et al., 2014; Tan et al., 2015; Crandall et al., 2015; Harley et al., 2016); (immersive) participatory simulations in which learners perform real-life like tasks simulated by mobile AR interfaces (Rosenbaum et al., 2007; Klopfer and Squire, 2008; Dunleavy et al., 2009; Ibanez et al., 2014); immersive learning (Liu, 2009); collaborative inquiry learning (Wang et al., 2014), collaborative informal learning (Sheehy et al., 2014), collaborative and autonomous learning (Martin-Gutierrez et al., 2015), and collaborative/constructivist/cooperative learning (Billinghurst et al., 2001; Kaufmann and Schmalstieg, 2003; Reitmayr and Schmalstieg, 2004; Dunleavy et al., 2009; Liu et al., 2009; Pemberton and Winter, 2009; Liu and Chu, 2010; Cuendet et al., 2013; Ke and Hsu, 2015) in which learners share the same learning space either physically or virtually and work together on virtual content to reach the desired learning outcomes; learning by doing (Chen et al., 2020), experiential learning (Santos et al., 2014), situated learning and learning by design (Alizadeh et al., 2017), design-based learning (Bower et al., 2014); learning by making (Ke and Hsu, 2015) in which learners actively create, design, and develop while interacting with their environment to learn; complex learning (Ifenthaler and Eseryel, 2013) in which learners are expected to understand complex systems with the help of virtual guidance, and therefore, integrate their knowledge, skills, and attitudes while transferring theory into practice in everyday life; conceptual and cognitive learning (Yoon et al., 2012) in which learners engage

in AR supported learning processes by using their brains to make connections when learning new concepts and organize information in logical mental structures; informal learning (Sotiriou and Bogner, 2008; Elinich, 2011; Cai et al., 2014; Koutromanos and Styliaras, 2015), informal workplace learning (Pejoska-Laajola et al., 2017) anytime/anywhere learning (Munoz-Cristobal et al., 2015), individualized learning (Ferrer-Torregrosa et al., 2015), interactive self-learning (Iwata et al., 2011) in which learners participate in real-life tasks backed up by AR and perform these tasks to create knowledge away formal learning settings; multi-sensory learning (Lu and Liu, 2015) in which learners are taught using more than one modality via an AR interface supporting visual, auditory, kinesthetic and tactile senses; blended learning (Jara et al., 2011) in which real world information on physical objects or print materials is hyperlinked to virtual information for more interaction; 21st century skills, such as interpretation, multimodal thinking, problem solving, information management, teamwork, flexibility, civic engagement, and the acceptance of diverse perspectives (Schrier, 2006).

In addition to the affordances above, there are several other advantages, if not many, reported in the literature, such as AR boosting creativity in fine arts education (Petrov et al., 2020), reducing on resource costs, i.e., supplying learning material and time for preparation, in learning environments and laboratories (El Sayed et al., 2010; Ferrer-Torregrosa et al., 2015) despite the amount of initial expenses at the deployment stage (Diegmann et al., 2015).

2.3.2. Constraints and Limitations of AR in Different Educational Disciplines

The current AR systems, particularly the commercially available ones, seem to be quite satisfying and promising in terms of their affordability, deployment, ease of operation, and user experience compared to the earlier versions. Parallel to the enhancements in the hardware and software components that make AR experience possible, the implementation standards are ameliorating, and the overall quality of acquisition is improving as well. However, when educational settings are considered, the penetration rates are still very low, and this could be due to the fact that commercial AR systems mostly target sectors such as entertainment, gaming or advertisement and the quality content produced is not always relevant for educational uses. Therefore, researchers have to repurpose those AR systems, the hardware and software of which are initially optimized for other purposes, create specific learning content and scenarios based on specific needs, and conduct activities in limited periods of time to gain an overall understanding of teaching and learning with AR. This may

well explain the constraints and limitations of the systems used in the studies as the majority of those constraints and limitations voiced out by teachers and learners are about content, mobility, operational skills, ease of deployment and technical issues. Radu (2014), in his systematic review, claims that while some of these concerns relate to AR in general, most of them are due to the specific versions and/or kinds of AR systems utilized in implementations. Because there is no standard system or implementation, every study has its own shortcomings. However, these challenges regarding technological, managerial, logistical, and cognitive issues to teaching and learning affect the added value of AR in a negative way (Dunleavy et al., 2009).

One of the biggest challenges is the lack of educational applications that are commercially available as a product or service in the market. That means, most implementations, if not all, were developed as part of the efforts of interested teachers and programmers, designed either individually or in smaller teams, with financial concerns and limited amount of content authoring tools. Therefore, it becomes very difficult for an individual to produce a content library including smooth, good quality and sophisticated 3D images to be viewed by users for learning purposes.

The deployment of AR systems is a highly challenging task. It requires greater amounts of time and resources invested by educators to explore what possibilities are available for specific teaching scenarios, and after that, longer hours of training for teachers and/or content authors to be able to develop content and maintain these systems. Chiang et al. (2014) report that such tasks add up to the workload of the teacher. Although the learning curve is not as steep for learners due to the highly intuitive user interfaces today's AR systems offer, learning how to produce high quality learning content and publish it on an AR platform is quite the opposite.

Many educational content developers, if not all, do not possess the programming and 3D modeling skills to design intuitive AR learning experiences. Although the idea of making learners content producers is technically possible thanks to the recent mobile AR applications, it is not a common practice in the research literature (Ke and Hsu, 2015). Moreover, as in the deployment of other forms of new technologies, resistance stands out as a major issue among the faculty members due to issues regarding lack of training, steep learning curve, time investment, accessibility, compatibility with existing curriculum and policies. Even if the

above conditions are met, it is not guaranteed that educators are willing to adopt this technology and adjust their pedagogies accordingly.

The mainstream curriculum and pedagogy should be adjusted to overcome the above challenges. Radu (2014) argues that, at this point, a clear set of guidelines is required for effective educational tasks. Before these guidelines are set up, the ability of learners and the impact of learning with AR on psychological and physiological development of learners have to be taken into account. Otherwise, ineffective classroom integration may cause several other pedagogical and instructional challenges. On one hand, as some studies in Radu's (2014) review report, attention tunneling is an issue and due to the higher attentional demand in some AR systems, learners bypass the preliminary points of the learning task but concentrate on the technical aspects of the system. On the other hand, when learners are concentrated, learning experience is limited to passive reception and digestion of information (Ke and Hsu, 2015), and therefore, it fails to promote higher order integrative thinking skills (Bower et al., 2014). Besides these issues, Munoz-Cristobal et al. (2015) notes that some AR tasks were reported to take too much time to complete and even require extra class time.

AR should become more mobile and easier to use and deploy. Because the industry standards are still inconsistent, AR systems vary in their form factors and could be difficult to operate at times. Some studies, especially on earlier versions of AR, noted that users faced extra challenges when they had to use AR applications instead of their real-life equivalents, such as AR maps vs. real maps, and issues regarding the perception of the physical world arose when they wore bulky head-mounted displays (Radu, 2014). Similarly, the size of the displays appears to be an issue in some studies as well. Munoz-Cristobal et al. (2015), for instance, reported low usage rates and user experience issues due to small screens of mobile devices used in their study. Han et al. (2015) also shared concerns regarding similar usability issues in pre-school contexts. As for the deployment of AR systems, Pelletier (2019) notes that although the prices of AR devices started to decrease, new challenges for implementers emerge, such as storing, maintaining, and securing these devices.

There are several technical issues which might interfere with the design and delivery of educational content, which may, therefore, impede the interactivity and engagement of learners while learning with AR. Regarding the interactions of young learners with an AR storybook, Dünser and Hornecker (2007) reported some technical issues such as spatial

confusion due to mirror effect, expecting physical feedback and reaction from the virtual objects, and navigational issues due to having print and digital elements combined in the same setting. In another study, Dunleavy et al. (2009) mentioned how GPS accuracy disappointed learners and impacted their task performance. When asked for the major technical issue, the participants of the study, i.e., learners and teachers, agreed on the lack of consistency in location information. Similarly, regarding video see-through AR systems, unresponsive or latent marker/image recognition, uneven or incorrect virtual overlays, ambient factors, such as too much light or print quality of markers/images were told to be major causes of problems in accessing virtual content (Ibanez et al., 2014; Chang et al., 2014; Ke and Hsu, 2015). Moreover, the stability of broadband internet connection to retrieve high-quality AR content without further lags and interruptions has also been reported among the major technical issues (Munoz-Cristobal et al., 2015).

Lessons learned from these studies, however, help prospective researchers to take several factors into consideration before designing and delivering AR learning experiences. To name a few, Dunleavy et al. (2009) warns about complicated tasks and too much information load as these may lead to the increase of cognitive load and impact the performers of learners in a negative way. Furio et al. (2013) notes that AR may not be as efficient in crowded groups. Chiang et al. (2014) argues that distractors, especially when AR tasks are conducted outside classroom, might interfere with learning activities and hinder learners' concentration. Despite all these concerns, Di Serio et al. (2013) claims that problems do not necessarily impede the learning processes, and students are capable of easily coming up with solutions. In order to improve the effectiveness of learning with AR, Ibanez et al. (2014) suggest considering some scaffolding options for learners who have problems with self-regulation skills or have difficulty in motivating themselves to engage in AR learning activities.

To conclude, research published on the educational uses of AR contributes to the current practices of pioneering educators and helps them adjust their pedagogies in the light of the expertise and know-how gained from those studies. Such first-hand experiences do not only reveal the unknown, unpredictable aspects of AR in use, but also encourage those who are interested in adopting it as an educational tool in their own teaching and learning yet could not do so due to several unanswered questions. It should also be borne in mind that most of the constraints and restrictions that relate to technology integration and deployment in

educational settings apply to AR implementations as well. Each implementation, therefore, is a step taken to explore the unknown realms of the educational landscape and provide a clearer map for those who want to set off a new journey.

3. METHOD

This section focuses on the methods used and procedures followed regarding the research model and setting as well as the data collection and analysis in this study. As mentioned earlier, the study adopts a qualitatively driven mixed methods design to seek answers to the research questions. This design places the qualitative inquiry (in the form of a qualitatively driven epistemology and methodology) at the core of the study while assigning the quantitative inquiry an auxiliary role to help in the elaboration or clarification of overall core qualitatively driven research question(s) (Hesse-Biber et al., 2015). It contributes to the current study by helping circumvent some of the challenges, if not all, arising from the existence of multiple variables in diverse learning situations as well as the of complexity of human behavior while compiling a clear account of the AR learning experience to address the research questions. Therefore, to explore the use of AR in the English classroom and understand its potential as a learning tool, draw insights from learners' engagement with language, and investigate the technical and instructional aspects of the implementation, user experiences have been documented via observations, interviews, and learning journals. The data gathered from these instruments has been analyzed for themes with Thematic Analysis. In an effort to pursue the formulated research questions that integrate the need to both explore and explain learners' AR experience in a single study and to expand an understanding of AR, the present research also deploys an experimental inquiry to search for any causal relationship or change in participants' awareness and use of new technologies as well as their attitudes towards language learning with new technologies before and after the 14-week AR learning experience. The data collected via pretest and posttest questionnaires and achievement tests has been analyzed with non-parametric tests, i.e., Wilcoxon Signed Rank Test and Mann-Whitney U Test and prepared to be discussed in the Results section.

3.1. RESEARCH MODEL: QUALITATIVELY DRIVEN MIXED METHODS

This study explores the use of Augmented Reality in the English classroom and seeks to understand its potential as a learning tool at tertiary level. It utilizes a qualitatively driven mixed methods design. The representative characteristics of this design are as the following:

1. They are related components that address the same research aim. One component is a complete qualitative project, and the supplemental component uses a different strategy, either qualitative or quantitative.
2. The results of the core and the supplemental component meet at the point of interface, and are integrated in a section called the Results Narrative, with the analysis from the qualitative core forming the basis of the narrative and the supplemental project adding details or examples (Morse and Cheek, 2014, p. 4).

While adopting a qualitatively driven mixed methods design in this study, several reasons as well as benefits have been taken into consideration.

First of all, because the supplemental quantitative inquiry uses different analytical techniques, and the quantitative findings are not just enough to cover all the aspects of the researched phenomenon, it becomes more comprehensible and makes more sense when these findings are interpreted within the context of the core qualitative component (Morse and Cheek, 2014). Thus, relying predominantly on the first-hand experiences of its participants -in the form of their self-reported opinions as well as their observed behavior while using Augmented Reality tasks in their learning, this study prioritizes the qualitative inquiry. However, because it is not possible to illustrate participants technological awareness and adoption level before and after the treatment as well as the impact of the treatment on their achievement test scores only by using the core qualitative method, the supplemental quantitative method elucidates these aspects and expands those significant areas to strengthen and deepen the overall interpretation.

Similarly, in order to obtain a general understanding of how Augmented Reality is experienced while learning English, a diverse and rich account of data is needed. Therefore, while formulating the research questions, the primary concern was in what ways the data could be collected so that it would allow a clearer interpretation of user experience. To address this concern, a set of questions were generated with the intention that they would represent various aspects of the learners' overall experience. The questions were, then, grouped into two sets, in a way that the first set could investigate learners' concerns, views, and observed behaviors with regard to learning with AR, whereas the second set could look for any meaningful, significant difference in their awareness levels, attitudes, and learning performance before and after the *AR learning*. Consequently, the data collected from both

strands through diverse research tools could portray the AR learning experience in the best way possible.

Another important reason for mixing methods is that Augmented Reality is still a new, fresh concept in educational contexts and requires a meticulous exploration at both qualitative and quantitative inquiry level. Because the implementations are rather limited to the efforts of early adopters or innovative, pioneering educators, it is reasoned that a qualitatively driven mixed methods design would allow to explore better and capture a more colorful, vivid picture of what *language learning via AR* means. Therefore, the study has to further investigate how learners adjust themselves to this new concept in a traditional learning environment, utilize their personal devices to access virtual course content, engage themselves in the assigned tasks and perform them, collaborate, and interact with the learning material as well as other learners in class, develop strategies and skills while learning with it, and experience technical challenges and work out solutions to overcome those challenges. With these questions in mind, the hardware and software used for viewing/interacting with the AR content have been specifically repurposed and readjusted around specific learning outcomes that are aligned with the course objectives so that a sample of the learning experience could be generated and captured without leaving any of the above aspects out. However, it is also important to investigate if there is any significant difference in the learners' attitudes and awareness levels before and after this learning experience as well as with students who did not receive this treatment. These findings would not only enhance the study as a whole, but also contribute to the qualitative findings at the interpretation stage. Exploring these aspects through one single method or research-design-only would be extremely difficult or incomplete (Morse, 2003). As a result, it appears that a mixed methods design is ideal because a quantitative-methods-only design would provide limited results which would be too challenging to interpret and draw conclusions from, and a qualitative-methods-only design would make it difficult to measure any statistically significant change during the implementation period.

Finally, both qualitative and quantitative inquiry complement one another and present a more comprehensive account of the area of inquiry (Bryman, 2006). They can support each other when they interpenetrate and inform each other (Miles and Huberman, 1994). This kind of information exchange was very crucial in this study, and it helped revealing different aspects and ensured a clearer interpretation of the findings. Therefore, while the quantitative

data, i.e., the data coming from the questionnaires, provide an understanding of the participants' experiences in terms of their knowledge and awareness of new technologies by presenting information on their technology usage habits, the qualitative data refine and explain these statistical results in depth by merging with the observation notes, i.e., how participants utilized AR in their classroom learning, and their opinions, i.e., how they perceive it as a means of learning and describe this unique experience in their own words and reflect on it, both from interviews and learning journals. This did not only help with putting together the missing pieces of a big puzzle, but also brought in more opportunities for further elaboration.

That being said, the qualitative strand in this study is situated at the core because of the fact that (1) participants' first-hand experiences with AR are the main focus/point of inquiry, (2) they have had no prior exposure to Augmented Reality and a record of AR learning experience, and (3) quantitative methods may fall short in providing a rich, multi-dimensional, and thorough description of the attitudes and beliefs of the participants. Therefore, this strand plays a significant role in exploring the participants' learning experiences through their self-reported and self-reflected insights along with their observed behavior in their actual learning environment, i.e., the language classroom.

The quantitative strand of this research design, on the other hand, serves the purpose of investigating all the participants' (1) technological awareness and use of new technologies, (2) attitudes towards language learning with new technologies, and (3) achievement test performances in order to allow the comparison and contrast of the scores of experimental and control groups within and across so that it does not only address the research questions statistically, but also tries to objectively identify the general profile of the participants, such as who they are, to what extent they are familiar with the new technologies and how competent they already are while adopting these technologies in their own learning. Although this strand is purposefully not as dominant and prioritized as the qualitative within the scope of the particular study, it is carefully positioned to enhance the qualitative strand at the core by providing further understanding of the context and environment, and therefore, leading to a more complex understanding of language learning via AR.

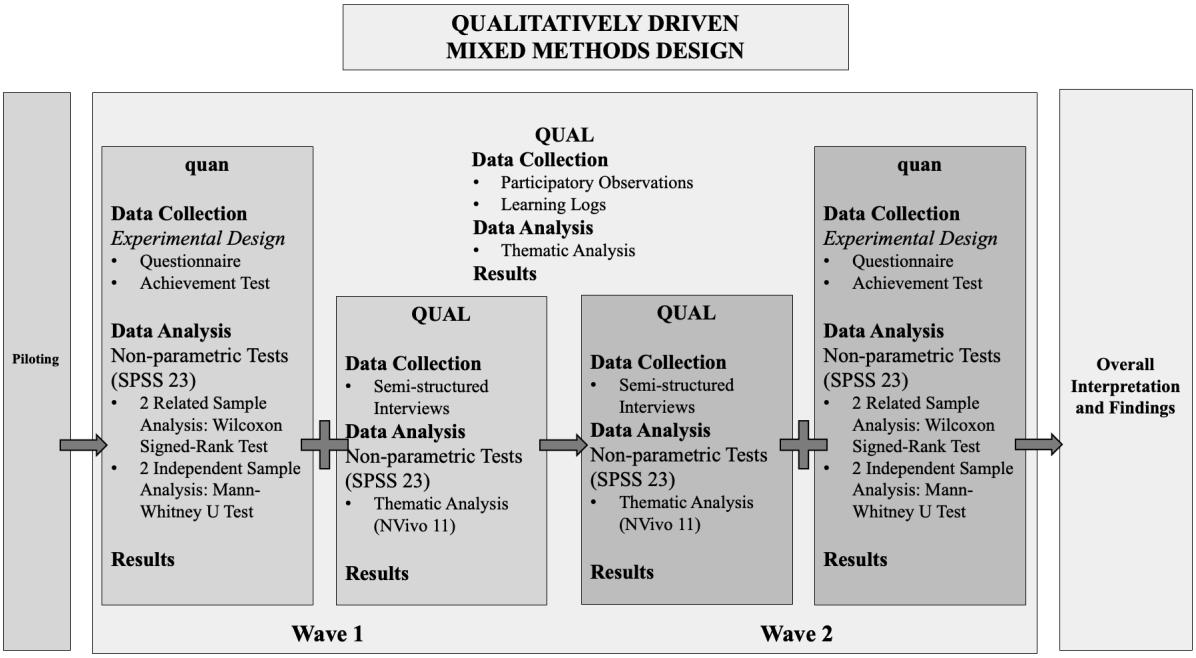

Figure 3.1: Research model

In terms of the prioritization of the methods, qualitative component has a clear priority in that it plays a significant role in addressing the research questions. The mixed methods notation, therefore, is represented as QUAL (quan) in which the parentheses indicate that quantitative data collection is embedded within a larger qualitative design (Plano Clark, 2005). Therefore, as seen above (Figure 3.1), while data collection and analysis occur independently, the findings and results from both components meet at the interpretation stage for a holistic understanding. This specific embedded mixed methods design, according to Creswell (2014), helps understanding the impact of an intervention program through collecting quantitative and qualitative data over time by blending the experimental results with the perspectives of individuals.

When it comes to framing the relationship between the quantitative and qualitative strands in this study, the level of interaction is independent (Creswell and Plano Clark, 2011); in other words, both strands are implemented discretely in the phases of data collection, and data analysis. However, while drawing conclusions for an overall interpretation of the study, i.e., in the discussion of findings, the quantitative and qualitative results are merged.

As for the timing of the methods, concurrent timing (Creswell and Plano Clark, 2011) is preferred since both quantitative and qualitative data sets are collected in the course of the implementation. The data derived from statistical analyses of the pre/post questionnaires and

achievement tests as well as the coding of interviews, observation notes, and learning journals are analyzed independently as soon as the implementation period is over, and the results are interpreted together towards a common understanding. Therefore, when all the above aspects taken into consideration, quantitative and qualitative strands in this study are mixed at the interpretation stage of the research process, and the independent results, i.e., statistical findings and emerging themes, are compared and synthesized in the discussion section.

As far as the design of its qualitative domain is concerned, because the aim is to capture the experience of the participants in their natural environment in order to understand their interactions with the researched phenomenon, the researcher is present in the observation site and is a complete participant. Although one may argue that this kind of participation in qualitative research may lead to a high level of subjectivity in the interpretation of the observed behavior, once combined with other qualitative data collection methods, interviews and learning journals in this case, it generates very rich descriptions of the participants' experiences (Given, 2008). Such combinations of multiple methods help the triangulation of the collected data, and by doing so, ensure the validity and reliability of the qualitative strand of the study (Golafshani, 2003).

Regarding the design of its quantitative domain, this study employs both an *independent measures design* (between experimental and control groups) and a *repeated measures design* (within the experimental group). The primary reason behind this choice is to keep the internal and external validity threats at the minimum level possible. According to Dörnyei (2007), a true experimental design in educational contexts, such as a one-group pre- and post-test design to measure change after a special treatment, is rarely feasible and quite unrealistic due to several possible sources of change, i.e., the maturation effect, the practice effect, or the Hawthorne effect, so it is recommended that a control group should always be included. Thus, to avoid such threats or at least minimize their impact, a control group has been involved to observe any statistically meaningful change as a result of the AR learning treatment in the experimental group. Likewise, having two groups with different individuals and comparing the changes in the test scores contribute to the external validity as this would somehow allow drawing conclusions or making generalizations within the context of this particular study. Although one may argue that the individual differences of the participants in each group decrease the internal validity and threaten the reliability of the study, e.g. some participants' being highly-skilled at using new technologies or having completely

positive/negative biases on technology-enhanced learning, the pre- and post-test procedures come to rescue and serve to identify the possible similarities and differences of the population and provide enough evidence to eliminate potential threats to the internal validity.

In terms of validity strategies, multiple approaches have been employed for the assessment of the accuracy of the findings. The primary validity strategy is to triangulate six different data resources, i.e., observations, interviews, learning logs, questionnaires, and achievement tests, by cross-checking findings and searching for evidence to justify the emerging themes. Likewise, a rich and thick description of the research setting and participant opinions as well as visuals from the implementation are provided while sharing the findings and interpreting the results so that the trial procedure become more realistic and transparent. In order to overcome researcher bias, the researcher's role has been identified by reflecting on the profile of the researcher, i.e., his relationship with the participants, his role in the research site; and more importantly, discussing how being a participant researcher could influence the data interpretation procedures in various sections of this study. Finally, spending prolonged time on site with the learners and working very closely with them from the first day of the class until the last one helped the researcher develop an in-depth understanding of how AR is experienced and draw more accurate and valid insights.

To sum up, the quantitative strand of this mixed methods research is embedded into the qualitative strand and aims to provide insights to the qualitative findings by statistically investigating the participants' technological awareness and use of new technologies and their attitudes towards language learning with new technologies and tries to compare the performances of the exposed and unexposed participants within and across in order to portray the general profile of the research participants in a more objective fashion. The qualitative strand, on the other hand, intends to find out about the participants' language learning experiences with Augmented Reality along with their opinions on new technologies, through their individual remarks and observed behavior, in order to bring about a holistic interpretation of the situation at a broader level. The relationship of the following research questions to the data sources, data collection and analysis procedures in this study is illustrated in Table 3.1.

1. How do learners describe their language learning experience with AR?

2. What do learners think about the role of AR in learning/practicing language skills (listening, speaking, reading, and writing) and aspects (grammar and vocabulary)?
3. What are learners' reflections on:
    a. the technical and instructional assets and liabilities AR holds in language learning?
    b. AR as an educational tool to language learners?
4. Is there a significant difference between the experimental (AR) group and the control (non-AR) group in terms of:
    a. technological awareness and use of new technologies?
    b. attitudes towards language learning with new technologies?
    c. achievement in language proficiency?

Table 3.1: Relationship of the research questions to data collection and analysis

Research questions	Data sources	Data collection	Data analysis
1	AR Group (n=18)	Interviews, Observations, Learning Journals	Thematic Analysis (NVivo)
2	AR Group (n=18)	Interviews, Observations, Learning Journals	Thematic Analysis (NVivo)
3	AR Group (n=18)	Interviews, Observations	Thematic Analysis (NVivo)
4	Experimental (AR) and Control (Non-AR) Groups (n=36)	Questionnaire on Technological Awareness and Use of New Technologies + Attitudes towards Learning Languages with New Technologies (pre- and post-test) Achievement Test (pre- and post-test)	Mann-Whitney U Test (two independent samples, SPSS) Wilcoxon Signed-Rank Test (two related samples, SPSS)

3.1.1. Qualitative Method: Thematic Analysis

The qualitative component of the study adopts a thematic design which enabled the coding and analysis of the participants' personal comments, opinions, observed behavior, and self-reported learning experience on the use of AR in language learning in terms of specific

educational concepts and themes. These concepts and themes work together in order to form key ideas which reveal the most outstanding aspects of the participants' recorded experience. As Marshall and Rossman (1999, p. 150) suggest "[thematic analysis] is the search for general statements about relationships among categories of data…it is the search among data to identify content", this kind of qualitative inquiry helps the researcher read through the data and detect common topics with regard to the cultural and individual preferences of the participants. Therefore, the major benefit of thematic analysis that has been taken into account while choosing it as the qualitative method in this study is that it is flexible and independent of theory and epistemology in contrast to other qualitative methods in which there is a particular theoretical or epistemological positioning (Braun and Clarke, 2006). This method was relatively more effective considering the type of collected data, and it allowed to make sense of the data by analyzing the standpoints of the participants and determining broad patterns by looking for insights without having to follow the specific conventions as required by other qualitative methods.

The thematic analysis in this study (Table 3.2) consists of the analysis of 36 individual semi-structured interview sessions (18 sessions on the third week of the implementation and 18 sessions on the fourteenth week of the implementation), observation notes (48 tasks in 27 sessions in 14 weeks), and 7 sets of learning journals (3 questions in each set answered by 18 participants in 14 weeks).

Table 3.2: Qualitative Components of Study

Data Collection Instruments	# of Participants	# of Questions and Tasks	# of Sessions	Duration
Semi-structured interviews	18	12 questions	36	2 weeks
Participant observations	18	48 tasks	27	14 weeks
Learning journals	18	3 questions	7	14 weeks

The participants were asked 12 questions in the interviews, and the first eight questions were somewhat indicative of the themes and aligned with the categories in the

codebook, such as the questions focusing on participants' learning experience as well as what the participants thought of their engagement with the language, yet the last four questions were provided in order to support the emergence of new themes. The data collected from the interviews were also reinforced with the observation notes and learning journals as these data collection processes were continuing during the implementation and providing more content to identify the fine details of the overall experience.

The data collected by means of various data collection instruments helped the corroboration processes. The analysis, i.e. coding for themes and categories and making connections between these themes and categories, was mainly conducted on QSR International's NVivo® software, a qualitative data analysis program. Thanks to the instant and efficient coding interface as well as the capability to review and analyze multiple datasets at once, the data sets could be treated and processed in a holistic way. By using search, query, and visualisation tools, recognizing the connections and patterns in the data was completed in a relatively effective manner.

3.1.2. Quantitative Method: Experimental Design

The quantitative component (Table 3.3) of the study adopts an experimental design in order to explore whether there is a relation or a causal link between the use of Augmented Reality as an educational tool in the language classroom and learner attitudes towards language learning. In order to measure this, a group of learners, i.e., the experimental group, selected via purposive sampling procedures, was asked to participate in a semester-long Pre-Intermediate level listening and speaking course, the content of which was converted and delivered via AR. On the other hand, another group, i.e., the control group, was formed out of those students in the parallel sections of the same course, and they were taught the same content in a more traditional manner with the same course text and teacher-generated materials without any AR elements.

Before the implementation, a thorough analysis of the course goals and objectives as well as teacher-generated materials was conducted, and an AR learning scheme was developed. Based on this scheme, 48 AR tasks were designed by the researcher to deliver the static course content in a more dynamic way, i.e., hyperlinked content enriched with multimodalities and digital tasks fostering participation, interactivity, and engagement via virtual interfaces, in a fourteen-week long implementation period (Appendix 1).

At the beginning and end of the implementation period, the members of both groups were given a questionnaire collecting information on the learners' technological awareness and use of new technologies as well as their attitudes towards language learning with new technologies along with an achievement test checking content knowledge and course objectives.

Table 3.3: Quantitative Components of Study

Data Collection Instruments	# of Questions	# of Participants (EG)	# of Participants (CG)
Questionnaire on Technological Awareness and Use of New Technologies + Attitudes towards Learning Languages with New Technologies (pre- and post-test)	45	18	18
Achievement Test (pre- and post-test)	27	18	18

The first set of pre-tests features a 45-item questionnaire which aims to collect data on participant demographics of the groups along with their technological awareness and use of new technologies and their reflections towards language learning with new technologies (Appendix 2). The second set of pre-tests is an achievement test which comprises 27 selected questions from the question bank of the course book backed up with extra teacher-generated listening tasks (Appendix 3). While selecting the questions, it was taken into account that major domains (listening, speaking, vocabulary) which the course focuses on are equally represented, and the course goals and objectives for the units are extensively covered.

The learning progress and classroom experiences of both groups had constantly been observed within this period in order to avoid any possible cross-contamination, which would undesirably threaten the internal validity of the study. Although the majority of the factors potentially causing cross-contamination between two groups were present, i.e., the level of interaction among learners outside of the classroom due to being physically very close to each other and sharing similar social groups, the content viewing and interaction through the dedicated AR application were strictly monitored through individual user accounts which were assigned to the members of the experimental group only. Issuing such individual accounts, consequently, did not only minimize the risk of cross-contamination, but also created the opportunity to access the user activity logs, which, in the end, provided excessive

statistical data on their learning behavior, such as which users accessed what specific task/content at what time, how much time they spend while working on a specific activity, and how many times they have viewed. Although the data from the activity logs are not used at the interpretation stage of this study, they at least help to validate the restricted access only by the participants of the experimental group.

The quantitative data are treated by non-parametric statistical hypothesis tests on SPSS,

- Wilcoxon Signed Rank Test (2 related samples, between the pre- and post-tests of the experimental group) and
- Mann-Whitney U Test (2 independent samples, between the pre- and post-tests of experimental and control groups),

due to the small number of participants ($n < 30$) in both experimental and control groups. The goal here is to compare the pre- and post-test scores of the two groups within and across in order to find out whether their mean ranks differ both at the beginning and end of the implementation.

3.2. RESEARCH SETTING AND SAMPLE

This section summarizes the research setting and sample of the study and explains the details of the related processes regarding where and when the study has been conducted, how long the implementation has lasted, who the participants are, what role the researcher has taken before, while and after the implementation period, what tools and resources have been utilized, and finally how the content development procedures have been followed. The detailed explanations in the sub-headings will contribute to the general understanding of the AR learning research context as well as the circumstances the data has been collected under, with reference to the decisions made and their justifications within the broader context of the research methodology.

3.2.1. Site And Duration

This study was conducted in the spring term of 2015 with 36 Pre-Intermediate Level (CEF-R equivalent A2) students in the English preparatory program of a foundation university. The university is a non-profit, foundation university in Istanbul, Turkey. It consists

of Colleges of Social Sciences and Humanities, Administrative Sciences and Economics, Science, Engineering, Law, Nursing and Medicine. There are 22 undergraduate, 31 graduate, and 16 doctoral programs. The university attracts many of the highest scoring students from Turkey's top high schools. There are about 5,500 students. The medium of instruction is English and the majority of classes (over 96%) are taught in English except for the School of Law and School of Nursing. Therefore, the English preparatory program is a mandatory preparatory program for all the new coming students who cannot receive a score of TOEFL IBT 80 or TOEFL ITP 550 (with a minimum TWE score of 4). Every year, approximately 700+ students enroll in the program and take courses on several different skills to improve their competences in English language.

The students who are supposed to study in the English preparatory program are placed according to four main levels depending on their language competencies: foundation, pre-intermediate, intermediate, upper-intermediate, and an extension level for repeat-year students. The language proficiency of the levels ranges from A1/A2 (foundation) to B2/C1 (upper intermediate). The average hours of instruction each week is 24.

The English preparatory program follows almost the same term system as the other colleges do. There are three terms: approximately 14 weeks in fall and spring, and 6 weeks in summer. Students who start at lower levels (foundation and pre-intermediate) are supposed to stay a minimum of two semesters in order to master their skills and be eligible to take the exit exam, while those who start relatively higher (intermediate and upper intermediate) can take the exit exam in one semester. After each semester, the groups are shuffled, and new groups are formed within levels. Therefore, the implementation period of this study had to last 14 weeks as the majority of the participants are promoted to become freshmen.

The course selected for this specific study is a Pre-Intermediate Level Listening and Speaking course. The main reason was because they were the ideal representatives of average English learners in the program compared to the other three levels available. The biggest challenge with the foundation level students was that their English level varied from zero beginners to upper A1 level, and there were also several false beginners who would take at least three semesters to master the required level of proficiency to get promoted as freshmen. Because these groups were formed of mixed ability students and some of them did not know enough English to understand the instructions and questions in the questionnaire and

interview, this would be a limitation for the study and interfere with the reliability of the results. The intermediate and upper intermediate level students, however, had more prior experience with English and were staying in the program mostly for a semester either because they could not fulfill the exit score requirement in the institutional TOEFL practice (550 or above) at the beginning of the educational year or they simply wanted to spend a semester or two to take a somewhat *gap year* in which they could have a smoother transition to academic life before being freshmen. Therefore, working with these students would be extremely difficult and not so reliable. It would also risk the continuity of the study as most of these students had attendance problems. As a result, when all the above concerns were taken into account, the pre-intermediate level students stood out as the ideal group of learners for this study.

The Pre-Intermediate Level Listening and Speaking course has seven hours of instruction per week. Participants attended the course for approximately 14 weeks between February 2, and May 15, 2015. In addition to this course, they also took a Reading and Writing course, Academic Project and Presentations course, and a Grammar course at A2 to B1 level.

The selection procedure of the research site primarily involved the convenience of the researcher's teaching position in the program. Being a full-time instructor, he was always present and could get a direct sense of what was happening on a day-to-day basis in the classroom, and as a participant observer, he could easily concentrate on each participant, keep a detailed record of their interaction, and make sense of it. Furthermore, he had a very clear understanding of the profiles in that site, especially after having worked there for eight years. Therefore, this insider view as an involved researcher contributed a lot to the perception and overall understanding of the participants' experiences and enhanced the design, development, and implementation phases of the study accordingly. Although one may argue that the data collection and analysis procedures include the researcher's own subjectivity to a high extent, and as a result, make the self-reporting difficult due to "the twin dangers of overmodesty and self-aggrandisement" (Walsham, 1995, p. 78), the merits of the role as an involved researcher still outweigh these concerns, especially in this study as it requires explicit interpretation and reflection of user experiences in a learning context.

3.2.2. Participants

This study adopts a purposive sampling approach. Its aim is to find out about how rich and varied insights of individuals can lead to the better understanding of the AR learning experience that is under investigation. In other words, instead of dealing with a substantial sample which helps analyzing particular individual differences, the researcher focuses on the description, understanding, and interpretation of the human experience (Polkinghorne, 2005, cited in Zoltán Dörnyei, 2007). Therefore, the participants' AR learning experience in this study does not necessarily represent the respondent sample, nor does the distribution of the AR learning experience within the general population.

The participant selection process started at the beginning of the semester as soon as the class lists were announced. The experimental group initially consisted of 21 students who were enrolled in the course; however, two students never attended the classes, and one student attended irregularly at the beginning of the semester and soon failed the course due to the attendance policy before the end of the semester. Therefore, these three students were not included in the experimental group. As for the control group, out of six pre-intermediate sections, two sections were selected and 18 students from these sections were recruited among those who volunteered to participate in this study. Within the domains of purposive sampling, this kind of sampling is called typical sampling (Dörnyei, 2007, p.128), and it was preferred in this study in order to achieve faster saturation due to feasibility concerns. The participants' English learning experience was typical with regard to the standard pre-intermediate level students at the B1 level in the preparatory program.

The recruitment process of the participants involved a brief information session about the research study for both experimental and control groups and required the participants to carefully read, understand and agree to the terms in the consent forms. The process of informing participants and receiving their consent took a week. Once the recruitment procedure was finalized, there were no additional participants added. The groups remained the same until the end of the semester so that the homogenity of the groups and reliability of the responses could be successfully ensured.

Although one may argue that the number of the participants is rather low and may not bear desirable and, more importantly, reliable results, research methodology literature seems to reflect quite diverse opinions on this matter. For instance, for the most commonly preferred

statistical analyses, the ideal number of participants is expected to be above 29 so that the data can bear meaningful, reasonable, and interpretable results. However, while there is no set quota in the number of participants in an interview study, Baker and Edwards (2012), in their methods review study featuring the commentaries of 14 renowned scientists and 5 early career researchers, conclude that the possibility of obtaining saturated data highly depends on the research, participants, and time and resources available; however, if they were to express a number, it would be 14 for renowned scientists, and 19 for early career researchers. This study, therefore, fulfills the requirement of the number of subjects respectively.

In order to fulfill the requirements of sampling-related validity and credibility in the quantitative component of the study, 36 students from three different sections were selected on a somewhat voluntary basis: 18 were identified as the experimental group which consisted of individuals in the same section, whereas the other 18 became the control group which included participants blended from two different sections. However, for the qualitative component, all the 18 members of experimental group remained the same.

The demographic background obtained from the first section of the questionnaire illustrates the profile of the participants for both groups. The table below shows the age distribution of the two groups (Table 3.4):

Table 3.4: Frequency and percentage values of age

Group			f	%	Valid %	Cumulative %
Experimental Group	Valid	18	9	50.0	50.0	50.0
		19	3	16.7	16.7	66.7
		20	5	27.8	27.8	94.4
		21 or older	1	5.6	5.6	100.0
		Total	18	100.0	100.0	
Control Group	Valid	18	8	44.4	44.4	44.4
		19	9	50.0	50.0	94.4
		20	1	5.6	5.6	100.0
		Total	18	100.0	100.0	

Each group consists of seven males (38.9%) and 11 females (61,1%), and a total of 18 participants (Table 3.5):

Table 3.5: Frequency and percentage values of sex

Group			f	%	Valid %	Cumulative %
Experimental Group	Valid	Male	7	38.9	38.9	38.9
		Female	11	61.1	61.1	100.0
		Total	18	100.0	100.0	
Control Group	Valid	Male	7	38.9	38.9	38.9
		Female	11	61.1	61.1	100.0
		Total	18	100.0	100.0	

The participants in each group are enrolled in the undergraduate programs below (Table 3.6):

Table 3.6: Frequency and percentage values of study program

Group			f	%	Valid %	Cumulative %
Experimental Group	Valid	Business Administration	7	38.9	38.9	38.9
		Economics	1	5.6	5.6	44.4
		Electrical Electronics Engineering	2	11.1	11.1	55.6
		Industrial Engineering	2	11.1	11.1	66.7
		International Relations	2	11.1	11.1	77.8
		Law	1	5.6	5.6	83.3
		Media and Visual Arts	1	5.6	5.6	88.9
		Medicine	1	5.6	5.6	94.4
		Molecular Biology and Genetics	1	5.6	5.6	100.0
		Total	18	100.0	100.0	
Control Group	Valid	Business Administration	4	22.2	22.2	22.2
		Chemical and Biological Engineering	1	5.6	5.6	27.8
		Chemistry	2	11.1	11.1	38.9
		Economics	3	16.7	16.7	55.6
		Industrial Engineering	1	5.6	5.6	61.1
		Law	2	11.1	11.1	72.2
		Mechanical Engineering	2	11.1	11.1	83.3
		Media and Visual Arts	1	5.6	5.6	88.9
		Psychology	1	5.6	5.6	94.4
		Sociology	1	5.6	5.6	100.0
		Total	18	100.0	100.0	

The majority of the students hold a scholarship, either full or half, because they have achieved higher scores at the university entrance exam (Table 3.7):

Table 3.7: Frequency and percentage values of scholarship

Group			f	%	Valid %	Cumulative %
Experimental Group	Valid	Yes	16	88.9	88.9	88.9
		No	2	11.1	11.1	100.0
		Total	18	100.0	100.0	
Control Group	Valid	Yes	16	88.9	88.9	88.9
		No	2	11.1	11.1	100.0
		Total	18	100.0	100.0	

The English learning history of the participants are as the following (Table 3.8). The members of the Control Group seem to have invested relatively more time in learning English:

Table 3.8: Frequency and percentage values of English learning experience

Group			f	%	Valid %	Cumulative %
Experimental Group	Valid	0-4 years	1	5.6	5.6	5.6
		5-9 years	14	77.8	77.8	83.3
		10-14 years	3	16.7	16.7	100.0
		Total	18	100.0	100.0	
Control Group	Valid	0-4 years	3	16.7	16.7	16.7
		5-9 years	8	44.4	44.4	61.1
		10-14 years	7	38.9	38.9	100.0
		Total	18	100.0	100.0	

3.2.3. Researcher's Role

Qualitative research is interpretative, and the researcher's interpretations in a study are based upon his biases, values, and personal background (Creswell, 2014). Because the researcher is an active participant in the research site, i.e., the instructor of the course, is involved in all the stages of the study from the very beginning, and has strong interactions with the participants to facilitate the AR learning tasks and collect data during observations and interviews, it is important to identify his biases, values, and personal background beforehand to present a clearer picture of the context this study has been conducted in.

According to Malterud (2001), the background and position of the researcher determine what is chosen to be investigated, how it is investigated, which methods are adopted for the investigation, what is considered as appropriate findings, and what constitue the conclusions of it. Such an effort, also known as *reflexivity*, requires:

> identifying preconceptions brought into the project by the researcher, representing previous personal and professional experiences, prestudy beliefs about how things are and what is to be investigated, motivation and qualifications for exploration of the field, and perspectives and theoretical foundations related to education and interests (Malterud, 2001, p. 483).

Therefore, the following reflexivity statement aims to reveal the background and position of the researcher in this study with regard to his prior experience and assumptions:

My perceptions of using new technologies in language learning have been formed in the early days of my undergraduate education, back in 2001. Witnessing the Internet revolution in Turkey at the time, i.e., transitioning from print to digital media in educational contexts, I could have the privelege of being able to compare the old and the new, adjust myself by mastering the required skillsets to be more productive on new media. Since then, I have always questioned how I could fuse new technologies into traditional teaching environments in a more meaningful way and make an impact on learning outcomes.

For me, CALL meant more than what was available at the time. Being influenced and inspired by the principles of Communicative Language Teaching as well as Social Constructivism, I had a critical stance against drill-based CALL exercises and was concentrating on tasks which would promote performing skills in a more communicative way, such as WebQuests, podcasts and vidcasts to make learning a more communicative, interactive, and social experience. Following the latest trends in educational technologies, I started working with three-dimensional (3D) virtual worlds (VWs), e.g. Second Life, where learners could immerse themselves in virtual simulations to learn or practice languages in a somewhat social context. I was so impressed with the capacity and potential of these environments that I explored the sociocultural dimensions of language teaching activities in three-dimensional virtual worlds as part of my master's thesis study.

Having these experiences and perspective, I worked as an English instructor and served as the head of the educational technology unit between 2011 and 2017, in a higher education institution in which I had the opportunity of implementing several important e-learning projects, administration of learning management systems, development and deployment of digital tools and resources, digital conversion of traditional study programs, and training students and faculty members on how to use these technologies effectively. Working very closely with all the stakeholders, i.e., publishers, administrators, teaching faculty, and students, I got familiar with the institutional culture and had a chance to learn how to deal with resistance, motivation, and attitude issues while introducing and integrating new technologies into academic contexts.

My first attempts of integrating Augmented Reality (AR) into my classroom teaching date back to 2012. These attempts mostly included scanning marker images with smartphones and viewing preset 3D images that were assigned to those markers. Although the amount of virtual content was limited, the quality of viewing experience was somewhat rough, and there was no flexibility in modifying the content to address specific learning objectives, AR was still a new concept, attracted great deal of attention among the students, and was well embraced by them in the classroom. The idea of enhancing and enriching the static content, i.e., books, handouts, and print materials, opened the door to a new dimension and offered endless possibilities to extend what had already been available. The sheer excitement of looking for the right spot to scan, and the utter glory of finding it and viewing the static content animating and becoming alive was truly an unusual, magical experience for them. That was the time when I thought AR was definitely the next big move after VR, and I should keep experimenting more.

The past experiences and future vision of the researcher may bring certain biases into this study. Although objectivity is intended to be ensured through different efforts in this study, these biases shape the way the data collection and interpretation processes are perceived and understood. Without this background, it would be impossible for the researcher to develop a prototypical AR learning tool and a learning schema to implement in his classes. Therefore, the researcher's background could be seen as an enhancement in his role as a researcher in terms of awareness, knowledge, and sensitivity to the challenges, decisions, and problems encountered during the treatment period, and therefore, helped him interpret the complex procedures in this study in the best way possible.

3.2.4. Resources and Tools

The resources and tools utilized in this study involve hardware resources, i.e., participants' personal technologies and spare devices provided by the researcher; software resources, i.e., the mobile AR application installed on these devices, and print resources such as the coursebook and worksheets generated by the instructor.

The main hardware resources were participants' personal technologies. Every participant owned smart phones, and some even had tablets in addition to those. With broadband Internet connection either through the Wi-Fi network available in the classroom or

their personal mobile data plans, they all had internet access. In case some participants had technical problems with their personal devices, the researcher brought two spare devices (an iPod touch and an iPad) to every session so that those who needed could use one of these spare devices. All of the devices were mobile and ran either Android (mobile operating system developed by Google) or iOS (iPhone Operating System developed by Apple). In addition to their devices, the participants were also asked to bring their earphones and headsets to the sessions so that they could listen to the audio content at their own pace, without interrupting others working on different tasks.

As for the software resources, although there were various Augmented Reality applications available on various platforms, for participants' convenience (free, easy to download and install, simpler interface, available both on Android and iOS etc.), a mobile AR application called Aurasma was chosen among all the available options, such as BuildAR Pro 2.0, Wikitude, Layar, Augment, Junaio, and Woices. The main reason why Aurasma was chosen was because it was available on the most common mobile platforms, i.e., Android and iOS, had the advantage of being relatively more flexible and functional in terms of content creation and delivery compared to the other applications and programs, and provided the opportunity to control subscribers, i.e., the experimental group, thanks to subscription-only-access private channels. Launched in 2011 and later acquired by HP Autonomy and rebranded as HP Reveal, Aurasma attracted over 80,000 customers operating in over 100 countries (https://www.aurasma.com., Accessed: 26 April 2016). Thanks to its swift image recognition technology on mobile devices, businesses and organizations have begun to use this new channel to publish their own augmented content and created millions of Auras, generating in the process more than one hundred million AR interactions since its launch.

The app required the following system specifications to run during the implementation period:

- A high-powered ARM or x86 processor
- Rear-facing camera, preferably with autofocus
- iOS (iOS 7.0+) or Android OS (Android 4.0+)

However, before being completely integrated into this study, Aurasma was piloted for a semester, fall semester of 2014, prior to the current study to fully explore its potential benefits and challenges as well as its feasibility and applicability in language classes. This

piloting stage provided lots of valuable insights in terms of addressing collaboration, interactivity, interaction, and engagement concerns in classroom learning as Aurasma app combined with an LMS at the background could afford these to a greater extent compared to the other prospective apps mentioned above.

Among the print resources, the course adopted Q: Skills for Success Listening and Speaking Level 3 (Craven and Sherman, 2011) by Oxford University Press as its main text. This text had been used over the last three years before the treatment, and the researcher was quite familiar with the content as he had been teaching this course. In addition to the course main text, there were also instructor-generated materials, handouts, and worksheets, that were exploited while making tasks AR friendly by creating trigger images and uploading relevant content online.

3.2.5. Content Development and Procedures

In order to produce and publish AR content, also referred to as *Auras* in Aurasma interface, which are units of virtual multimedia information layers placed on physical objects through the recognition of their pre-defined images stored in an online database, the researcher requested access to an Aurasma Developer Studio account (Figure 3.2), acquired it, created a private Aura channel, and shared its subscription link only with the participants in the experimental group so that it would be a closed circuit system, and the AR content would only be available to the subscribed members. This also restricted the participation in the treatment, prevented any possible cross-contamination from the control group, and provided access and usage data to see how many times they viewed/clicked on the AR content or how much time users spent while working a task.

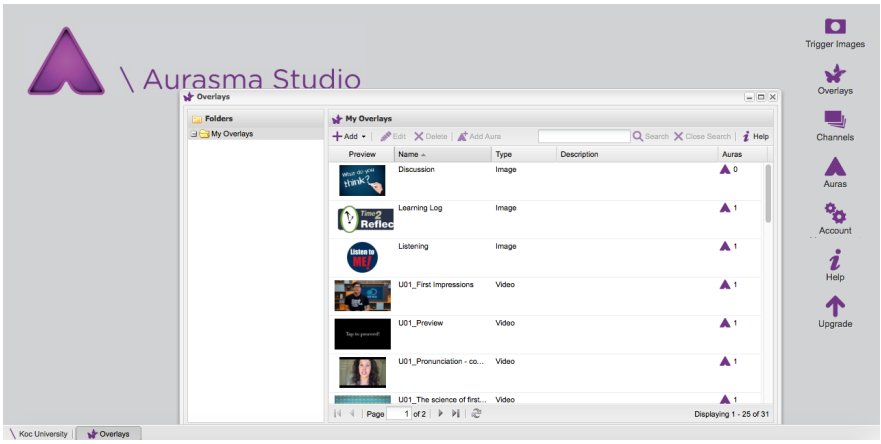

Figure 3.2: Aurasma Developer Studio

After an intensive preparation period, the Auras were created prior to the beginning of the semester and made ready to be deployed. These Auras were basically formed of either selected authentic multimedia materials, such as video animations, info sessions and songs on a specific topic, or three-dimensional (3D) virtual images, which were publicly available online, or the researcher's own production providing guidance on specific tasks. Each and every one of these Auras was then assigned to specific tasks in the book, aiming to convert the traditional and *offline* activities in the course book into interactive tasks which would ideally increase the amount of interactivity and multimodality, and therefore the quality linguistic reception and production. In the end, there were 48 AR tasks addressing several different skills and sub-skills that are in line with the following course learning objectives:

- use prior knowledge and personal experience to predict content
- listen for main ideas
- listen for details
- listen for exact words and phrases to improve word recognition
- use intonation, volume, and other features to infer a speaker's attitude
- listen for signposts to understand the structure of a passage
- ask for clarification to understand difficult concepts
- give reasons and examples to support opinions expressed
- use sequence expressions to clarify the order of events in a presentation
- understand and use the key vocabulary
- use context to understand the meanings of unfamiliar words and phrases
- understand phrasal verbs to accurately interpret statements
- correctly use idiomatic expressions
- use contractions
- correctly place stress on important words in sentences
- effectively use intonation in different sentence types

The assignment of the tasks involved a series of technical preparations and procedures, which started with uploading the images of the relevant sections in the book into the Aurasma Developer Studio account and matching these images with the relevant virtual content that had already been uploaded using the tools on the web interface. After the matching, a transparent overlay was added onto the trigger image and certain gestures could be integrated

into this overlay so that the virtual content could be responsive and interactive. Therefore, when the related area on the physical medium, e.g., an image in the book, is scanned by a subscribed user, the AR application immediately recognizes that image by matching it real-time with the trigger image in the developer studio database and overlays the previously uploaded virtual content, e.g., a short video, onto that actual image of the object that can be seen on the device screen (Figure 3.3). After viewing the content, the user performs one of the gestures, i.e., tapping once, and proceeds to the next stage. This could then direct the user to a different screen, which could be a static page where they read more information on the topic or a dynamic page where they type in their responses to a question posed in the previous content.

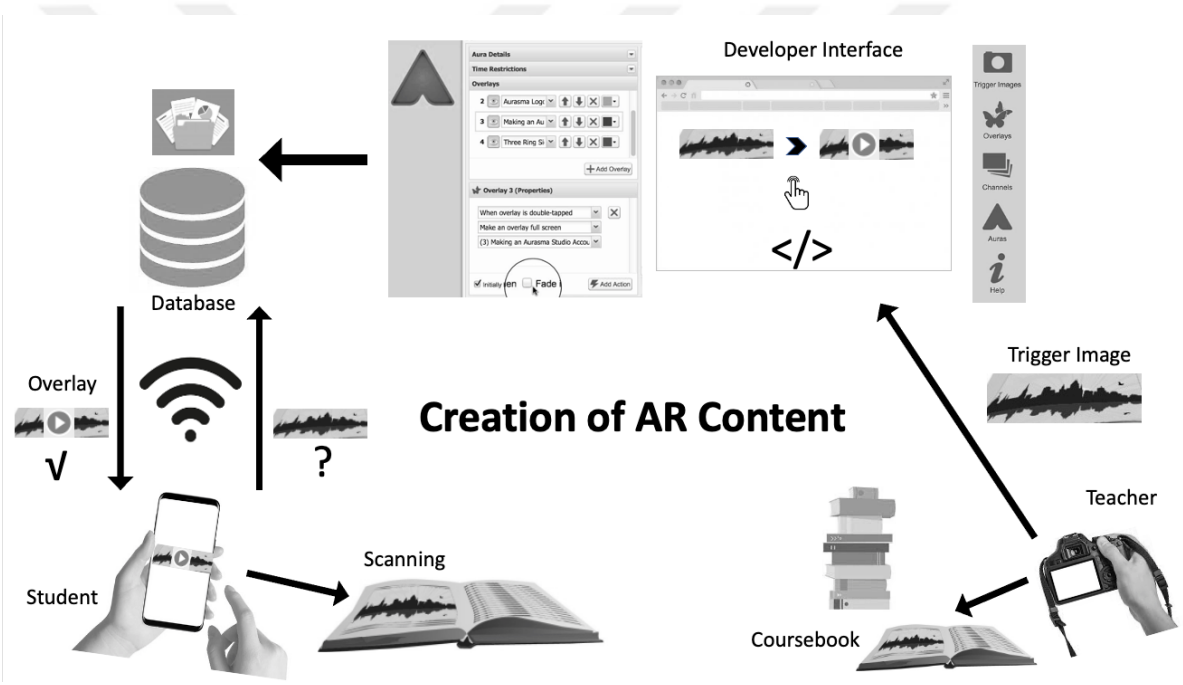

Figure 3.3: Creation of AR Content

As mentioned above, because the functionalities of AR applications were limited at that time and did not allow much flexibility in terms of productive interaction, the learning management system of the institution, Moodle, was also integrated into the AR activities so that the participants could engage better, not only viewing the ready content but also producing and contributing to that content (Figure 3.4). This integration also helped the researcher collect more efficient activity participation data as Moodle has the capability of logging all access activity.

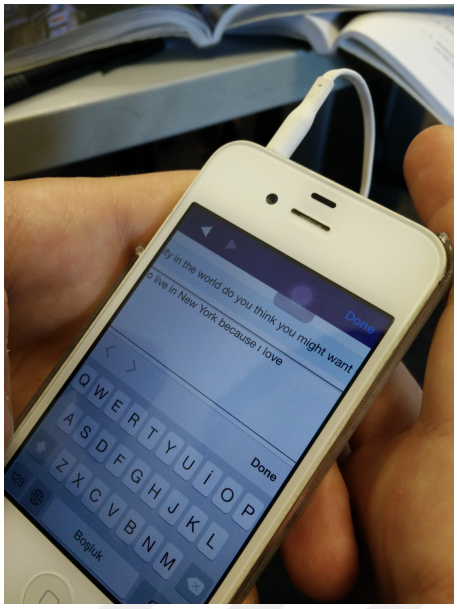

Figure 3.4: Moodle Integration with Aurasma

Each task covered one or more course objectives featuring hyperlinked virtual content on the existing print materials for the course and introducing multimodalities, interactivity, engagement, and involvement in a shared virtual learning space through AR. The tasks followed the below scheme which was developed after a detailed consideration of the course objectives and a thorough analysis of the existing course content and materials (Table 3.9):

Table 3.9: AR Learning Scheme

Stage	Sub-stage	Objective	Receptive Task	Productive Task
Modeling	Pre-listening, Warm-up	Activating schemata	Class discussion audio, introductory video	Participating in a poll
	Vocabulary	Introducing key vocabulary	Viewing audio-visual cues (pictures, songs) for context	Adding a glossary entry
Application	While listening	Listening for details and/or comprehension	Watching a lecture, interview, presentation etc.	Answering multiple choice and short answer questions
Production	Post listening	Listening for further interpretation	Watching authentic videos (documentary extracts, conference talks etc.)	Expressing opinions in a discussion forum

Speaking	Identifying and recognizing pronunciation, intonation, and stress patterns	Watching interactive videos on English phonetics	Mimicking the speaker

Table 3.9: AR Learning Scheme (continued)

The AR Learning Scheme involves the modeling, application, and production stages, and aims to cover all the possible substages in the course, teaching objectives that are mentioned in the curriculum for the pre-Intermediate level courses, and a variety of receptive and productive tasks that could be fitted with AR to create a sample of language learning experience. The tasks designed according to this model were aimed at enabling a smooth transition from print to hypertext, enriching learning contexts, fostering interaction at various levels, and contributing to the literacy skills of the learners. After three years of experimenting with AR applications in the given context, using the same text over and over again, piloting the Aurasma app for content creation for one semester, and taking the course dynamics as well as institutional expectations into consideration, it was concluded that these tasks were the most feasible and affordable ones to be conducted during the implementation period.

Based on the model above, the tasks in the course text, Q: Skills for Success Listening and Speaking Level 3 (Craven and Sherman, 2011), were converted to AR learning tasks before the implementation period. The unit and task progressions for each unit addressed a variety of skills and tasks that could be designed and delivered on the AR learning interface (Appendix 1). The AR tasks for Unit 5, for instance, included the following activities:

1. Section: Preview (p. 85)
    - Trigger image: Preview task image [*Unit Q Listening*]
    - AR overlay: Group discussion listening – *Are we responsible for the world we live in?*
    - Overlay follow-up action: Poll submission on embedded LMS window – *Should we be responsible as individuals, or should we have the government take over some responsibility? Why?*
2. Section: Speaking (p. 89)
    - Trigger image: *What do you think? Discuss the questions in a group.*

- AR overlay: Discussion animation with visual instructions
- Overlay follow-up action: Forum discussion on embedded LMS window – *At what age do you think someone becomes responsible for his or her actions (for example, behaving well in public, doing chores, or handling money)? Explain.*

3. Section: Listening (p. 93)

- Trigger image: Listening task image [*environmental problems*]
- AR overlay: *TED Talk: Pam Warhurst – How we can eat our landscapes* (https://www.youtube.com/watch?v=vqhx4Etdvr0, Accessed: 24 May 2022)
- Overlay follow-up action: Listening comprehension worksheet – *Answer open ended questions*

4. Section: Vocabulary (p. 95)

- Trigger image: Word *abuse* in vocabulary list
- AR overlay: *PSA – Spot animal abuse, dial 9-1-1* (https://www.youtube.com/watch?v=TyuXkdqvJpw, Accessed: 24 May 2022)
- Overlay follow-up action: In-class discussion – *Alternative context, different meaning*

5. Section: Pronunciation (p. 97)

- Trigger image: Section sub-heading – *Intonation in tag questions*
- AR overlay: *Rachel's English – Questions and Intonation Up or Down* (https://www.youtube.com/watch?v=Aoj4HZlLQBY, Accessed: 24 May 2022)
- Overlay follow-up action: In-class speaking practice

6. Homework: Listening (instructor-generated print worksheet)

- Trigger image: *ESLPod Scan Here* Tag
- AR overlay: *ESLPod880 Forming a Union* (https://secure3.eslpod.com/podcast/esl-podcast-880-forming-a-union/, Accessed: 24 May 2022)
- Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

As can be seen above, the AR tasks address specific learning objectives by hyperlinking physical content in the book or on a worksheet to virtual content via carefully selected overlays. They also enrich the static print content with the dynamic virtual content on the interface which combines real and virtual spaces and provides learners the exposure needed. The tasks then promote productivity with the follow-up actions upon interaction with the virtual content and create more opportunities to use the newly learned concepts and forms in meaningful contexts.

3.2.6. Implementation

The implementation of AR learning tasks covered an active 14-week period of a 15-week semester, from the beginning of the Spring semester of 2015 to the end (Table 3.10) in the Experimental Group. The first week started with preparations, that is, downloading and installing the Aurasma application into participants' personal devices, creating Aurasma accounts and subscribing into the private Aura channel to be able to view the AR content prepared for this study. The participants were also given a brief orientation session on the application interface, performing basic operations using gestures, and demonstrations of sample tasks. By the end of this session (one class hour), all of the participants were able to scan and view the sample tasks without any further questions. The distribution of the AR tasks was seven tasks per unit (Appendix 1) on average. The unit related tasks, i.e., the tasks that were on the book were mostly done during the actual lessons in the classroom, while the tasks marked as "extra listening" were given as homework or self-study.

Table 3.10: Implementation Calendar

Week	Monday	Tuesday	Wednesday	Thursday	Friday
Feb 9 – 13	First Day of Classes	**Unit 1 (AR Orientation)**	**Pre-Tests (EG and CG)**	**Pre-Tests (EG and CG)**	**Pre-Tests (EG and CG)**
Feb 16 – 20	**Unit 1 8 AR Tasks**	*Unit 1*	*Unit 1*	**Unit 1 (Learning Journal 1)**	*No Classes*
Feb 23 – 27	**Unit 2 7 AR Tasks**	*Unit 2*	*Unit 2*	*Unit 2*	*No Classes*
Mar 2 – 6	*Unit 2*	**Unit 2 (Learning Journal 2)**	**Unit 3 9 AR Tasks**	**Interviews (EG)**	**Interviews (EG)**
Mar 9 – 13	*Unit 3*	*Unit 3*	*Unit 3*	*Unit 3*	*No Classes*
Mar 16 – 20	**Unit 3 (Learning Journal 3)**	**Unit 5 6 AR Tasks**	*Unit 5*	*Unit 5*	*No Classes*
Mar 23 – 27	*Unit 5*	*Unit 5*	**Unit 5 (Learning Journal 4)**	**Unit 6 8 AR Tasks**	*No Classes*
Mar 30 Apr 3	*Midterms*	*Midterms*	*Unit 6*	*Unit 6*	*No Classes*
Apr 6 – 10	*Spring Break*	*Spring Break*	*Spring Break*	*Spring Break*	*Spring Break*
Apr 13 – 17	*Unit 6*	*Unit 6*	**Unit 6 (Learning Journal 5)**	**Unit 7 6 AR Tasks**	*No Classes*
Apr 20 – 24	*Unit 7*	*Unit 7*	*Unit 7*	*No Classes*	*No Classes*

Apr 27 May 1	**Unit 7 (Learning Journal 6)**	**Unit 8 5 AR Tasks**	*No Classes*	*No Classes*	*No Classes*
May 4 – 8	*Unit 8*	*Unit 8*	*Unit 8*	**Unit 8 (Learning Journal 7)**	*No Classes*
May 11 – 15	**Post Tests (EG and CG)**	**Post Tests (EG and CG)**	*Revision*	**Interviews (EG)**	**Interviews (EG)**
May 18 – 22	*Finals*	*No Classes*	*Finals*		

Table 3.10: Implementation Calendar (continued)

In the control group, on the other hand, the main learning content was presented via the print course book and worksheets. In addition to the print materials, the course audio files were available on the LMS page of the course and preferred by the instructor during the lessons to a portable CD/MP3 player. Homework was done on the book pages, worksheets, or hand notes. Some major assignments were collected in document or online text format on the course page and graded by the instructor. The discussions were held in a traditional way, i.e., face-to-face in the classroom, and the format varied between group discussions to whole class discussions. The contextualization of learning content as well as engagement with multimodalities were somehow to a lesser extent compared to those in the experimental group.

Before the actual implementation started, towards the end of the first week, both groups were invited to do the pre-tests, i.e., questionnaires and achievement tests to compare and contrast how both groups were similar/different in their views, opinions, and knowledge levels. After almost a week, having completed eight AR tasks, the participants in the experimental group were asked to send their first learning journal submissions to share their first impressions on the AR learning experience. On the third week of the implementation, having some more experience with AR and the course, the participants were interviewed to further elaborate on their individual experiences so far.

Until the last week of the implementation, the participants kept sending their learning journals upon the completion of units. Once all the units were completed and there were no AR tasks left, both groups were given the post-tests to find out about any significant changes with regard to the topics they were asked in the questionnaire and achievement test, and the participants in the experimental group were interviewed once again to have another opportunity to extrapolate on their semester long AR learning experience.

3.3. DATA COLLECTION INSTRUMENTS

This section summarizes the data collection instruments of the study and explains the details of the related processes. Due to the design of the mixed methods research deployed in this study, data collection in qualitative and quantitative domains was treated independently. That is, the data collection instruments and their content had been finalized shortly before the implementation period started. After a brief piloting phase of the instruments, i.e., the questionnaire, achievement test, and interview questions, some of the questions were modified or rephrased not only to avoid guiding or misinterpretations but also to encourage more elaboration, particularly in the interview questions. Once the implementation phase started, the data collection procedures were initiated. Although the data collection was an ongoing procedure for the observations and learning journals, the interviews, questionnaires, and achievement tests were deployed in two waves, i.e., first wave being at the beginning and the second wave being towards the end of the implementation. At the end of the implementation, the collected data was transferred into formats that could be processed by the data analysis software.

3.3.1. Qualitative Data Collection Instruments

The qualitative data collection process of the study involved three main instruments: semi-structured interviews, participant-observations, and learning journals (Table 3.11).

Table 3.11: Qualitative Components of Study (Experimental Group Only)

Data Collection Instruments	# of Participants	Questions and Activities	# of Sessions	Duration	Total Time Spent
Semi-structured interviews	18	12 questions	36	2 weeks	~528 mins.
Participant observations	18	48 activities	27	14 weeks	~235 mins.
Learning Journals	18	3 questions	7	14 weeks	~105 mins.

The qualitative data collection procedure was initiated with the observations from the moment the researcher, introduced the AR application and gave the instructions for the first

activity (Appendix 4) in class, and it continued for 14 weeks, by the time the last AR activity was completed. The estimated amount of time spent on the observations is approximately 235 minutes on 48 specific AR activities. Parallel to the observations, after each unit, the participants filled out an online learning journal asking for a detailed report of their particular experience regarding the activities they had had in that unit, in an estimated total of 105 minutes. The learning journals were integrated into the procedure so as to ensure that the recorded experience is not only how the researcher sees or feels it, it is also about how the students reflect on their own experience for enhanced validation. Similarly, the semi-structured interviews constitutes the bulk amount of the qualitative data from 36 individual sessions with a total recording time of approximately 528 minutes, and also played a significant role in the validation process, helping the researcher maximize the reliability of the data while minimizing the subjectivity concerns related to self-reporting of the involved researcher.

3.3.1.1. Semi-structured interviews

Interviews are versatile research instruments which help generating data constructed out of the interactions between participants (Cohen et al., 2011). In order to capture the participants' interpretations of the AR learning experience with sufficient depth and breadth, which may be argued to bear relatively better results compared to the quantitative inquiry in an exploratory study, the researcher interviewed the participants twice, using the same interview questions, on the second and fourteenth weeks of the trial phase, with the intention that the participants could have enough time to think more profoundly about their experience (Dörnyei, 2007).

The interview questions were designed by the researcher taking the participants' experiences into consideration and focusing on how to retrieve a clearer picture of the AR learning with regard to the following points (Appendix 5):

- if and to what extent AR impacted their attitudes toward language learning,
- if and to what extent they find AR useful in practicing language skills and aspects,
- if and to what extent they see any potential in building other skills through AR,
- if and to what extent AR is useful in collaborating with other learners in class,
- if they experienced any technical problems due to AR use,
- if they experienced any instructional problems due to AR use,

- if they would be interested in learning with AR more in the future,
- how they describe AR as a learning aid/tool/method,
- how they evaluate their AR learning experience,
- how they would feel about AR learning in other subjects,
- what they would suggest potential AR learners,
- which specific AR activity they liked/benefited most,
- and which specific AR activity they found ineffective.

The interview sessions were, therefore, semi-structured, accompanied by a total of twelve questions (6 yes/no questions and 6 open-ended questions), all of which aimed to collect individual experiences related to the use of AR as a part of the course. Because the interviews were semi-structured, the participants were given the flexibility to extend their thoughts and opinions on the questions posed, especially in the last two questions.

As mentioned above, the interview questions were also piloted with a small group of students, prior to the implementation, to check if they were easily understood and interviewees could clearly interpret and respond. In addition to minor modifications in the question stems, it was found out that the interview questions were given only in English caused some interpretation issues. Therefore, it was obvious to provide bilingual support, i.e., Turkish translations when needed. This helped those interviewees who were at low B1 level and needed extra explanations to respond accurately and maximize the amount of verbal input as opposed to what had been received in the piloting phase.

The interviews were held one-on-one, lasting about 15 to 20 minutes. The participants were not forced to use English to reflect on their experience although the questions were initially posed in English, yet with extra explanations and literal translations in Turkish when needed. All of them preferred to respond in Turkish as they were more capable of talking about abstraction in their mother tongue. However, the participants were often code-switching to refer to specific terms, such as *reading*, *listening*, *pronunciation* and *vocabulary*, frequently used in the course instead of using their Turkish equivalents. Therefore, each session was recorded in Turkish and stored on an electronic medium, a digital voice recorder in MP3 format, and later transcribed non-verbatim by the researcher on word processing software, i.e., a simple notepad program, to be transferred for analysis on NVivo.

3.3.1.2. Participant observations

Creswell (2014) defines observation as a qualitative research activity in which the researcher records notes on the behavior and activities of individuals at the research site, either as a complete participant or a non-participant while having some prior questions to find out about. With this in mind, the researcher is a participant observer in this study, i.e., the observation role is complementary to the participant role; therefore, while teaching the class, he also keeps a record of students' daily activities.

There were several advantages to having a participant role during the observation period as it gave the researcher the opportunity to have a firsthand experience and record information as it occurred. While teaching the course using the materials available, he could also conduct the AR tasks and assisted students who needed either technical or pedagogical support. When students were busy working on a task, he could jot down notes on the side, take photographs of important and unique moments, and record the experience without necessarily distracting them. The textual and visual data collected from the observations were stored in an observational log by the researcher after each session, which were then collected in an appropriate format, i.e., *pdf*, to be sent to NVivo to be coded and then integrated into the data analysis section.

3.3.1.3. Learning Journals

Learning journals, also known as diary studies, help the researcher delve into the inner world of individuals and find out about the particulars of their experiences through the records that contain certain aspects of their daily lives in their own words (Dörnyei, 2007). Taking this aspect into account, the researcher created an online learning journal for the participants of the experimental group so that, at the end of each unit in the book, they had an opportunity to reflect on their self-learning experience with AR. These solicited (at the request of the researcher), interval-contingent journal entries were intended to back up the findings coming out of the observational and interview data and help the researcher cross reference the key concepts for further elaboration.

Each learning journal was made up of three questions and participants were asked to reflect on their experience by referring to these questions outside of the class:

1. Which AR activity did you like most in Unit X?
2. What are some things that you liked or found useful while doing the activities?

3. What are some things that you did not like or found difficult while doing the activities?

Although participation to learning journals was somewhat voluntary, to encourage the participants, the learning journals were announced in weekly email digests, which also served as a refresher and reminder of the tasks they had previously performed in class as well as the summary of what had been done so far regarding the progress of the implementation period.

3.3.2. Quantitative Data Collection Instruments

The data collection of the quantitative part of this mixed methods study adopted two major instruments: a questionnaire and an achievement test (Table 3.12):

Table 3.12: Quantitative Data Collection Instruments

Data Collection Instruments	# of Participants	# of Items	Time Allocated
Questionnaire on Technological Awareness and Use of New Technologies + Attitudes towards Learning Languages with New Technologies (pre- and post-test)	36	45	15 mins.
Achievement Test (pre- and post-test)	36	27	35 mins.

The tests were given to experimental and control groups simultaneously at the beginning and end of the term, so that it fulfills the pre and post test formats. The medium of the instruments is an online environment, a surveying tool developed as a plug-in on Moodle, the learning management system of the institution. This environment was also a closed circuit system and required an institutional account and user authentication to log in. Therefore, the test results could be kept confidential and not shared by any other third party entity.

The data collection for both groups was run in a controlled environment, a dedicated computer lab, with the guidance of the course instructors at the beginning of the semester. Group administration method (Dörnyei and Murphey, 2003) was employed as it helped to achieve 100% response rate. The participants were given a 50-minute time frame to complete both the questionnaire and the achievement test in the same session. 36 participants in total attended two concurrent sessions. One of the sessions was dedicated only for the 18 participants in the experimental group, whereas the other one was allotted to the members of

the control group. There was no record of system failures in both sessions nor any technical issues which would risk the data collection process. The same tests were given to the same participants again in the same format at the end of the semester.

The results were retrieved immediately after the participants' submission, also accessible in a more visually enhanced way on the survey tool interface, i.e., color-coded bar charts for the multiple choice items, yet the data sheets could be exported in raw data format, i.e., .CSV, for the data analysis in SPSS without any intervention in the data.

3.3.2.1. Questionnaire on Technological Awareness and Use of New Technologies and Attitudes towards Learning Languages with New Technologies

The questionnaire on technological awareness and use of new technologies and attitudes towards learning languages with new technologies (Appendix 2) in this study was designed to collect factual, behavioral, and attitudinal data from the participants to clearly define their profile as English learners and consumers of new technologies. Its definition in this research context matches Brown's (2001, p. 6):

> any written instruments that present respondents with a series of questions or statements to which they are to react either by writing out their answers or selecting from among existing answers

There are 45 Yes/No and Likert Scale items, which were prepared to ask for information in three parts: the demographic background of the research subjects (Part I), their level of technological awareness and use of new technologies (Part II), and finally, their attitudes towards language learning with new technologies.

Items 1-7 in Part I ask for personal information not only to help portray the profile of the learners in both groups, but also find out about any similarities and differences between the experimental and control groups. Items 8-31 in Part II focus on the learners' current level of awareness and understanding of new technologies as well as how they use these technologies in their everyday lives. Items 32-45 in Part III try to seek answers on how the learners use new technologies in language learning and what they think of them.

The piloting of the questionnaire was conducted in two separate classes in the Fall term of 2014. The participants were chosen among the pre-intermediate level listening and speaking class students so that the questionnaire participants are almost identical to those of

the actual research population. The items were also cross-checked with a colleague who was familiar with the research context and participant profiles.

The results of the piloting process helped the researcher to revise the wording in the item stems and choices of some items in order to eliminate ambiguity, avoid misinterpretations and respondent literacy problems by making it bilingual (Turkish and English), remove double-barreled questions for the best results.

The questionnaire was given twice, i.e., at the beginning of the implementation and towards the end of the implementation, in order to measure if there had been any changes in the attitudes and preferences of the experimental group participants in terms of their individual technology adoption and awareness levels after a 14-week exposure to AR tasks. The control group also participated in the questionnaire at the same time while taking the non-AR version of the course, which involved the same course goals and objectives, course book and materials, and quizzes and final exams in print format.

3.3.2.2. Achievement Test

The Achievement Test (Appendix 3) was indeed a practice test which aims to measure the learning objectives that are stated in the course outline as well as the text of the course. Because the AR tasks were designed around the learning objectives, the researcher's intention was to find out whether AR would have any significant impact on the achievement of those objectives at the end of the course through paired tests.

The test was divided into three main sections: listening, speaking and vocabulary, based on the objectives and outcomes which were explicitly indicated in the curriculum as well as the course book, Q: Skills for Success Listening and Speaking Level 3 (Craven and Sherman, 2011). Therefore, the items were prepared to assess the following objectives and learning outcomes:

- use prior knowledge and personal experience to predict content
- listen for main ideas
- listen for details
- listen for exact words and phrases to improve word recognition
- use intonation, volume, and other features to infer a speaker's attitude
- listen for signposts to understand the structure of a passage

- ask for clarification to understand difficult concepts
- give reasons and examples to support opinions expressed
- use sequence expressions to clarify the order of events in a presentation
- understand and use the key vocabulary
- use context to understand the meanings of unfamiliar words and phrases
- understand phrasal verbs to accurately interpret statements
- correctly use idiomatic expressions
- use contractions
- correctly place stress on important words in sentences
- effectively use intonation in different sentence types

Following the questionnaire in the same session, it was also given in a computerized environment in which the participants could log in using their personal accounts and answer the questions at their own pace. As soon as they completed the achievement tests, the results were immediately available to the instructor as there were no items that required manual grading.

The achievement test was also given twice, both at the beginning and at the end of the semester, not only to measure how well the participants could perform in terms of the aforementioned objectives and outcomes when they were exposed to Augmented Reality learning experience, but also to find out about if the treatment had any effect on learning outcomes at the end of the semester.

3.4. DATA ANALYSIS

This section presents the processes of how the collected data have been treated. As mentioned in the previous sections, the data analysis procedures were initiated immediately after the implementation period was over in two phases. The quantitative data was treated first with the guidance of a statistician, inspecting the data sets against any format-related errors before the analysis. The data sets were drawn from the questionnaires and achievement tests platform, converted to the appropriate format, and fed into the software for the analysis. The idea was to search for any significant patterns or change that might assist in making meaning of the data in the bigger interpretation framework. Once the quantitative results were collected, the qualitative data analysis started with the transcription of the interview data.

After an extensive transcription phase, the qualitative data sets were transferred into the analysis software and coding for themes started. Although the coding procedure did not take too long, the organization of codes and identification of themes took a substantial amount of time as these procedures required constant reviewing of the data and discussing the codes and potential themes until there was an agreement in reaching saturation. The data analysis phase was concluded with the creation of the codebook, a table that summarizes the categories, themes, sub-themes and descriptions, presented in the 4. Results section.

3.4.1. Qualitative Data Analysis: Thematic Analysis

For the qualitative data analysis method, thematic analysis was used to find recurrent themes in the data. This type of analysis involves coding for themes, looking for patterns, and making interpretations (Ellis and Barkhuizen, 2005, cited in Dörnyei, 2007; Marshall and Rossman, 1999). Therefore, in order to understand the participants' interactions with the researched phenomenon and further investigate their specific experiences, the content of the collected data are analyzed and specific themes relating to these experiences are derived from these data, which eventually helped the researcher grow ideas, interpret them, and draw conclusions with regard to the research questions.

With this in mind, all the audio (recorded), visual, and textual data collected in the interviews, observations and learning journals were transformed into compatible electronic formats. To maintain confidentiality of the participants' identities, they were given pseudonyms following an alphanumerical format. After that, the data was imported into the NVivo coding interface for the data analysis.

The reason why the researcher preferred the data analysis conducted in NVivo is mostly because of the affordances and the abilities QDA programs provide. Almost all the steps of the data analysis procedure were maintained in a computerized environment, thanks to the software's advanced coding and analyzing capabilities. Reducing the time spent on scanning and coding through the data sets significantly, the software spared a great deal of time to concentrate on data interpretations, discover themes and develop assumptions through complex queries and visual models, which would be extremely difficult to realize through manual procedures. As Kuckartz (2005, cited in Mayring, 2014, p.116) mentions, these programs gives the researcher the ability to:

- transcribe using a word processor so that the material can be edited and organized for the different procedures of analysis,
- mark specific segments of the material ("underlining") and attach keywords or categories to them (coding). Some computer programs do this by referring to the line numbers, some by using the mouse, others by using hypertext functions,
- mark other segments of the material and subsume them under formerly defined keywords or categories,
- gather all material coded with a specific category, even from huge quantities of text. This allows to single out typical quotations for individual categories,
- pick out segments of text marked with keywords or former coded categories,
- alter, revise, and refine the categories in the process of analysis,
- order categories hierarchically, divide into subcategories, combine into general categories, together with all associated text segments,
- attach rules of analysis, comments on the material, and explanations of categories to the categories within the computer program, so they are available and revisable at any moment within the process of analysis.

Therefore, considering the vast amount of the qualitative data in this study, using a QDA program seemed to be the best option and helped the researcher handle the data corpus in a relatively easier manner especially while coding for data extracts and analyzing the relationship between diverse data sets.

The data analysis procedure started with the semi-structured interviews which were recorded by an electronic recorder and transcribed non-verbatim in Turkish into an MS Word document. The interview questions were initially prepared in English, yet the interviews were conducted in the native languages of the interviewees, i.e., in Turkish, which made them feel more secure, comfortable, and competent while expressing their opinions and ideas on the questions posed. Because the researcher is fluent in both English and Turkish, familiar with the cultural realities of the participants, and knows the research context better than any other prospective translator, he was able to convey the best meaning possible under the given circumstances and coded the data extracts in English for potential themes. To address the issue of objectivity in translation and maintain rigor in qualitative research, the codes were cross-checked by an expert who speaks both languages and shares similar educational and professional background with the researcher.

While transcribing the audio data at the end of the interviews, computer-assisted transcription through dictation was first tested; however, due to the high amount of mismatches and errors in the transcripts, the researcher did the transcription himself, which helped him go over the raw data once again. Unlike the other qualitative analysis methods, i.e., conversation, discourse or narrative analyses, thematic analysis does not require as much detail in the transcript, yet a rigorous and thorough 'orthographic' transcript of the verbal utterances provides the information the researcher needs (Braun and Clarke, 2006; Schreier, 2014). Therefore, once all the interview data was transcribed non-verbatim, the transcripts were imported to NVivo.

Similarly, the observation notes were written in English after each session based on the notes taken. These notes were then compiled on a single electronic document at the end of the implementation. Visual materials from these sessions, such as photographs, screenshots, or handout/worksheet images were also embedded into the observation notes in order to better reflect the user experience. Because the NVivo interface allows coding diverse forms of data, i.e., audio, video, and text, they were imported without having to change their format. This feature helped a lot while searching for recurrent topics and key terms in the data corpus.

The learning journal entries were collected from the course page housed in the institutional learning management system (LMS) and put together in an electronic document file again in an appropriate format that can be imported into NVivo. The language of the learning journals were up to the participants' discretion, submitted both in English and Turkish.

The journals also included polls on their most/least favorite choices for specific weeks; therefore, these results were also compiled and added to the coding interface (Figure 3.5).

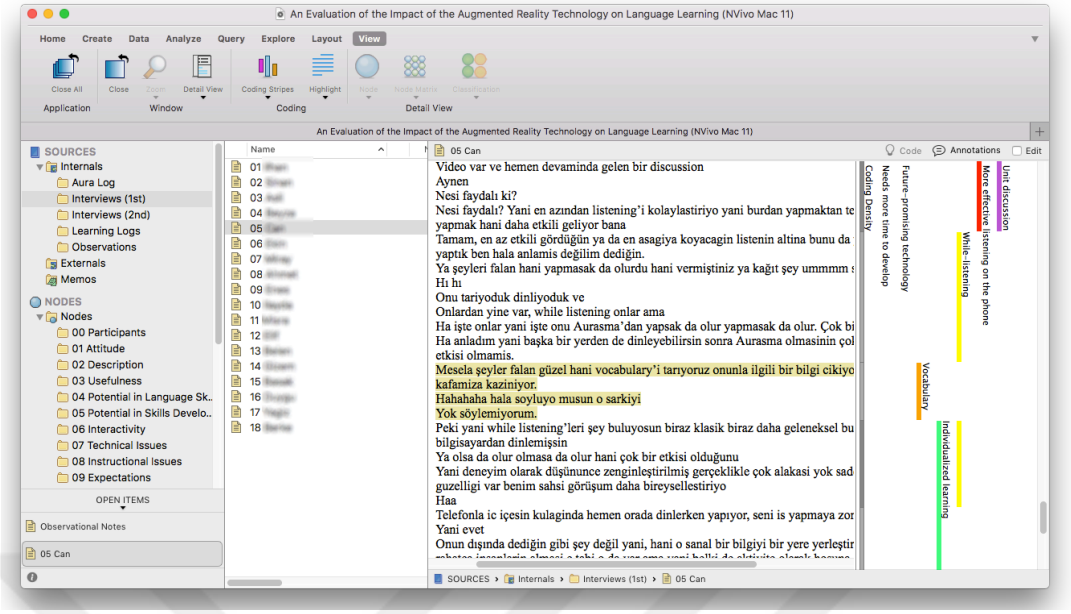

Figure 3.5: NVivo version 11 coding interface

Before the actual coding procedure started, no data preparation, such as a detailed description of verbal, prosodic, and paralinguistic features, on the transcripts and observation notes, was needed as the focus is on the themes occuring in the text. Because the interviewees were quite identical in their background, and all the interviews followed the same format and protocol, the material selection procedure was not challenging at all. The transcripts from the interviews were used for the purposes of finalizing the initial coding frame. Although the majority of the main categories were created in a concept-driven way, based on the research questions, some main categories and the sub-categories, and even their sub-subcategories, were generated in a data-driven format, based on subsumption strategy in particular (Mayring, 2014; Schreier, 2014). As Patton (2002, p. 41) suggests, qualitative inquiry entails:

> immersion in the details and specifics of the data to discover important patterns, themes, and interrelationships; begins by exploring, then confirming; guided by analytical principles rather than rules; ends with a creative synthesis

That being said, the theme analysis featured both deductive and inductive styles. In other words, although a list of themes was initially developed based on the interview agenda and sections of data collection procedure, more themes were added to the list progressively while the data were being analyzed through repetitive rounds of reading and cataloging, without

further referral to the research questions so that the researcher could identify the commonalities in the data for a more holistic interpretation.

The first cycle of coding follows one of the elemental methods, that is, *in vivo coding*. According to Saldaña (2009), elemental coding methods feature basic but focused filters while analyzing the data and makes the future coding cycles easier by setting the foundation. Also used in thematic analysis*, in vivo coding* is the initial review attempt on the data corpus, follows a relatively more open-ended format, and uses the participant's own words to draw codes from, and therefore, is accurate and exact. The main benefit of coding *in vivo* in this study was to code the interviews and learning logs with the actual words of the participants', i.e., the students, whose learning experience with Augmented Reality is the main source of inquiry and is supposed to help finding answers to the research questions. As Stringer (1999, cited in Saldaña, 2009, p. 91) puts, this helps the researcher frame the interpretations of terms "that participants use in their everyday lives, rather than in terms derived from the academic disciplines or professional practices." Although the primary cycle of coding provided a low level of interpretation due to the high amount of descriptive codes, i.e., simply labelling the responses of the participants along with their observed behavioral pattern, this process enabled the evaluation and modification of the main and subcategories, and lead the way to the secondary cycle of coding, in which the final versions of the actual themes were revealed more clearly as data saturation was achieved after detecting and extracting all the significant statements from the data corpus.

The second cycle of coding featured *pattern coding* (Saldaña, 2009; Miles and Hubermann, 1994), in which codes are more explanatory or inferential and identify emergent themes. In this phase, the *in vivo* codes from the first cycle were sorted according to their similarity, and those similar codes following the same pattern of action and interrelationship were then grouped together with the intention of synthesizing them into single, emerging themes in the second cycle (Table 3.13).

Table 3.13: Coding of semi-structured interviews

Transcribed Text: Semi-structured Interviews	1st Cycle of Coding: In Vivo Coding (Initial Code)	2nd Cycle of Coding: Pattern Coding (Emerging Theme)	Category

"Ya bence eğlenceli en başta, sonuçta bir şey öğrenirken eğlenceli hale getirmek kalıcılığını arttırıyor. Onun için ben sevdim, genel olarak." (B04) TRANSLATION: *"In my opinion, it is fun first of all, making something fun while learning increases its retention. That's why I liked it, generally speaking."*	It is fun to learn with AR.	Fun	Learning Experience
"Bence güzel gidiyor, yani normal dersten daha iyi, en azından bazı videolar izliyoruz, işte bazı testler yapıyoruz, daha eğlenceli oluyor, yani sıkıcı geçmiyor ve dersin hem öğretici, hem eğitici, hem de eğlenceli bir tarafı oluyor, o yüzden bence AR etkinlikleri güzel yani." (G14) TRANSLATION: *"I think it is going well, I mean, better than normal lesson, at least we are watching some videos, say, doing some tests, it becomes more fun, I mean, the lesson is not boring, and the lesson becomes more informative, educative, and entertaining, so AR activities are nice I think."*	Classes are more fun with AR.		
"Kesinlikle tavsiye ederim, şöyle açıklarım, öncelikle derse bir neşe getirdiğini söylerim, yani derse değişik bir eğlence kattığını söylerim, eğlence derken sadece bu gülüp oynamak gibi bir şey algılanmasın." (S02) TRANSLATION: *"I would definitely recommend, explain it like this, first of all I would say that it brings joy to learning, I mean, it adds a different kind of fun to class, when I say 'fun', it shouldn't be perceived as 'frolic'."*	AR brings fun to class.		

Table 3.8: Coding of semi-structured interviews (continued)

The data coding procedure on NVivo involved a thorough scanning and repeated reading of transcripts and extracting meaning units by labeling them as nodes (in vivo codes) in the first coding cycle, which subsequently lead to subcategories and categories (pattern codes) in the second cycle, and eventually final themes. The diverse layers of data coming from the interviews, observations and learning journals at different levels and in distinct formats helped to identify significant patterns with respect to the participants' experience. These findings are presented accordingly in the following chapter.

3.4.2. Quantitative Data Analysis: Non-Parametric Tests

As mentioned earlier, due to the low number of participants (n=36) both in the experimental group (n=18) and control group (n=18), this study adopts non-parametric statistical tests for the analysis of the quantitative data collected. Therefore, within the experimental group, the results of the pre and post tests of the questionnaire and achievement

test were analyzed with Wilcoxon Signed Rank Test (2 related samples), whereas between the experimental and control groups, the results were analyzed with Mann-Whitney U Test (2 independent samples) in order to compare both groups for any statistically significant difference.

Because the data collected by the questionnaire and quiz activities were available in the learning management system (LMS), Moodle, as soon as the participants answered the questionnaires/tests, the results were generated and exported through the interface of the learning management system into spreadsheets, and datasets were created out of these spreadsheets so that they feed properly to the SPSS (Figure 3.6).

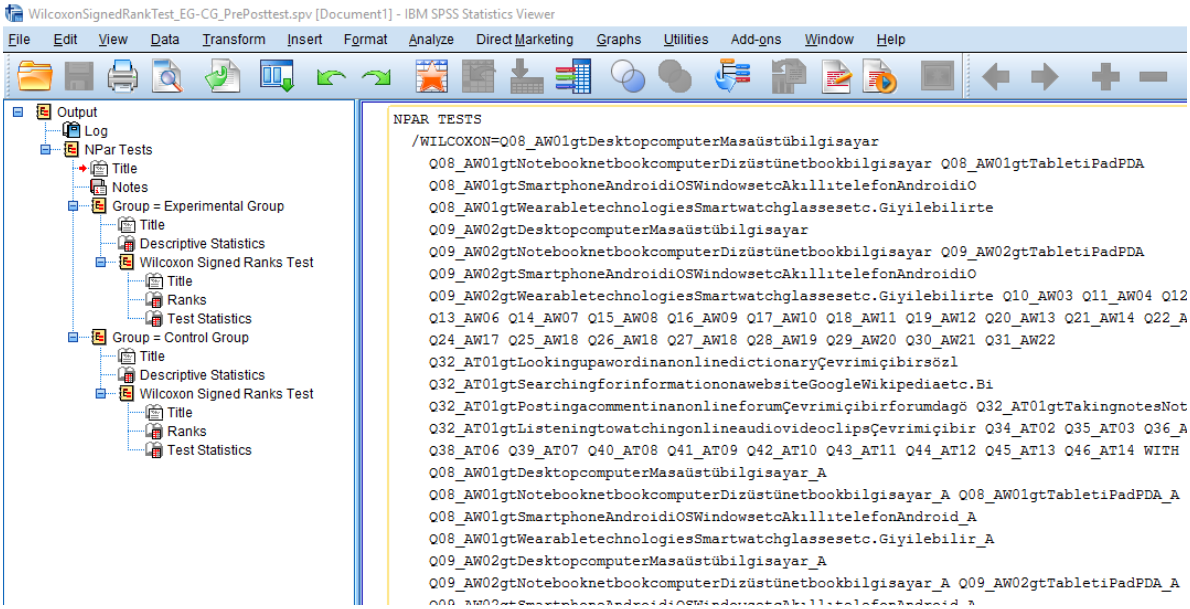

Figure 3.6: IBM SPSS Statistics 23

During the quantitative data analysis stage with SPSS, especially while transferring the data from spreadsheets to the statistics program, there were minor problems in the values of some variables. After a critical review with the guidance of a statistician, it was found out that the values of some of the likert-scale items, were reversed in the data sets, which changed the results in favor of the control group. This was due to the arrangement in the original spreadsheet exported from the questionnaire environment. These problems were eliminated by assigning the accurate values manually in the data sets.

4. RESULTS

This chapter presents the findings from the qualitative and quantitative data analysis procedures of this study. The sections are organized in a way that the qualitative results are presented first to explore and describe the AR learning experience by concentrating on the main research questions, i.e., presenting the themes that have emerged from an extended period of coding and discussion cycles. The categories, themes, codes, and their descriptions are listed in a codebook and detailed interpretations are made with direct references to and excerpts from the qualitative data, e.g., observation notes, interviews, and learning journals.

The quantitative findings, on the other hand, depict a detailed picture of the participant profiles by comparing and contrasting to the profiles of learners in the parallel sections. The pre and post-test group statistics of the experimental and control groups do not only portray learners' technology awareness and use levels but also help us gain a comparative point of view regarding the change in the scores, within and across. After that, the pre and post-test group statistics of participants' opinions on using new technologies are presented to demonstrate what they think about technology integration in language courses and how they approach the idea of learning languages with new technologies. Finally, the pre and post-test statistics of the achievement tests taken by the participants of the experimental and control groups are reported. Unlike the findings in the questionnaire, there is no statistically significant change found in the test scores of both groups.

As indicated earlier in the research model, the findings and results are treated independently in this chapter, yet these interpretations are merged in the following chapter, i.e., discussion, to create a holistic account of the AR learning experience while addressing the research questions.

4.1. QUALITATIVE FINDINGS: THEMES FROM INTERVIEW, OBSERVATION, AND LEARNING JOURNAL DATA

The presentation of the qualitative findings is organized around four main categories. While the first category, learning experience, aims to present a descriptive account of AR's

potential as an educational tool with direct references to the students' experiences, the second category, engagement with language, highlights specific matters relevant to the linguistic progress of the individual learners as well as trending topics related with language pedagogy. The third category, technical assets and liabilities, introduces findings regarding the participants' expectations and concerns as well as technical processes, procedures, and challenges within the existing infrastructure, deployment, and implementation frame of the AR learning. Finally, the fourth category, instructional assets and liabilities, presents further themes that are peculiar to instructional matters with regards to learning and teaching via AR.

When the interview, observation, and learning journal data sets were analyzed after two coding cycles, i.e., in vivo coding and pattern coding on NVivo, the codes were clustered under relevant categories, and based on their descriptions and detailed readings of the excerpts, the codes were reorganized in order to avoid any redundancies and/or repetitions by removing or merging. The themes and sub-themes were then created with the help of the notes taken during the coding processes as well as the long discussions with the experts in the field. Once the structure showing the relationship between categories, themes, codes, and descriptions was finalized, the following codebook was created to demonstrate the big picture of the AR learning experience with reference to the research questions (Table 4.1):

Table 4.1: Codebook

Category	Theme		Code (Sub-theme)	Description
Learning Experience	Attributes of AR Learning	Medium-related	compact	combines several different technologies in its body, and therefore, stands out as a more condensed form of an instructional technology
			contextual	provides extra context which help learners understand, see the usage of new forms, or review previously acquired concepts better
			multimodal	rich in terms of the available modes the AR interface offers, i.e., the visual, aural, and haptic output formats make the learning content deliverable in diverse formats
			inclusive	embraces learners having diverse backgrounds and addresses their needs
		Use-related	assistive	aids learning processes by providing guided practice and simulating physical training
			innovative	represents the new and disruptive technologies and inspires learning in different ways that were not possible before
			interactive	allows interaction with content, other

				learners, and the instructor via a dynamic interface in a virtually shared workspace
			fun	combines the fun and play element with the appeal in using technology in learning, i.e., scanning a physical object and viewing the virtual surprise AR content overlaid
			motivating	addresses learning needs and makes learners feel more attracted and willing to access the learning content
			engaging	attracts attention and increases learners' focus for better concentration
			collaborative	allows meeting and working together in a virtual venue to access the same learning content or produce new content
			autonomous	relinquishes control and responsibility to the learner so that they can improve their knowledge and skills, become highly self-reliant in both accessing and producing content, and even reflect on their learning experience
Engagement with Language	Receptive skills	Listening	use of authentic language	increases the possibility and frequency of listening to more authentic use of language
			allowance for task variation	allows designing diverse listening tasks to model language forms, provide further context on a given topic, or check comprehension
			controlled immersion experience	creates a controlled immersion experience in the physically perceived world via virtual prompts through which learners are exposed to language
			enhanced comprehension	incorporates audiovisual content that promotes comprehension and introduces the context and relevant vocabulary to allow expansion and further elaboration
		Reading	multimodal reading	introducing a more semiotic approach towards an enriched reading experience by combining verbal and non-verbal elements (print+ visual)
			hyperlinked reading	text annotations appear either directly on the text or in the margins, guiding learners by underlining the main idea, summarizing key points, or even raising guiding questions to promote critical thinking
	Productive skills	Speaking	providing virtual coaching	integrates pop-up videos of a speaking coach, providing mini tutorials on phonological and phonetic features of English, i.e., practical tips on correct pronunciation, intonation, rhythm, and stress patterns as well as English phonemes and their articulation with reference to the IPA chart
			awareness on performance	helps explore the language by presenting performance-related elements and descriptive focus on

				auditory texts
		Writing	listening into writing	short writing tasks were fused into preceding listening comprehension tasks as a follow-up to harvest their answers or as a preparatory activity before a group discussion via opinion polls or forum posts to help them formulate their thoughts and ideas
			on-the-spot writing	writing in a non-traditional way as they were constantly asked for their opinions or reflect on their experience after viewing each AR task
	Vocabulary and Grammar		internalization and long-term retention	helps forming meaningful associations with language items learners interact with and allows them to easily recall those items by giving fine details
			multi-layered vocabulary learning	different from looking up a word in a print dictionary as the interface allows interaction with a vocabulary item at all levels, i.e., phonetic/phonological, morphological, syntactic, semantic, and pragmatic levels.
			increased levels of intercultural awareness	allows retrieving information about the language and its speakers through authentic virtual content embedded into words and language forms on a print page, and by doing so brings about an intercultural awareness which enables learners to develop the ability to understand the other and become aware of their values, beliefs, and perceptions through the language they speak
Technical Assets and Liabilities	Hardware-related		personal technologies	required physical components: personal smartphones, tablets, and earphones
			spare device	personal technologies need to be backed up by spare devices
			video output	although OST (optical see-through) provides users with more realistic and natural exposure experience, smart phones offer only VST (video see-through)
			audio output	earphones are required to create a personalized audio space for better concentration
			storage and memory	could be a point of concern if devices have low storage and memory
			power use	not draining battery, has the power use of an average app
			ideal configuration	no need to invest extra money or resources for this kind of AR learning as it uses the existing technologies most students nowadays have. Their personal tech equipment suffices as long as they are allowed to use them in class.
	Software-related		UI (user interface)	anyone can use it as the interface is very plain and simple, and it is very easy to perform the assigned tasks without any hesitation or confusion

		UX (user experience)	all the AR content, i.e., the 3D images, animations, or videos, is shown at user's request in a natural flow, and the follow-up actions, such as connecting to a poll or a discussion board, can be successfully executed
		navigation	two different buttons, the first one being "Done", placed on the application frame to switch from the viewing mode to the scanning mode, and the second one being "Submit", placed on the embedded LMS page to send their comments in the discussion forum. Having tapped "Done" first, instead of "Submit" upon the completion of their text, they noticed that their responses disappeared and were not sent.
		image recognition	physical obstacles on the materials, such as annotations and doodles drawn by users or stickers on the book pages, physical deformation of the books and handouts from water or coffee spills, block image recognition
	Network-related	internet connectivity	Although it is technically possible to run AR applications offline, it would take so much effort to maintain the dynamic AR content on users' devices, keep them updated, and even if it were somehow achieved, it would be impossible to speak about sharing the same workspace, and therefore, collaborate on a specific task
		stability and speed of connection	A satisfying AR learning experience highly depends on the stability and speed of the connection.
		use of mobile data	occasional use of mobile data (3G mobile connection with download speeds up to 63,3 Mbit/s depending on the carrier) whenever issues encountered with the wireless internet connection
Instructional Assets and Liabilities	Instruction-related	direct instruction	clear instructions, given by an instructor, appearing on the material to be scanned or on the display of the smart device attached to the AR content to purposefully guide the participants' learning
		instructional support	without particular training or induction, users could easily get confused and expect the instructor's mediation
		instructor's role	instructor as guide on the side, having a stand-by role, yet not only providing support and guidance on the tasks when needed, but also selecting and curating the learning content that is pedagogically tailored and served to the best interest of the learners
	Interface-related	distraction	no distraction in general while working on AR tasks as the experience is much

			more engaging than notifications on the device
		dedicated devices	goggles or head units could help minimize the amount of distraction caused by a multipurpose device
		orientation	using personal smart devices does not pose any challenges while following the instructions, nor does it cause losing track
	Content-related	challenge	when challenge is beyond a learner's expectation, it results in distraction or difficulties to maintain focus
		pedagogy	learning content must be designed or reviewed by educators with pedagogical concerns
		quality content	focus on quality educational content must be prioritized, and material design must be given more importance
		task preference	tasks that involve audiovisual content were rated as the most favorite and effective tasks
			tasks that require text submission were among the least favorite
	Delivery-related	hybrid delivery	the interface will never replace the teacher or will substitute classroom learning
		pacing	not being able to catch up with the others in class as the app required the individual learner to adjust his/her pace
		peer group interaction	when everyone attempts working on the same content at varying times, it becomes difficult to manage who is doing what
		procedure	delivery being strictly structured with explanations was monotonous for some as they could not skip those parts

Table 4.1: Codebook (continued)

4.1.1. Learning Experience

The AR learning experience of the participants, in broader terms, was reportedly a positive one. Their semester-long experience provided them with ample insights to be able to identify and differentiate AR as not only a new instructional technology for learning in general but also a novel language learning medium. They acknowledged that this experience altered their existing opinions about possibilities in language learning by giving specific references. Although the implementation was not purely AR-based, that is, the AR tasks were incorporated into the conventional media introduced in a semester-long face-to-face course, the participants could draw conclusions as much as their experiences allowed. Based on those ongoing interactions and reflections, there are specific attributes that mark AR learning as a peculiar experience. These attributes can be introduced in two categories, that is, the attributes

that the AR learning interface offers to learners are grouped under medium-related attributes, while those that are related with use and interaction are presented as use-related attributes (Table 4.13).

Table 4.2: Attributes of AR Learning

Attributes of AR Learning	
Medium-related	Use-related
compact contextual multimodal inclusive	assistive innovative interactive fun motivating engaging collaborative autonomous

4.1.1.1. Medium-related

The medium-related attributes are comprised of the affordances the AR learning interface and its components provide the individual learner with. These affordances, as perceived by the participants, do not only make AR learning stand out as a unique form of instructional technology, but also help learners develop an implicit understanding of how to use it for their learning. These diverse characteristics of the medium have revealed as the following.

To start with, AR learning is *compact* as it combines several different technologies in its body, and therefore, stands out as a more condensed form of an instructional technology. When the participants were asked to specify what this meant, they explained it by making references to their experiences with other instructional technologies and drew comparisons with AR's all-in-one aspect:

> I think it is something like a combination of all because you can transfer what you want into it and view, that is why this is something like a combination of generic technologies, such as a projector, a smart board and so on, I think… (B04)

Bence hepsinin birleşimi gibi bir şey çünkü hem istediğini oraya aktarabiliyorsun görebiliyorsun onun için bu projektör akıllı tahta falan onların genel bir teknolojinin birleşimi gibi bir şey bence… (B04)

I think, if we think of a smart board, a miniaturized version, we place a book in that miniaturized smart board and we increase its interaction with people more, and by doing so, I mean, it becomes something more three-dimensional, more different, something more operational… (E09)

Bence hani akıllı tahtayı, küçültülmüş halini, düşünürsek içine kitap yerleştiriyoruz o küçük akıllı tahtanın ve insanlarla etkileşimi daha fazla artırıyoruz bu şekilde hani üç boyutlu daha değişik daha böyle kullanılabilir bir şey olmuş… (E09)

The aforementioned compactness meant a great deal of convenience for almost all the participants as they valued the fact that they could access information on a single interface instantly, whenever and wherever they wanted or needed, without making any major effort, and at the ease of their personal smart devices which have long become part of their everyday reality. The ease of deployment thanks to its being compact must have also attracted the students' attention that they appreciated (1) the practicality of retrieving information on a specific topic without much effort, (2) ease of use as they all owned a smart device or two which ran the application with no specific requirement, (3) the flexibility AR learning provided independent of time and space, and finally (4) the idea of using new technologies in their learning, especially at times when instant access to information made a big difference.

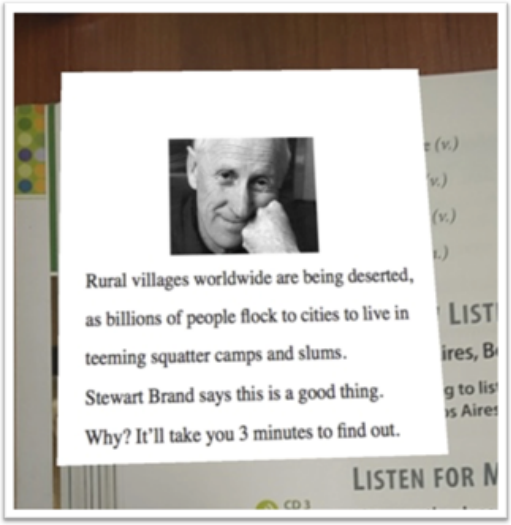

Figure 4.1: The interactive abstract of a discussion video which starts playing once tapped on

As can be seen in Figure 4.1 above, all the required information for a discussion activity were fitted into a small icon on a page. Once scanned, the content revealed step by

step at the request of the learner. Regarding this specific task, the participants reported that all they needed to do was to simply scan and follow the pop-up instructions to successfully retrieve information and exchange their ideas in a virtual environment, by interacting with virtual objects, on the screen of their smart devices, without any effort and at no further cost. Making comparisons with other forms of new technologies they had experienced thus far, they could distinguish how AR stands out as a viable medium with such compactness, which also ensures a great deal of convenience and ease-of-access to learning content. Similar insights could be drawn from the following comments by I10:

> I10: You know, without having to rely on the book, you know, I am learning with technological devices, watching videos, and looking up words and learn where [in what context] they are used.
> Interviewer: Well, you can also do this on a computer.
> I10: But searching this, you know, this is a kind of technology that is put in front of me, so. (I10)
>
> *I10: Hani sadece kitaba bağlı kalmadan, hani teknolojik "device"larla öğreniyorum hani, videolar izliyorum ve kelimelerin anlamına bakıyorum, nerede kullanıldığını biliyorum.*
> *Araştırmacı: E bunu bilgisayarda da yaparsın.*
> *I10: Ama hani bunu aramak, sonuçta önüme koyulmuş bir teknoloji bu, öyle. (I10]*

Parallel findings regarding the possibility of instantly accessing diverse course content anytime and anywhere using a single interface on a single device, were noted in the observations as well (Observation Note, 10.03.2015, Tuesday, 9:30 - 10:20 session). In a class where 7 students were missing, participation to an in-class discussion, with several small pre-requisite and follow up tasks, was still possible as the missing students could access the required resources, work with them, and submit their answers in response to what had been discussed. This was possible by simply scanning a tag (Figure 4.2) which was made available on a print worksheet and also in the weekly email digests digitally. Therefore, it appears that AR has great potential in making learning tools more compact and possible, which would be difficult or impossible otherwise.

Figure 4.2: "Scan here" tag printed on a worksheet to provide access to learning content required to complete an assigned task

Another descriptive quality of AR learning as a medium, as reported by the participants, is that it is *contextual*. In other words, by augmenting the course artefacts, such as superimposing virtual content over an image on the course book or a vocabulary item on a handout, AR learning expands the possibilities of input channels and provides extra context which would ideally help learners predict the meaning of unknown words, see the usage of new vocabulary items, or review those previously acquired concepts better. In discussion tasks, for instance, by enabling the provision of more contextualized content, learners gain new perspectives on general themes or specific prompts. A08 and A03, likewise, reflected on this in their comments as the following:

> A08: When you learn from a book, you open the dictionary and look it [new vocabulary] up, but here, this predicting becomes more like... You say there is only text there [in the book]. But here, you know, I am gonna give the same [example], though, "rules and regulations". You see that "regulations" and "rules" are interrelated.
> Interviewer: You mean you see the usage.
> A08: Exactly, you see the usage.
> Interviewer: Wouldn't it give the same feeling or have the same effect if you read an example sentence?
> A08: Maybe we would again, but it is much better like this. It becomes much easier and more effective.
> Interviewer: All right…(A08)

> *A08: Kitaptan öğrenince şöyle sözlükten açıp bakıyorsun ama burada tahmin etme de daha şey oluyor. Şimdi orda sadece metin var diyorsun. Burada hani yine aynısını vereceğim ama "rules and regulations" "regulations"ın "rules"la alakalı olduğunu görüyorsun.*
> *Araştırmacı: Kullanımı görüyorsun yani.*
> *A08: Aynen öyle kullanımı görüyorsun*
> *Araştırmacı: Örnek bir cümle okusaydın aynı hissiyatı vermez miydi, aynı etkiyi vermez miydi?*
> *A08: Yine belki çıkarırdık ama böyle daha iyi oluyor. Daha kolay oluyor ve daha etkili oluyor.*
> *Araştırmacı: Peki… (A08)*

> I would say that this is advantageous because one is able to see not only the examples a single narrator [instructor] gives but also more different examples... (A03)

> *Sadece bir tek anlatıcının verdiği örneklerle değil daha farklı örnekleri görebildiğim için bunun avantajlı olduğunu söylerdim. (A03)*

The comments above clearly show that the participants are aware of the significance of the context in their learning and have the ability to use it to their advantage while learning. Similar reactions were also observed in the classroom (Observation Note, 15.04.2015,

Wednesday, 9:30 - 11:20 session). When the participants were asked to scan the vocabulary task image in their books, a pop-up song video started playing on rules and regulations. The moment they started viewing the content, one could easily notice the positive reaction on their faces. They all looked happy and were smiling. They watched it until the end with great interest. Then, they were asked what other words could be associated with law. This time they added regulations and codes. The expressions noted on the board at the beginning of the lesson were expanding as they could retrieve more context, such as "to make/pass a law/rules and regulations". This task was then followed up by a discussion as they had more to say on the topic, which provided them with enough context to internalize the word "regulations". At the end of the class, they were successfully using the word "regulations" along with related vocabulary items.

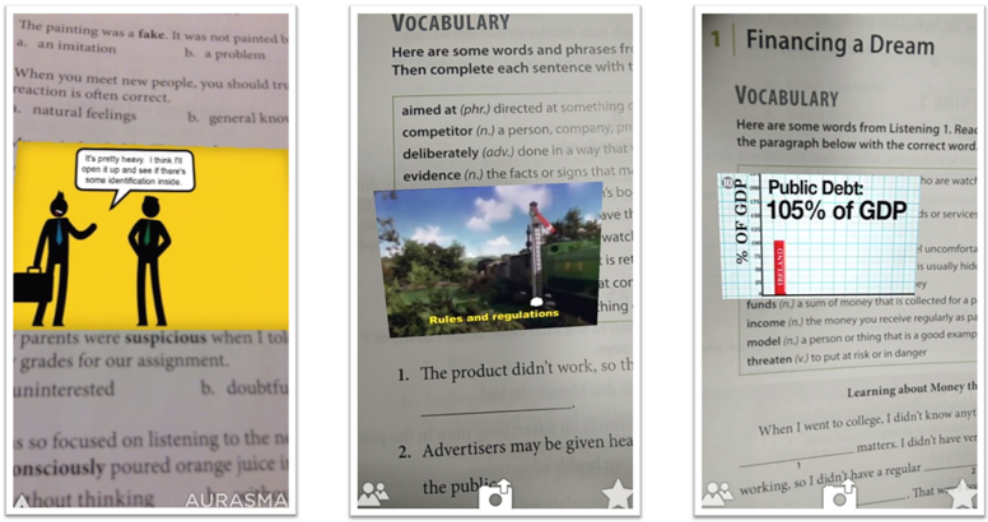

Figure 4.3: Contextualizing unit vocabulary via authentic resources

This shows that AR learning promotes contextualization of learning concepts by providing direct authentic input (Figure 4.3, from left to right: a public service announcement for the word "suspicious"; a song featuring the expression "rules and regulations"; an explainer video for the term "Gross Domestic Product"). By using carefully curated content, students' levels and needs could be addressed more accurately, more context and examples could be presented, and therefore, distinct learning opportunities could be created for students to acquire new concepts.

Another medium-related attribute of AR learning is that it is *multimodal*, that is, rich in terms of available modes an AR interface offers. The visual, aural, and haptic output

formats make the learning content deliverable in diverse formats and support an individual's senses and perception while interacting with the learning material. The participants' comments were also focusing on this aspect. They specified this richness further by adding that AR learning:

- enriches learning content via multimodalities, i.e., augments the paper-based texts and 2D print materials or even everyday objects in the physical environment by hyperlinking them to virtually an unlimited amount of 3D digital content composed of textual, aural, linguistic, spatial, and visual assets;

- combines the development of all skills simultaneously thanks to the intensive multimodal exposure; therefore, learners are constantly alert and actively produce/consume learning content while listening, speaking, reading and writing;

- stimulates audiovisual perception, which helps learners form meaning, and therefore, gain an understanding in a relatively easier and faster way;

- visualizes abstract or difficult-to-see/access learning concepts by overlaying 3D models in science and engineering, such as working with subatomic particles in a chemistry class, exploring cells in human body in an anatomy class, or interacting with scalable models of structures in an architecture class;

These multimodalities were found extremely valuable especially in the explanation of abstract concepts that require a great deal of metalanguage to understand. One of the most popular examples of this was that they could scan the section on intonation patterns in their books and watch a video featuring an English speaker performing the related task both visually with annotations overlaid (Figure 4.4). While they were watching, they could also hear the nuances highlighted by the speaker and concentrate on the annotations in order to combine the freshly acquired knowledge with practice.

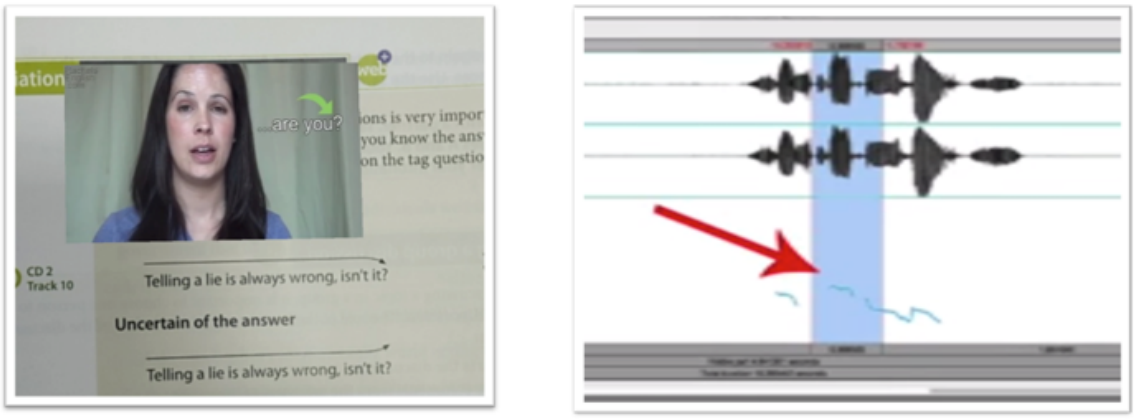

Figure 4.4: Rising/falling intonation illustrated in the video that is overlaid on the book

Along similar lines, some participants stated that AR learning is *inclusive* as they believe that it embraces all the learners having diverse backgrounds and addresses their needs. For instance, AR learning interfaces can be easily used by learners of all ages in both formal and informal learning settings as well as those with disabilities or suffering from lack of learning materials or instruction in their physical environment. Furthermore, learners with diverse learning preferences can benefit from this kind of learning experience as they are provided with the means to participate in a variety of tasks. Therefore, the overall learning experience becomes more diverse and inclusive, the monotony and monopoly of text-based learning, especially in classical studies, are no longer an issue; and therefore, learners can explore more on a given topic in a number of ways thanks to the virtual references made possible via AR interfaces. B13, for instance, pointed out how everyone in class could participate in conversations involving higher levels of social interactions even though she later admitted that she would rather not make comments unless she was explicitly asked by the instructor:

> Interviewer: Hmm, what do you think about writing, writing in the fora and so on?
> B13: Well, that one, too, I think, everyone instantaneously, I mean, 20 or 25 people, at the same time, with one another, an incidence of a forum setting or stating their views etc.
> Interviewer: For example, I am wondering this thing, if we had this discussion in class, are you someone who participates in discussions?
> B13: Well, I am not someone who participates unless I am asked for, that is why, at least some people are introvert, at least they can better express themselves by writing, that is why I think it has become a good system… (B13)
>
> *Araştırmacı: Hmm, peki şeye ne diyorsun writing'le ilgili ne diyorsun, forumlarda yazmalar falan*

B13: Eee, ha onda da bence hani anında herkes birbirine bir yani 20 kişi 25 kişi bir anda birbirine karşı hani böyle bir forum ortamı oluşması ya da görüşlerini bildirmeleri vs.
Araştırmacı: Mesela şeyi merak ediyorum sınıfta yapsaydık bu tartışmayı sen çok tartışmaya katılan birisi misin?
B13: Ya ben söz verilmediği sürece çok katılan birisi değilim, o yüzden en azından belki insanlar bazıları çekingen oluyor en azından orda hani yazarak kimisi daha iyi ifade eder kendini o yüzden bence daha iyi bir sistem oldu… (B13)

This aspect of AR learning promotes task participation as each learner feels that he/she is also an active and valued member of the classroom community and his/her opinions matter for others, too. As a result, this creates a great opportunity for learners to express themselves via alternative communication channels and benefit from the task equally.

In the observations, such an inclusion manifests clearly as well (Observation Note, 05.03.2015, Thursday, 9:30 - 11:20 session). One of the AR tasks required listening to a conversation about success and failure, and upon completion, students were prompted to submit their opinions in a poll. The AR learning interface allowed receiving responses (Figure 4.5) from all the students, and the teacher could pose specific questions to those who made a specific choice. They were also able to give their answers in their groups without having to relocate themselves because the students were already grouped according to their preferences on the screen. Even the quietest ones in class could express their ideas in length, without any hesitation. This was very convenient since there was no extra time spent to form groups or ask every individual to express their opinions. A very typical in-class discussion issue, which involves only the participation of a few high-achieving students, was also avoided peacefully. In the end, the discussion experience on what success meant to them included the contributions of each member of the classroom community.

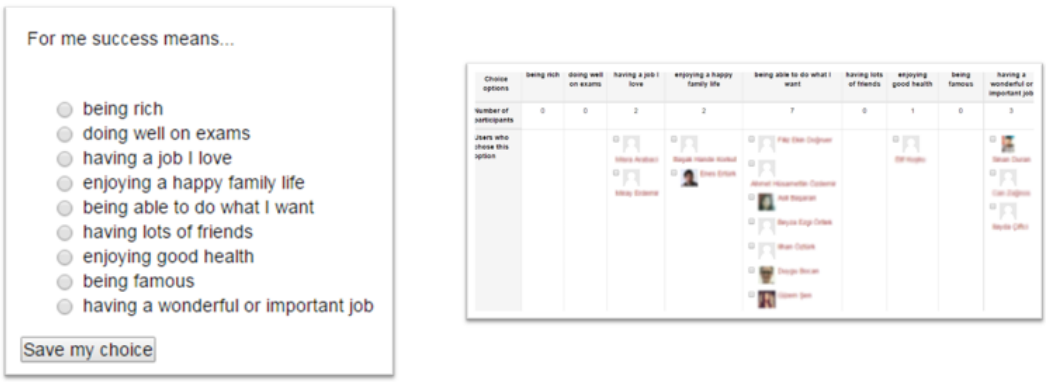

Figure 4.5: Poll questions and answers

It appears that, in AR learning, diverse channels of expression are enabled and available, so learners can participate in discussions by sharing their opinions in written or even spoken formats, which are again very different from conventional textual or verbal communication as the virtual media allow them to compose their messages by embedding special signs and symbols, emojis and emoticons, still or animating 2D/3D images, or audio/video content. As can be seen in the following figure (Figure 4.6), AR learning also bridges the gap between the static print learning material and the dynamic virtual learning environments. The discussion activity on a book page in this case is enriched with multimedia content, and after consuming it, learners are encouraged to build upon the existing information by discussing further in personalized and shared online spaces. The learning, therefore, has been taken outside the classroom context, yet does not leave any member of the learning community behind.

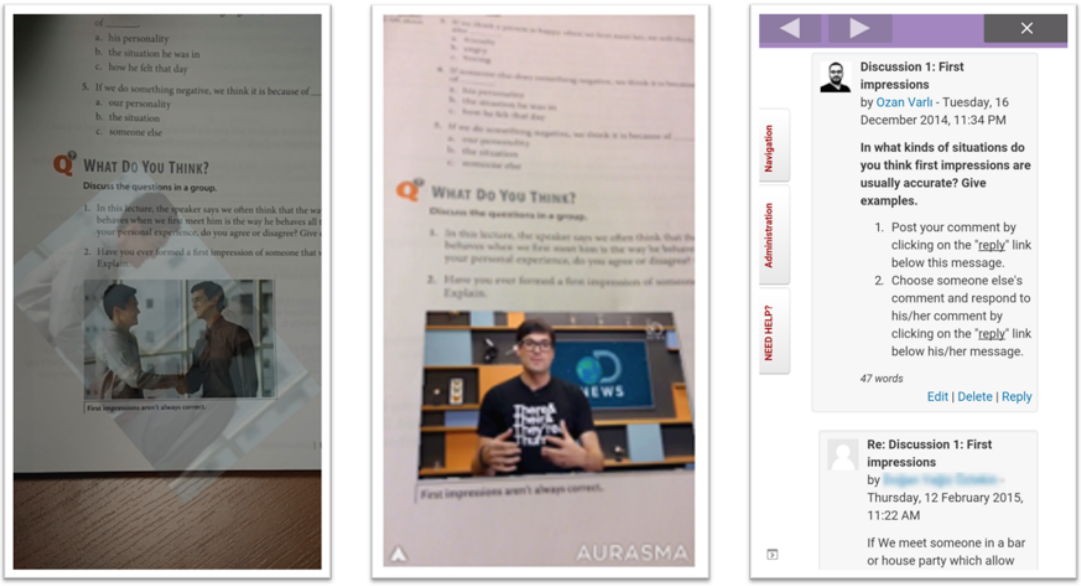

Figure 4.6: Forming first impressions video loading, playing, and participants are posting on the discussion board

4.1.1.2. Use-related

The use-related attributes, on the other hand, involve the affordances which are an outcome of the interaction between the learner and AR learning. These affordances support diverse aspects of learning processes and promote the creation of a desired learning

environment for better learning outcomes. These diverse characteristics of the medium are as the following.

According to the participants, the AR learning experience is *assistive* in that it aids learning processes by providing guided practice and simulating physical training, particularly in speaking tasks. All the participants reported that they benefited a lot from the pronunciation activities in which they scanned the relevant section in the book, full of IPA signs and further annotations that they were not familiar with at all and watched specific videos on how to articulate certain sounds with detailed explanations and training exercises on a model speaker (Figure 4.7).

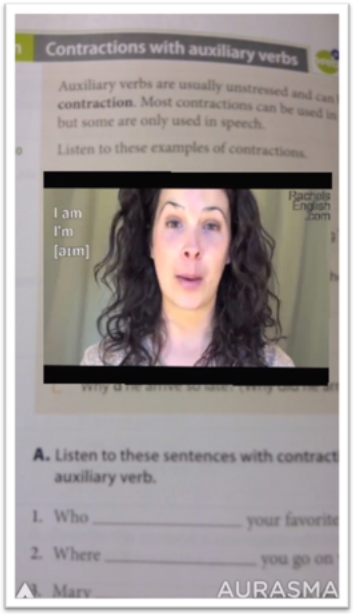

Figure 4.7: Contractions video with a model speaker and IPA annotations

I01 and E12, for instance, indicated how effective they find such guided practice and how much they appreciated the simulated physical training with the following quotes:

> Well, AR learning, for me, was really good because I believe it is such a great convenience, indeed. You know, we, with the book, I mean, I really enjoyed this pronunciation practice, we wouldn't do this with the book. And there is also, you know, it would be difficult to do it here [pointing to the projector]. We handled it altogether on our personal devices… but this [pronunciation] practice showed us how to study both for free and in a very convenient way, you know, what to pay attention to from the very beginning, and you know, how to pronounce, and I am really glad. (I01)

> *Ya AR learning benim için gerçekten iyiydi çünkü çok büyük bir kolaylık olduğunu düşünüyorum açıkçası ve hani biz kitapla yani benim gerçekten şu pronunciation*

> *çalışması hoşuma gitmişti kitapla bunu yapamazdık bir de hani buradan açmak zordu hep beraber hani kendi "device"ımızla hallettik bu işi…ama bu çalışma bize hem ücretsiz hem de hani kolay bir yönden nasıl çalışmamız gerektiğini, hani nelere dikkat ettiğimiz gerektiğini en başından hani nasıl telaffuz etmemiz gerektiğini çok kolay bir şekilde gösterdi ve ben gerçekten memnun oldum (I01)*

> …for one thing, comparing what you say, and we repeat to what an American says and we see her things, you know, her experience is a different thing. That is why the videos [AR content]and such are helping us a lot I think. (E12)

> *…mesela sizin söyleyip bizim tekrar etmemizle bir Amerikan söylerken onun hani oradaki şeylerini deneyimlerini görmek farklı bir şey o yüzden videolar falan çok yardımcı oluyor bence (E12)*

The pronunciation practice, indeed, stands out as one of the most favored activities throughout the implementation. Those moments were also observed during the session in which intonation patterns of questions were covered (Observation Note, 18.03.2015, Wednesday, 9:30 - 11:20 session). The lesson started with a quick revision of various question types and continued with a focus on tag questions. After the form, a mini discussion on the intonation of tag questions and how the intonation would change the meaning followed up. To assist the learning process further, the students were told to scan the relevant area in their books to access a training video on the intonation of questions. While they were watching the video, they started repeating after the speaker in the video. They could clearly follow her lips and facial expressions as she was demonstrating, and in the meantime, there were virtual annotations and signs appearing on a speech bubble and helping simulate natural intonation patterns. The learners were so engaged and interacting with the content by mimicking the model speaker in the video and trying to intonate different types of questions. With the help of a virtual personal trainer, everyone was so focused on task and following her instructions and performing tasks at their individual pace.

The participants also noted that the ability to replay the AR content as much as the learner wants helps listening comprehension and increases the possibility of a deeper understanding of the content. B04, likewise, stated that she used this to her advantage while working on more challenging content. With the AR app, she felt like she was making more effort but understanding much better with the following quote:

> For instance, you gave us homework, these 10- or 20-minute-long videos. We listened to [watched] them at home. We are making an effort to understand them. Compared to the videos you assigned us, there are so many ordinary and simple things in the book.

> Yes, that is why I think it is such an improving thing in terms of listening. Because I tried too hard to understand, I listened to [watched] at the dorm, and I rewound to better understand and when it is so different, making an effort while learning something eventually increases learning things [outcomes]… (B04)
>
> *Mesela şey, ödev vermiştiniz bu 10'ar 20'şer dakikalık videolar. Dinledik evde. Onları anlamak için caba sarf ediyoruz. Normal çok basit şeyler var kitapta yani bu verdiğiniz videolara göre. Evet onun için bence listening açısından bayağı geliştirici bir şey. Çünkü onu anlamak için ben çok uğraştım, yurtta böyle dinledim, anlama dinleme için geri aldım böyle değişik olunca bir şeyler öğrenirken çaba sarf etmek sonuçta arttırıyor öğrenme şeylerini… B04*

Similar to B04's experience, the observation notes also point to the fact that when the participants were given the supplementary AR content in addition to the textual vocabulary list in the book, they became more aware of the introduced vocabulary, and besides that, they could carry out longer discussions by giving references to the AR content they viewed.

In addition to the assistive, simulatory, and supplementary characteristics of AR learning mentioned above, some of the participants also argued the potential of AR in removing the limitations of the physical world, helping people acquire new habits, particularly in the teaching of motor skills as it has the potential to serve as a good alternative to physical reality. Although these do not directly refer to the participants' current experience, seeing what is available, they were inspired by the capabilities of AR and therefore sharing their ideas regarding possible scenarios for AR learning in the future.

Another aspect, as described by the participants, is that AR learning is *innovative*. Different from their conventional learning experiences, AR learning represents the new and disruptive technologies and inspire them to learn in different ways that were not possible before. Although the implementation took place in a traditional classroom environment as tasks and activities embedded into a traditional course, the participants stated again and again how non-traditional, extraordinary, and futuristic their experience was and how these attributes made them think that it was useful, and they benefited from it:

> E06: …because it is something different, I mean, it actually piqued my interest, because it is different from the classic methods, I mean, it became more useful.
> Interviewer: Is it because it is useful, or because you say "well, I like trying out different things"?
> E06: Both, I like trying out different things, I did, I think it is useful. (E06]
>
> *E06: ...Değişik bir şey çünkü, hani, ilgimi çekti açıkçası, klasik yöntemlerin dışında olduğu için, hani, daha faydalı oldu.*

Araştırmacı: Faydalı olduğu için mi yoksa ya ben değişik şeyleri denemeyi severim dediğin için mi?
E06: İkisi için de, değişik şeyleri denemeyi severim, denedim, faydalı olduğunu düşünüyorum. (E06)

…because it (an AR-aided language course) is really more different, and you know, the other one (a traditional language course) is very standard, I think this one (the AR-aided language course) is one level up, a different application, and that is why, you know, in a … way, so, I, for example, suppose while writing the word, I can recall, oh, we have done this in class, we have done so and so, for this reason, I think, you know, it is useful. I mean, I would say, the classic one has become very boring or so… (M07)

...çünkü gerçekten daha farklı ve hani çok standart oluyor diğeri bu biraz daha hani bir tik yukarı farklı bir uygulama bence o yüzden hani daha bir ... şekilde böyle ben mesela hani atıyorum kelimeyi yazarken aaa sınıfta bunu yapmıştık söyle yapmıştık filan diye çağrışım yapıyor bence o yönden yani faydalı yani klasik olan artık bence çok sikti mi diyeyim yani... (M07)

While some participants further defined "different" by comparing AR learning to traditional and classic learning methods or media, as seen above, several others based their arguments on the modern and innovative aspects of AR learning as it follows:

…because, under normal circumstances, while teaching something, we use very classic methods, we write things on the board, say a few things on them, and move on, but in this one (AR learning), you are using technology, you are moving this whole thing to a more different dimension, I think, it is much closer to today (today's technology), makes more sense, I don't know, we are using everything, not only the course book, nor the board, but many things we can access, by doing so. (B04)

...çünkü normalde bir şeyler öğretirken çok klasik yöntemler kullanıyoruz, tahtaya yazıyoruz yazıları ve bir şeyler söyleyip geçiyoruz ama bunda teknoloji de kullanıyorsun olayı daha farklı bir boyuta taşıyorsun bence yani daha günümüze yakın daha mantıklı bilmiyorum her şeyi kullanıyoruz sadece ders kitabini değil, sadece tahtayı değil de ulaşabildiğimiz çoğu şeyi kullanıyoruz bu şekilde diye. (B04)

In my opinion, this has to be the application (of teaching) method required at modern times, you know, it has to be different from the book or writing things (on the board). I think, in terms of both making students more active in class, and you know, because it is a requirement of the modern times, I find it helpful and useful. (M07)

Bence çağın gerektirdiği zaten uygulama metodu bu olması gerekiyor hani artık kitaptan veya işte bir şeyler yazmaktan farklı bir şey olması gerekiyor. Hem öğrencileri daha derste aktif kılmak açısından bence hani çağın gerektirdiği bir uygulama olduğu için ben yani yararlı faydalı buluyorum. (M07)

Both comments above indicate the expectation that this method or medium has to be the standard, the one that is taken for granted since this is what the modern educational

paradigms and contemporary innovations, which stress out the importance of interaction and communication, require and demand.

Thanks to the multimodal aspect of the AR learning interface, the participants were stating how much interaction occurred in a typical AR learning task compared to the traditional tasks and described their AR learning experience as one of the most *interactive* learning experiences. The content was no longer static, that is, it was not only limited to text printed in a book or a handout, but also dynamic and live as new information popped up when they scanned their books with their mobile devices and even more information followed when they tapped on the virtual content on the screen:

> Interviewer: So, what is it that you are doing with your phones?
> E09: By using our phones, we are scanning any word, whatever our instructor has assigned beforehand, and after scanning, there is an application, for example, sometimes questionnaires pop up, sometimes a forum appears. We are discussing the [given] topic or word in the forum with our friends.
> Interviewer: So what happens? You can do this at home as well…
> E09: No, it can't be [the same] at home. I mean, there is this classroom environment, and we are talking in class. For example, when we scan that image or video in class, our opinions are taken. We get the opportunity of having a discussion with friends.
> Interviewer: But what would happen, don't you have normal discussions?
> E09: No, it is not as effective as this one. That is, it is easier and more explanatory to discuss something when we get it visually. For instance, we have read it, well, OK, but, for instance, when there is a specific frame in those visuals or videos, we can do this thing [refer to] or explain it to ourselves by saying well, look, this happened so and so, at that moment, there appeared this subtitle… (E09)

> *Araştırmacı: Ne yapıyorsunuz ki o telefonlarla?*
> *E09: Telefonlarla böyle kitapta herhangi bir kelimeyi artık hocamız ne verdiyse, kelimeyi taratıyoruz, tarattıktan sonra ya böyle uygulama çıkıyor mesela bazen anketler çıkıyor, forum çıkıyor bazen, forumda tartışıyoruz arkadaşlarımızla, o konuyu o kelimeyi*
> *Araştırmacı: E ne oluyor, bunu evde de yapabilirsin?*
> *E09: Olmaz, evde olmaz, yani şimdi bir sınıf ortamı var biz sınıfta konuşuyoruz mesela sınıfta o resmi tarattığımızda o videoyu tarattığımızda bizim fikirlerimiz alınıyor, arkadaşlarımızla discuss etme şansı buluyoruz.*
> *Araştırmacı: Ne olurdu ki yani, normal discussion yapmıyor musunuz?*
> *E09: Yok, bunun kadar etkili olmuyor, yani mesela şimdi görsel olarak aldığımız bir şeyi discuss etmek daha kolay ve daha açıklayıcı oluyor, mesela okuduk, ha tamam, bu ama mesela o görsellerde o videolarda bir kare geçtiği zaman, ha bak bu da böyle olmuştu, bu anda şu altyazı geçmişti diye çok rahat şey yapabiliyoruz, yani açıklayabiliyoruz kendimize… (E09)*

The participants, therefore, did not only receive the learning content on their device screens, but also produce and submit their responses with regard to the content they had viewed. These responses were submitted in several different formats such as polls, forum posts, glossary entries, log commentaries, or individual assignment submissions (Figure 4.8). Having been able to participate actively and interact with the learning material, the participants believed that such learning experiences were highly appreciated. They even added how great it must have been to use goggles/headsets with natural hand/finger gestures to touch or control those virtual learning objects and register their responses on the interface.

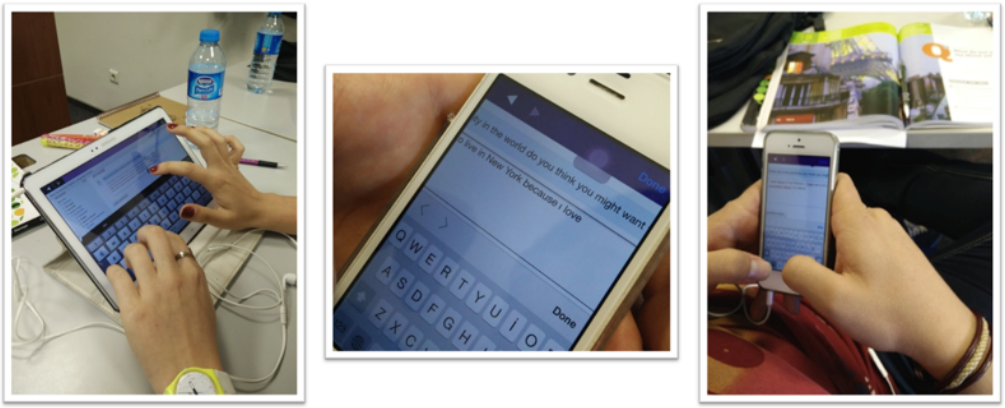

Figure 4.8: Students posting a comment

The interaction in AR learning did not only reveal in learner-material domain, but also among learners' themselves, as members of the classroom community. This aspect revealed in the learning journals as some participants directly referred to it: "It contributed to increase the interaction in the class..." (Learning Journals, U5). However, completed tasks later shown that the interaction among learners could take place not only publicly and openly as in a face-to-face classroom discussion, but also anonymously thanks to the capabilities of online learning spaces (Figure 4.9), so diverse forms of interaction could be achieved in the learning community, which convincingly contributed to the improvement of social and communicative skills.

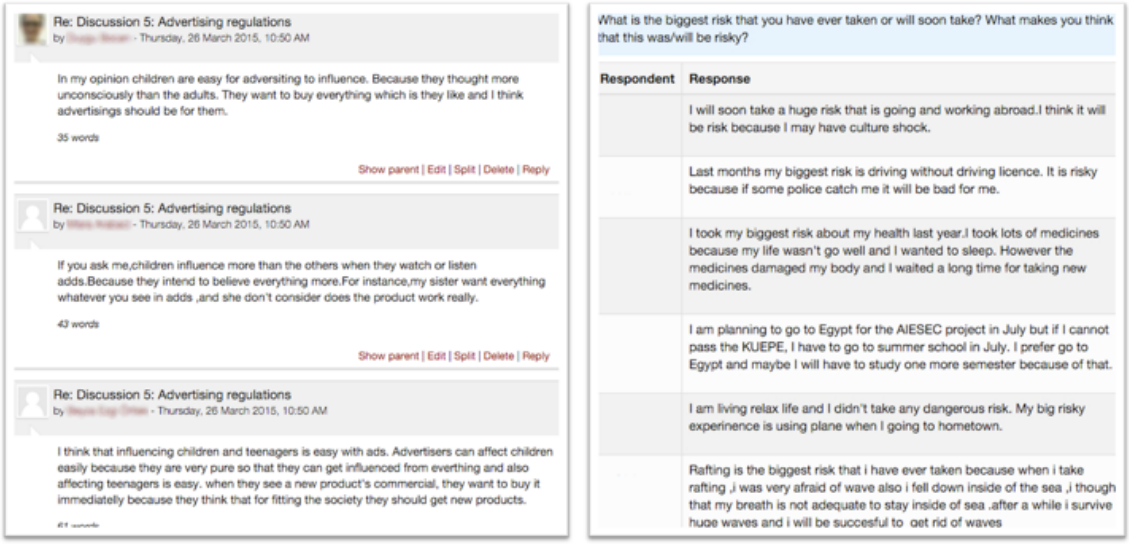

Figure 4.9: Idea exchange both publicly and anonymously

The majority of the participants believe that learning with AR makes language learning *fun* for them. They emphasized the fact that the fun, which denotes to the play element merged with the appeal in using technology in learning, i.e., exploring the physical world by scanning objects and viewing the surprise AR content attached to them, impacted their desire to learn in a positive way:

> Of course, it [AR learning experience] did impact [my attitude in a positive way] because we are constantly watching videos in some way, and those help us improve ourselves more. By making it more entertaining at the same time, it eradicates the monotony and tediousness. (D16)
>
> *Tabii ki etkiledi çünkü sürekli videolar izliyoruz bir şekilde ve onlar duyarak kendimizi geliştirmemizi sağlıyor daha çok aynı zamanda daha eğlenceli hale getirdikleri için sıkıcılıktan da uzaklaştırıyor. (D16)*
>
> OK, well, it is fun in the first place. All in all, making something enjoyable while learning it increases its retention. That is why I liked, in general. (B04)
>
> *Tamam, ya bence eğlenceli en başta, sonuçta bir şey öğrenirken eğlenceli hale getirmek kalıcılığını arttırıyor. Onun için ben sevdim, genel olarak. (B04)*
>
> I think it is good, because I am a person who likes technology, and this [AR] is something that fascinates me, this thing, I mean Aurasma, I think it is a good thing... Perhaps, using more electronic devices motivates us more, I mean, because these are what we are used to nowadays, so by using this [AR], similar to teaching kids while letting them play, we can also [learn] unconsciously like that… (C05)
>
> *Bence güzel yani, çünkü hani ben zaten teknolojiyi seven bir insanım hani bu da beni hani cezbeden bir şey bu şey işte Aurasma'ya yani değişik ki bence iyi bir şey yani… Yani belki biraz daha elektronik cihazları kullanmamız bizi biraz daha motive ediyor yani çünkü zaten alışkın olduğumuz şeyler son zamanlarda o yüzden hani bunu*

> *kullanarak belki daha çok hani şey gibi hani çocuklara oyun oynatarak öğretmek gibi biz de aynı şekilde hani farkında olmadan… (C05)*

These comments show that AR learning constructs a somewhat playful learning atmosphere by evoking feelings of curiosity and enjoyment, as in having fun while playing a game, yet still ensuring learning without any further compromises, such as getting stressed, bored, feeling extremely challenged or having the fear of failing or making mistakes.

Closely related to theme above, most participants frequently pointed out how *motivating* it was to learn via the AR learning interface as they felt like AR learning tasks addressed their learning needs and made them feel more attracted and willing to access the learning content, particularly compared to the conventional media with reference to the commonly attributed monotony. Having performed the tasks, they stated that they were somewhat encouraged make more effort in their learning, and this made them think that they did something good for themselves:

> I liked tasks 5 and 6 because I made extra effort to understand while watching those videos, and I think, those things that we spend effort on are more useful in terms of learning... (Learning Journals, U2)

As can be seen in the comment above, the participants think that the time and effort investment could be justified easily as they believed that the return of such an investment was reasonably high. During the observations, it was also noted that some students even spent extra time in their break viewing the AR content that they had previously covered. This means that they are ready to make small sacrifices, i.e., continuing with the tasks although they were not supposed to at that very moment (Figure 4.10). This could be due to the fact that AR learning was a justified and goal-oriented performance, and the participants were convinced that the return on this sort of investment was going to be high.

Figure 4.10: Student taking notes to answer T/F and open-ended questions during break

Another aspect of AR learning is that it is *engaging*, that is to say, the participants were actively involved in the tasks assigned and demonstrated a positive attitude since the beginning of the implementation. They always had their devices with them, followed all the instructions, and participated in the tasks. Each time they were asked to scan a specific part of the book or a handout, they showed great enthusiasm and were even getting impatient to view the AR content. The surprise element presented in multimedia format must have played an important role in that. The levels of behavioral and emotional engagement were so high that they led to greater levels of cognitive engagement (Figure 4.11).

Figure 4.11: Students fully engaged in a given task

They argued that AR tasks attracted their attention and increased their focus for better concentration. This sort of concentration contributed to their intellectual engagement and made them think deeply about the subject matter taught. In vocabulary tasks, for example, the participants were asked to build a virtual glossary using the words that were introduced in the

unit. Interacting with words very closely, i.e., scanning the vocabulary section logo to create new entries by providing definitions and example sentences, gave them the opportunity to invest more attention and interest, and as a result, increased the amount of exposure.

Moreover, the interaction with the virtual content became somewhat like a game, and in order to advance to the next levels, the learners found themselves in a flow. This flow experience encouraged more participation and concentration and urged even the most reserved learner to be involved actively. In one of the lessons, this moment of focused concentration was accompanied with the phrase “deep silence” (Observation Note, 17.03.2015, Tuesday, 9:30 - 10:20 session). Although the students appeared quiet in the physical classroom, they were actively engaged, interacting with the content to generate more ideas and share with one another in the virtual forum. Those moments of deep silence seemed very much like as the students lost their sense of time and place and gave their full attention to the content trying to either find out about the answer to a question or collect information to prepare for a discussion. Such engagements, employing elements of inquiry-based learning, were reported to be evoking new ideas, contributing to their critical thinking on a specific topic, broadening their perspectives, and therefore, deepening their understanding.

Next, according to the majority of the participants, AR learning involves a considerable amount of collaboration and promotes *collaborative* learning. Although each learner had his/her own personal workspace via their private devices, they could still meet in the same virtual venue, access the same learning content, and work together to produce content and post it in one of the common areas, i.e., a forum discussion thread, a wiki or a glossary, where others could also see, review, and even make further comments or contributions (Figure 4.12).

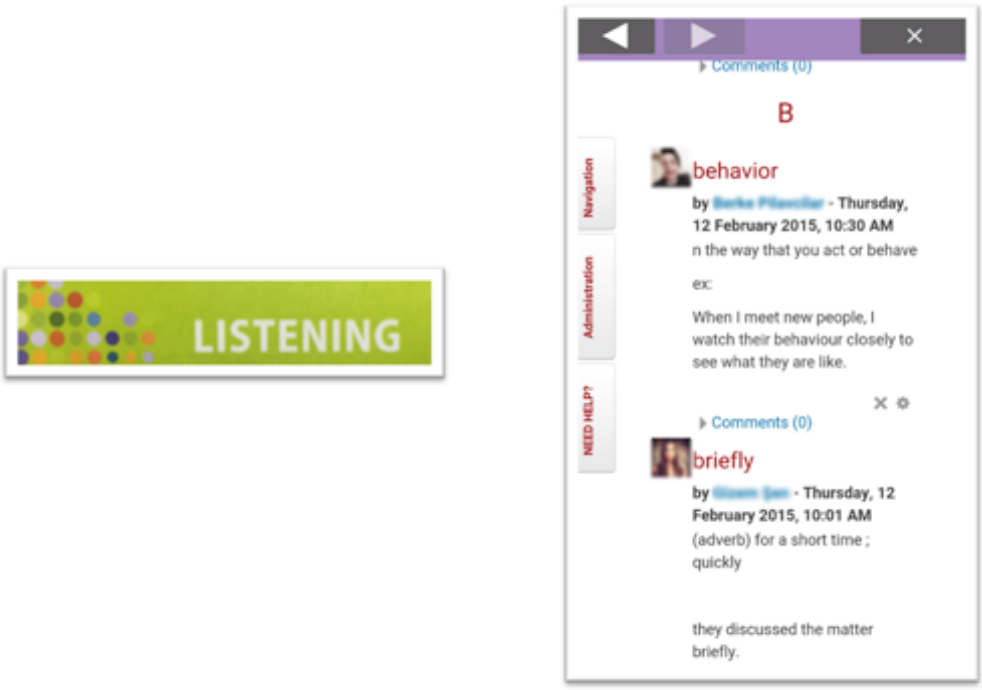

Figure 4.12: (From left to right) glossary trigger image, glossary entries created by students

Finding this aspect very useful, B13 made the following comment with reference to AR interface's potential in communicating with others in a virtual environment:

> Interviewer: … did you find it useful in collaborating with others in class, or do you?
> B13: Well, for example, with this system [AR learning], even people sitting in two different corners of the classroom could have a chance to speak with each other, in my opinion, thanks to the forum, it wouldn't be possible to have a dialog in the classroom, otherwise… You know, it doesn't matter at all who sits where in a virtual environment (B13)
>
> *Araştırmacı: … sınıftaki diğer arkadaşlarınla iş birliği yapmada faydalı buldun mu, buluyor musun?*
> *B13: Yani mesela ben bu sistemle sınıfın iki ucunda oturan kişi bile konuşmuş oldu bence forum sayesinde ama öbür türlü hani bir diyalogumuz olmayabilirdi sınıf içerisinde… Hani sanal ortamda şey yok kimin nerde oturduğunun hiçbir önemi yok… (B13)*

Likewise, M11 points out to the fact that the peer-to-peer collaboration does not only take place in the virtual environment around structured tasks, but also with the people sitting around in a more informal manner:

> I think it is very useful, especially we help each other a lot in that thing, I mean, for example, it is useful that we make comments to each other, for instance, or even

> opening those things, even opening those videos, you know, we are getting in an interaction mode, I mean, there is something going on there… (B13)
>
> *Bence faydalı yani özellikle şeyde çok yardımlaşıyoruz, yani mesela forumlarda birbirilerimize yorumlar yapmamız faydalı, mesela ya da şeyleri acarken bile, videoları açarken bile, hani bir etkileşim haline giriyoruz yani hani bir şey dönüyor orda yani… M11*

The peer-to-peer exchange appeared in different formats as well. M07, for instance, mentioned that she felt like she needed to discuss what she saw on her screen with the person sitting next to her. Because some AR tasks featured videos of experts giving information on a specific topic in a pop-up window like a talking head, she noted that it was like having the third person in that conversation and working together to complete the given task (Figure 4.13).

Figure 4.13: Students working together not only in virtual space but also in physical space

In addition to the potential of a relational space, one of the participants also noted that collaborating in an AR interface is indeed more efficient and improves the quality of collaboration in discussion tasks as it allows learners switch between individual and collective spaces when needed:

> G14: … in a normal discussion, too, I was the leader [in the discussion group], you know, I ask, and someone answers in two sentences, well, if the person sitting next to agrees with him/her and adds another sentence, then the topic [discussion] continues. But it doesn't work so in the videos we watch or the things we speak about. We all start watching the same thing and because we watch it individually, everyone has an opinion, everyone wants to say something and there is more participation.
> Interviewer: Do more diverse opinions come out?

G14: Well, because people think directly at an individual level, because something new comes to their mind at that moment, more diverse opinions come out, and they don't get influenced from each other.

G14: ...normal "discussion"da hani, ben liderdim mesela, şu anda hani ben soruyorum, o cevaplıyor iki cümle hani yan taraftaki ona katılırsa bir cümle söylerse konu devam ediyor. Ama hani bu izlediğimiz videolarda konuştuğumuz şeylerde öyle gitmiyor. Hepimiz aynı şeyi izlemeye başlıyoruz ve bireysel izlediğimiz için hani herkesin bir fikri oluyor, herkes bir şeyler söylemek istiyor ve daha çok katılım oluyor hani
Araştırmacı: Daha mı farklı fikirler çıkıyor?
G14: Yani insanlar direkt çok kişisel düşündüğü için o anda aklına hemen bir şeyler geldiği için daha farklı fikirler çıkıyor etkilenmiyorlar birbirlerinden…

The dynamic structure of an AR learning environment and the flexibility of having an individual space to think and concentrate on the subject matter and then sharing those diverse opinions with others in a social space seem to be enjoyed by the participants.

Finally, the observations as well as interviews revealed that AR learning has great potential for *autonomous* learning. By utilizing their personal devices as a learning tool, learners take control and responsibility for their own learning, improve their knowledge and skills, become highly self-reliant in both accessing and producing content, and even reflect on their learning experience by giving feedback (Figure 4.14).

Figure 4.14: Students reflecting on their learning experience at the end of each unit

They can even extend such learning activities outside the classroom, without being dependent on the instructor. Once created and published, the AR learning content stays stable and can be viewed anytime, anywhere, and as many times as the learner demands. This also helps the

instructor to monitor the individual learning processes as system access logs are available on the back end.

4.1.2. Engagement with Language

When participants were asked to reflect on how they would describe their language learning experience using AR, they shared various interesting perceptions and insights with regard to their personal experiences as well as some potential features AR holds in a language learning setting. With regard to their engagement with language in this context, it appears that the participants mostly referred to language as vehicle or means of communication in their reflections, yet rarely as object, which may not only be due to the attributes of the AR learning interface, but also the way the course content and learning tasks were designed. Because the curriculum focused on the teaching of discrete skills, the implementation took place in a listening and speaking course in a communicative manner. Therefore, the tasks designed were mostly focusing on the improvement of these skills through interaction and communication. On the other hand, because it is difficult to separate skills from one another, the tasks required using all four, particularly in order to stimulate reception and production. Nevertheless, the participants were able to develop an overall understanding of all the potential skills and aspects implemented via the AR learning interface, even suggesting some potential learning scenarios and discussing several other possibilities for language learning in the future. The findings were therefore grouped under receptive and productive skills, touching upon grammar and vocabulary aspects at the end (Table 4.3).

Table 4.3: Engagement with Language

Engagement with Language		
Receptive Skills	Productive Skills	Grammar and Vocabulary
Listening	Speaking	internalization and long-term retention multi-layered vocabulary learning increased levels of intercultural awareness
use of authentic language allowance for a diversity of tasks controlled immersion experience achievement of enhanced	providing virtual coaching awareness on performance	

comprehension		
Reading	Writing	
multimodal reading hyperlinked reading	listening into writing on-the-spot writing	

Table 4.3: Engagement with Language (continued)

4.1.2.1. Receptive skills

As mentioned in the above section, there was a common understanding that the learners held positive opinions of AR as a new medium and a potential new tool to support language learning processes and were eager to use it in their English class. According to the majority of the participants, AR learning offers the greatest value in the *listening* domain. Thanks to the interface's ability to integrate multimedia objects, such as streamable audio and video files, listening tasks could be designed in diverse ways. The tasks could model the use of authentic language, provide more context on the given topics, and fostered their comprehension. Having viewed several different examples of such AR content, the participants noted that there are numerous benefits of doing listening tasks on the AR interface.

Within the listening domain, one of the major findings is that AR learning increases the possibility and frequency of hearing the *authentic use of language* as it is used in real life by its speakers to convey real meaning. This, according to the participants, enabled them to have an awareness of what they are about to experience or how they are expected to perform in real life communication. In a textbook-based course, such exposure has great benefits, especially considering how it fosters the linguistic progress and communicative competence of the individuals. Therefore, AR learning interface could be seen as an opportunity to move away from the text-driven approach by amending the existing structure into a more exploitable one.

Similarly, the participants also argued how difficult it is to improve listening skills without proper exposure or examples. However, the tutorials virtually incorporated into the textbook created a feeling of *controlled immersion experience* through which learners observe how language is used and are somewhat expected to understand to interact. Referring back to his former English learning context, E09 points out the lack of immersion in a typical

classroom setting and states how much he appreciates the possibility of interacting with genuine content and real-life language in such a convenient way:

> What we have done so far, you learn how to listen to, until now we have heard Turkish in some way, for 20 years, we have just started hearing English, and from slow to fast or directly fast, it has been adjusted for everything [different levels] until now… (E09)
>
> *Mesela yaptıklarımız, dinlemeyi öğreniyorsun, bir şekilde şu vakte kadar 20 yıldır Türkçe dinlemişiz yeni yeni İngilizce dinliyoruz ve yavaştan hızlıya doğru veya direkt hızlı bir şekilde her şeye adapte edecek şekilde zaten uygulanmış şu ana kadar. (E09)*

Several similar remarks have been received from the interviews that AR learning increases the possibility and frequency of exposure to the language as they have never had so much of it before.

Another important contribution of AR learning for listening is its *allowance for task variation*. Designing diverse tasks to model language forms, provide further context on a given topic, or checking comprehension is highly possible. Moreover, listening tasks could be easily supported with visual input, it helps understanding the subject matter. I10, for instance, makes the following comment in this regard:

> For listening, I listen to while seeing, and [this is] very useful, and I don't forget the face of the person saying that, this is more useful all in all, when the radio [CD player] is played, you hear the voice only, this one has both visual and aural benefits… (I10)
>
> *Listening için bir kere direkt görerek dinliyorum ve çok faydalı ve söyleyen kişinin suratını da unutmuyorum, bu daha da faydalı sonuçta burada radyo çalındığında sadece sesi duyuyorsun, onun hem görsel hem işitsel faydası oluyor. (I10)*

Referring to a visual tutorial on the articulation of sounds, she underlines the importance of facial expressions and lip movement and how such non-verbal elements simulate spoken performance and contribute to the processing of the audio input on the listener's end. Some participants, along similar lines, mentioned this helps bridging the gap between listening and speaking skills as they could also pick up patterns from the modeled language in a controlled environment.

In addition to the points above, the majority of participants mentioned that AR learning provided *enhanced comprehension* by instant, pop up videos that became available when the discussion images were scanned on the book. These short introductory videos

allowed them to understand the topic better and introduced them the abstract concepts and relevant vocabulary to perform better in the discussion activities. Having a clearer picture in their minds, the students could effectively express their opinions and complete the tasks independently. All in all, the listening skill was the most popular one and nominated to be the best skill to be supported by AR in all the data sources of this study.

In the *reading* domain, there are no direct findings or references as the course did not include explicit reading tasks, such as an article from a news resource or a passage from a book. Nevertheless, there were few comments indirectly describing the reading experience so far via the AR learning interface as *multimodal reading*. This means that reading is exercised not only by texts on the print media, but also through virtual signs, images, or visual instructions appearing on the screen and understanding the message these fmultimodal texts convey requires the individual to have or adopt new media literacy skills. As multimodal texts have already become an essential part of everyday communication for the participants' generation, i.e. sending emoticons or exchanging memes via instant messaging applications, none of the participants experience any struggle while receiving instructions in diverse modes.

When the participants were asked to think about possible implementation scenarios to practice reading skills, *hyperlinked reading* was considered to be a feasible and an efficient way of integrating reading into the AR learning interface. E06 suggested that it could be used as an assistive tool in active reading. When reading texts are viewed through the AR interface, for example, text annotations may appear either directly on the text or in the margins, guiding the learner by underlining the main idea, summarizing key points or even raising guiding questions to promote critical thinking. These assistive virtual annotations serve as conceptual scaffolding, showing students what to consider while reading and equip them with the right tools to consume more complex texts in the best way possible. Consequently, the role of the reader is redefined as such a reading experience goes beyond decoding linear texts on print materials. On the contrary, it advances into a relatively more interactive skill allowing space for literacy development.

4.1.2.2. Productive skills

Productive skills on the AR learning interface was the most challenging in terms of the technical capabilities and capacities of the application. Although a web application that would allow submission of audio or text input could be embedded into the interface, live spoken interaction via the interface was not technically possible at the time of the implementation.

Asynchronous spoken interaction could be an option; however, it was not practical to send and receive large audio files generated by the users and it required more resources. Therefore, productive skills in AR learning in this study was actively practiced in the writing domain via text submission in the form of a response or a comment to a question appearing as a 3D image or in an audio or video content. Speaking, however, was handled in a more blended fashion. The students were introduced a concept or an idea in the virtual environment via listening tasks, which were particularly geared towards spoken production, but the actual speaking practice extended into the real environment and performed either individually or in groups.

In the *speaking* domain, the participants reported how well they think AR learning fostered their speaking by *providing virtual coaching*. This was the most valued and favored speaking practice according to the majority, and it was done individually via short video clips that featured a speaking coach, giving mini tutorials on phonological and phonetic features of English, e.g. tips on correct pronunciation, intonation, rhythm, and stress patterns as well as English phonemes and their articulation with reference to the IPA chart. Although similar content was also available in the course book, it seemed that they lacked the knowledge and understanding. These topics were the most neglected ones in their past speaking courses, and the AR tasks opened the doors to a new world and created a great deal of awareness on these matters. C05, for instance, explains it as the following:

> C05: Well, for instance, those pronunciations[tasks] were good, you know, the woman was saying [modeling pronunciation of contracted forms] and we were saying at the same time, one-on-one, for instance, they were very effective.
> Interviewer: The same thing was also in the book?
> C05: Exactly, but when the woman says, it is more effective, plus, you do one-on-one.
> Interviewer: Hm, don't you understand if you read it in the book?
> C05: Well, of course, you don't understand because this speaking is also a little bit about listening, that's why.
> (C05)

> *C05: işte mesela pronunciationlar güzeldi hani hem o kadın söyledi aynı zamanda biz söylüyorduk birebir mesela onlar etkiliydi.*
> *Araştırmacı: Aynısı kitapta da yazıyordu?*
> *C05: Aynen ama işte kadın söyleyince dinlemek daha bir etkili oluyor bir de birebir şey yapıyorsun.*
> *Araştırmacı: Hm kitaptan okusan anlamaz mısın onu?*
> *C05: Yani tabii ki de anlamazsın çünkü bu dinlemekle ilgili biraz da speaking o yüzden. (C05)*

Pointing to the importance of exposure to the real spoken performance and its impact on his speaking via the AR learning interface, C05 argued that viewing the same content in the book would not only be as effective, but also difficult to understand due to the lack of audiovisual explanations that support the learner on the spot and model the expected performance. This awareness was extremely important and possible only through such a simulatory experience.

In addition to the points above, the participants could also develop a special understanding or *awareness on performance*. Some stated how much they appreciated learning how to properly pronounce certain words and expressions in English. Others told that they valued the opportunity to realize the mistakes they had made and correct them. Nonetheless, one of the biggest gains was that they got to learn about the differences between the spoken and written language. In one of the lessons (Observation Note, 28.04.2015, Tuesday, 9:30 - 10:20 session), there was a short presentation on the features of the spoken language and they were shown examples of contracted forms that were different from the auxiliaries. To reinforce their learning with further explanations and make them notice the difference via real examples, they were told to scan the related part in their books and watch an AR video on “wanna” and “gonna” and how they were used. The activity took about three minutes, but most of them had a moment of revelation. Later, in the Learning Logs, they mentioned how they benefited from such tasks. Because the students lacked speaking practice in their past learning, they had considered spoken performance nothing but memorizing written expressions, rehearsing them, and utttering them when needed. After the first few tasks, one could easily see how they were thriving to follow the advice given in the videos, repeating after in full concentration, and working hard to improve their speaking.

As for practicing the *writing* skill, the participants reported that AR learning contributed positively and significantly increased the amount of written production compared to the non-AR version of the course. Although they did not do any extensive writing as they had a dedicated writing course for that, they still had the opportunity to express themselves in written format thanks to AR learning interface’s enabling *listening into writing* concept in an extremely compact way. These short writing tasks were fused into listening comprehension tasks as a follow up to harvest their answers or as a preparatory activity before a group discussion via opinion polls or forum posts to help them formulate their thoughts. Such tasks gave them the immediate opportunity to practice the language forms recently introduced,

make a conscious effort to produce with them, and create a written record of their opinions to express themselves. (Observation Note, 26.02.2015, Thursday, 9:30 - 11:20 session).

In addition to those structured writing tasks, the students were expected to perform *on-the-spot writing*, reflecting on their learning experience after viewing specific AR content. E12 states how much he valued this kind of writing as the following:

> As I said, in the classroom environment, it is a nice thing for everyone to be able to say their own opinion after watching the video. For instance, those comments we have made in that forum, or other things [we have done], everyone's making a comment on a video and discussing it at the same time, this is also improving our speaking, this is improving our listening, too. For example, you know, we watched a video and then did some writing after that, I think that was very useful because, you know, it becomes like summarizing it after watching it, and we don't get the chance to do this in each class, nor do we get the chance to send them to you and you check them for us all the time, I think for those reasons, this [AR] is a useful thing… (E12)
>
> *Ya sınıf ortamında dediğim gibi videoyu izledikten sonra herkesin kendi fikrini söyleyebilmesi falan çok hoş bir şey falan. Mesela bizim yaptığımız o forumdaki yorumlar olsun diğer şeyler olsun bir videoyu yorumlayıp herkesin aynı anda tartışabiliyor olması bu biraz daha speakingimizi de geliştiriyor bizim listeningimizi de geliştiriyor. Hani mesela biz videoyu izleyip sonra writing yapmıştık ya mesela bence o çok yararlı oldu çünkü hani insan izledikten sonra onun özetini çıkarıyormuş gibi oluyor ve bunu her derste yapma fırsatımız yok ya da size yollayıp sizin kontrol etmek gibi bir fırsatınız hep olmuyor bence bu o yüzden yararlı bir şey... (E12)*

Due to time restrictions and number of topics to be covered, such on-the-spot summary tasks or reflecting further on learning materials become a challenge, and unfortunately they are often ignored or neglected by teachers with the intention of saving time. However, it can be interpreted from E12's comment that AR learning makes on-the-spot writing possible in a way that students can easily and effectively voice out their opinions at the same time, in a common workspace, without having to wait for their turn. Therefore, they see this not only as a regular occasion to review the content for better understanding but also as an opportunity to practice and improve their skills.

4.1.2.3. Vocabulary and grammar

Regarding the *vocabulary* and *grammar* practice, the participants had very clear opinions. Because grammar was not handled explicitly in the course, there were only occasional mentions to the benefits of authentic language use in the AR content viewed, and therefore, this might have a possible impact on learners' knowledge and understanding of the

structure of the target language. In other words, learners did not focus on forms; instead, they were indirectly obtaining functions, which might have led to an understanding of contextualized grammar where they see the use of forms in specific contexts and trace their contribution to meaning. The vocabulary tasks, however, were found to be useful and favored as much as the listening tasks. The findings indicate that there was an agreement upon AR's significant potential in learning new vocabulary.

One of the main findings was that AR learning helped *internalization and long-term retention* of vocabulary expressions thanks to its ability to contextualize learning concepts. The participants stated over and over again how much they liked the idea of introducing new language with creative and catchy content, such as songs or advertisements. During the interviews as well as in the learning journals, the participants gave direct references to the AR content related to the vocabulary section. These references were not only about the definitions or meanings of specific words and expressions, but also the usage and different contexts presented when scanned and viewed. The students formed meaningful associations with each and every item they interacted with, and it was quite impressive to see how they could recall those items by giving fine details.

Another significant finding was that AR learning allowed *multi-layered vocabulary learning*. Learning new vocabulary with AR was very different from looking up a word in a print dictionary as the AR interface allowed interaction with a vocabulary item at all levels, i.e., phonetic/phonological, morphological, syntactic, semantic, and pragmatic levels. The students could listen to a word's pronunciation, see its form and function, read various definitions and all the important notes on its usage in specific contexts. They could also watch specially selected video clips attached to those words, which immediately visualized those levels in a real-life situation, and finally apply what they have just learned by creating an entry in a virtual glossary to be shared with the others in class. They perform all of these tasks on the same interface and at their own pace. At the end, they feel very fulfilled and satisfied as they could see the output of their investment.

Last but not least, the participants reported that AR learning experience leads to *increased levels of intercultural awareness*. As implied by G14, when a new word is scanned and the associated content is viewed for more context, there is indeed more happening at the background than simply retrieving its definition or pronunciation:

> Actually, while watching the video [via AR interface], for example, we can acquire new ideas about a language, about the people who speak that language, and in addition to that, we can acquire some pronunciation and stress [patterns] as well. This is nice, I mean, sometimes it's a word that we learn and speak about, I think, it is going on well for that reason. It's effective in learning a new language… (G14)
>
> *Ya şöyle, videoyu izlerken mesela bir dil hakkında yeni fikirlere, o dili konuşan insanlar hakkında yeni fikirlere sahip olabiliyoruz ve üstelik bazı telaffuzlar ve streslere de sahip olabiliyoruz. Bu güzel, yani bazen yeni bir kelime oluyor öğrendiğimiz, üzerine konuştuğumuz, bence o yüzden güzel gidiyor. Yeni dil öğrenme konusunda etkili... (G14)*

Regarding the comment above, it may be argued that retrieving information about a language and its speakers through authentic virtual content embedded into words on a print page brings about an intercultural awareness which enables learners to develop the ability to understand the other and become aware of their values, beliefs and perceptions through the language they speak.

In conclusion, the findings revealed that AR learning offers unique solutions by addressing the needs of language learners in a more comprehensive way, introduce new practices by combining different technologies in its body, and improve the quality of the overall language learning experience. Being considered an innovation, AR is argued to be useful and preferable over conventional methods and technologies in language learning by the majority of the participants.

4.1.3. Technical Assets and Liabilities

The findings under the technical assets and liabilities aim to present insights into the understanding of AR Learning in terms of available technology, resources, and the infrastructure. That being said, several remarks which are related to the hardware, software, and network provide a clearer picutre of the actual user experience, help towards making meaningful connections with the issues regarding instruction, and therefore, help us gain deeper insights to what comprises the AR learning experience (Table 4.4).

Table 4.4: Technical Assets and Liabilities

Technical Assets and Liabilities		
Hardware-related	Software-related	Network-related
personal technologies	UI (user interface)	internet connectivity

spare device video output audio output storage and memory power use ideal configuration	UX (user experience) navigation image recognition	stability and speed of connection use of mobile data

Table 4.4: Technical Assets and Liabilities (continued)

4.1.3.1. Hardware-related

The hardware required for the implementation of AR learning in this study was primarily the participants' *personal technologies*. All of the participants owned a smart device or two, had them in their possession during the sessions. These devices were mainly smartphones running either the most recent version of the Android operation system (five participants) or Apple's iOS (thirteen participants). They were relatively new, that is, the oldest being maximum one and a half years old at the time, which helped ensuring a standard implementation and eliminated the possibility of differing experiences due to unfair advantages in terms of technology ownership.

Although all of the participants brought their own technologies into the classroom, there were occasional issues that required immediate replacement of those devices so that the tasks could be completed on time. Therefore, there were two *spare devices* that were made available for the use of the participants.

For instance, E09 reported that, at the beginning of the implementation, he owned a smart phone that was not very old, yet it was not enough to meet his everyday needs, including the viewing of AR learning tasks. He had difficulty in playing videos due to configurational issues, such as due to missing codecs, and therefore, he had to borrow one of the spare devices for a few weeks. As the implementation phase continued, he decided that he needed a device with better specifications and bought a new device. He later added that this upgrade also contributed positively to his AR learning experience.

The smart devices the participants owned worked very well during the implementation period, and except for a few expected technical issues, all of the AR learning activities could be performed without any interruption. Apart from smart phones and tablets as primary AR

viewing equipment, some of the participants mentioned that they were aware of other possibilities to view the AR content in the course, such as wearable goggles, VR headsets, or HUDs, but no one owned such devices nor were they given during the implementation. Therefore, in terms of *video output*, although OST (optical see-through) offers a more realistic and natural AR experience, the smart phones could only offer VST (video see-through). Therefore, knowing that OST was not an option, the majority mentioned that they would favor bigger screens over smaller smart phone screens as they believed the bigger the video output device is, the better the exposure would be. Yet again, one of the participants raised the concern that the image/video resolution would then be an issue if the size of the output did not support the content, and this would negatively impact the viewing experience.

As for *audio output*, some participants stated that earphones are an essential component of AR learning and play a very significant role, especially to create a personalized audio space for better concentration. Otherwise, it becomes very distracting or sometimes even chaotic to hear the same content playing from the loudspeakers of other participants' devices (Figure 4.15).

Figure 4.15: Student trying to do a listening task without earphones

This happened a few times when some participants forgot to bring their earphones to class. Although some shared their earphones with those who did not have and worked on the tasks together on the same device, others either borrowed a pair of spare earphones from a friend or waited until their friends were finished and borrowed theirs to catch up with the rest of the class. Therefore, audio is experienced best when it is transmitted via personal earphones or headsets.

As for device *storage and memory* requirements, only three participants reported that they did not have enough space to install and run the Aurasma app (18MB) on the first day of classes. Although Aurasma was not considered as a resource intensive app at that time, those participants reported that they had to remove some of the media content stored on their devices (i.e., photographs, music and video) and uninstall the apps they never/rarely used in order to create the required space to install and run the app without any issues. This must have fixed the problem as there were no interruptions or respective comments later on. However, for better performance and smoother operation, it is recommended that there is enough storage space and memory allocated for the AR learning app on the device.

In terms of *power use*, although two of the participants stated that the app consumes too much power and drains their batteries fast, the rest commented otherwise, i.e., that the battery use is quite regular and realistic, they did not have to change their charging cycle, the app and the way they used it did not require so much power, and the amount used for learning is fair and absolutely worth. What all participants agreed upon was that the battery use of a smart device used for AR learning anyway depended on several other factors, such as their personal device specifications and battery capacity, battery status of the device at the time of learning, the format of viewed content (video, audio, image, or all combined) and personal usage habits. Nevertheless, no matter how much power the app required, they thought this was an investment with a high return and they were ready to make such a sacrifice. In other words, considering the amount of power used by other apps throughout the day, this was undoubtedly prioritized as they all believed that AR learning was important, and this app made it real and supported their learning efforts. Therefore, to minimize the battery drain concern, some were suggesting that there should be charging stations or docks installed on the desks or learners should have portable powerbanks in their possession in case they needed extra power.

Finally, when they were asked to make a suggestion regarding the *ideal configuration* or setup, i.e., what device or equipment would ensure a successful AR learning experience for prospective AR learners, the majority answered that it would be best to follow BYOD (bring your own device). Therefore, any device learners own is fine. There is no need to invest extra money or resources for this kind of AR learning as it uses the existing technologies most students nowadays have. Their personal tech equipment suffices as long as they are allowed to use them in class. This also shows that there is a growing trend towards the use of personal

technologies for school work as such smart devices require higher levels of personalization or customization before they could be used, and this could be a very challenging task for institutions to deploy and maintain them due to the need for dedicated technical staff as well as financial concerns.

4.1.3.2. Software-related

The AR learning software, the Aurasma app, has a very minimalist *user interface (UI)*. That being said, the participants did not have any major challenges while they were asked to interact with what they could see on the display of their phones. When the participants started the app on their smart devices, they were greeted with a welcome animation, and afterwards, the camera view was on with a bunch of watermarked balls animating. This meant that the device was ready to scan an object or a surface, and once this was done, the virtual content appeared within seconds and was ready to be tapped on or play automatically. In addition to those, there were small, faint icons on the top right and left corners of the app window, which were to activate the camera flash in case there is low ambient light and to retrieve more information about how to use the app to scan. Finally, there was the Aurasma icon at the bottom, centered, in order to quit the current task and reactive the scanning mode. Almost all of the participants reflected their positive comments. For them, the interface was quite intuitive, that is, they could easily find their way around the application module, perform the given tasks without any hesitation or confusion. Thanks to these aspects of the application, the training phase did not take long at all, and their orientation to the interface, and therefore, AR learning was very easy and smooth. They could tap on the icon in their smartphones, open the application, hold their devices onto the trigger images, view the displayed content, and with a few taps and gestures on the screens of their personal devices, they could complete the activity assigned. Therefore, in terms of the interaction between the users and the Aurasma app, there was nothing to be concerned about neither technically nor pedagogically.

As for the *user experience (UX)*, that is to say, how useful, easy to use, and efficient the participants thought AR learning app was, all the findings were positive again. The AR learning tasks, for example, were considered useful for learning, by the majority. They thought that the app was very helpful and contributed to their learning. Regarding the ease of use of the interface, for instance, they stated that there was nothing particularly difficult about using the app to trigger the display of the AR content, and that anyone could use it as the interface was very plain and simple. They also noted that there was nothing to complain about

in terms of the amount of challenge involved, and that they had not experienced any technical issues during the implementation period when all the given conditions, such as stable internet connection, were met. In terms of efficiency, scanning of the trigger images went very fast thanks to the processing capacity of the devices used as well as the application's optimized use of resources, i.e., accessing the database at the background over the internet, recalling the requested content, and overlaying it onto the corresponding image, was within seconds. The virtual content was instantaneously superimposed, and the participants' interaction with the content, i.e., viewing and then responding by tapping to complete further tasks, was almost flawless. None of the users reported a stutter, freeze, or crash while using the application, again given the fact that all the required conditions were met. The AR content, including 3D images, animations or videos, was shown at user's request in a natural flow, and the follow-up actions, such as connecting to a poll or a discussion board on the course LMS, could be successfully executed. All in all, it can be concluded that AR learning app has been perceived as a useful, easy to use and an efficient learning medium by the participants.

Although *navigation* was not referred to as a problematic experience by the majority, a few participants suffered from occasional challenges while navigating around the interface, using the controls on the interface, and streaming content on specific tasks. To be more specific, while working on a pre-listening task that was connected to a discussion forum, three participants reported that they were confused when they saw two different buttons, the first one being "Done", placed on the application frame to switch from the viewing mode to the scanning mode, and the second one being "Submit", placed on the embedded LMS page to send their comments in the discussion forum. Having tapped "Done" first, instead of "Submit" upon the completion of their text, they noticed that their responses disappeared and were not sent. This created some disappointment at that moment; however, lesson was learned, and no one did it again. This was certainly not due to the Aurasma app, rather the integrated solution developed for this study, that is, the course LMS interface embedded into the AR app frame.

Although the problem above did not persist, a few participants reported occasional scanning issues regarding *image recognition*. There were times that the trigger images were not recognized by the devices and the users could not proceed further from the scanning mode of the app. Physical obstacles on the materials, such as annotations and doodles drawn by

users or stickers on the book pages, physical deformation of the books and handouts from water or coffee spills, did not allow image recognition (Figure 4.16).

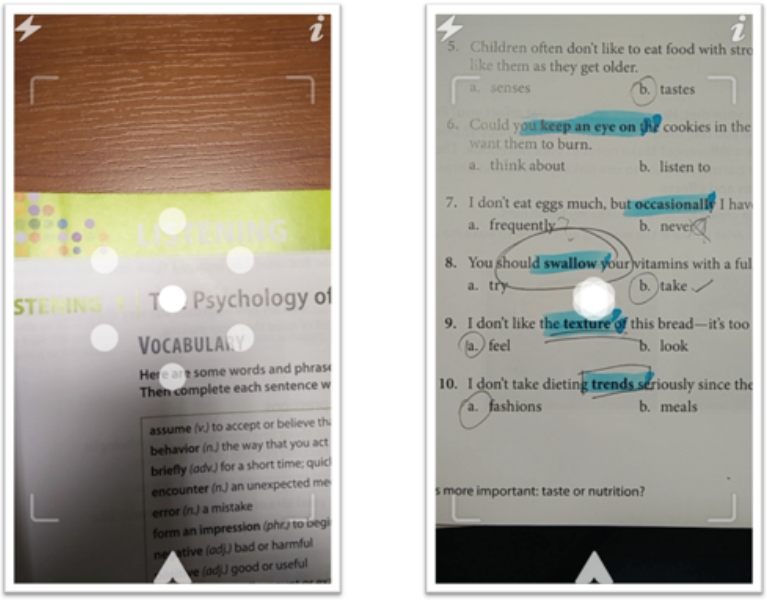

Figure 4.16: Distorted trigger images (from left to right): light reflecting on print material and impeding image recognition, annotations disable image recognition

Besides that, low resolution trigger images uploaded to the AR streaming server caused interruptions as they were not recognized by device cameras with low specifications. Similarly, some device cameras could not focus well due to dirty or scratched lenses or the amount of light available in the environment. However, these issues were adressed immediately. The participants were provided with the relevant instructions to overcome the problems not only by the instructor but also by their peers who knew what was going on at that moment. For example, these users were encouraged to use a spare device in case of a device-related problem, share learning materials when the triggger images were blocked, or asked to change their spots for better light conditions when they were sitting in a dark spot. As for the back-end related issues, the low resolution trigger images on the server were replaced immediately on the first week based on the feedback from the participants. Although there was a common awareness and understanding about these potential issues in the group, a few participants kept mentioning these scanning issues over and over again in their learning logs until the end of the implementation.

4.1.3.3. Network-related

As discussed earlier, the delivery and quality of AR learning experience rely on several different components; however, without network, i.e., *internet connectivity*, it would

not be possible or not so convenient at all. In other words, although it is technically possible to run AR applications offline, it would take so much effort to maintain the dynamic AR content on users' devices, keep them updated, and even if it were somehow achieved, it would be impossible to speak about sharing the same workspace, and therefore, collaborate on a specific task without proper network connection. As explained several times, when users hold their device cameras to a real image, the AR app initiates a process to search for its virtual equivalent in the AR content library, which is a database hosted on a remote server, and once a matching image is found, it requests the affiliated content, e.g. a video clip, to overlay exactly on the real image as defined beforehand by a developer. Although this entire process seems to take only a few seconds, there is an ongoing two-way data traffic at the background, several megabytes of data are sent and received to ensure a smooth, flawless AR viewing experience. Therefore, under network-related issues, internet connectivity plays a key role in the realization and success of AR learning and has been pointed out several times by the participants to be considered as a "must have" for future deployments.

However, network connection by itself does not guarantee a seamless learning experience as it also depends on several factors. The *stability and speed of connection* appeared to be a major concern among the participants. All the participants, except for two of them, voiced out their distress in this regard at least once throughout the implementation period. During the interviews, they made suggesstions for the improvement of AR learning by giving direct references to the necessity for uninterrupted data traffic, strong Wi-Fi signal, and broadband internet in the learning environment. Some of them gave personal examples, such as how they suffered from slow campus internet at times, both in the classroom and dormitory area. They were suspecting that the weak signal was due to their proximity to the access points located in the hallways, and those who were sitting at the back rows had to move to the front of the room so that they could get better signal reception. As for the unstability or latency expeienced in the data traffic, it could be speculated that these are mostly likely due to the overload when all the participants started an activity at the same time. However, none of the claims above was confirmed by the IT department as the network infrastructure (ADSL broadband with download speeds up to 16 Mbit/s) was able to meet the needs of the participants without any problems at the given scale.

While the above concerns were raised by those who were using the wireless connection that was campuswide available at no cost, four participants mentioned that they

occasionally had to switch to *mobile data* (3G mobile connection with download speeds up to 63,3 Mbit/s depending on the carrier) whenever they encountered issues with the wireless internet connection. They mentioned this as their backup plan even though this was considered a personal sacrifice among a few participants at that time when mobile data plans were limited in quota, and the costs were high. Those used their mobile data instead of the free Wi-Fi reported that they did not think that AR leaning required too much data transfer. It indeed used up from their monthly data usage quota, yet they did not mind as they thought it was useful and worth. This suggests that the participants were content with their AR learning experience, in general and did not mind making the necessary time and resource investment as required on their end. Although these occasional technical liabilities may sound like concerns, there were quick solutions or alternative options provided to continue and finalize the tasks and provide the participants with a technically uninterrupted learning experience.

4.1.4. Instructional Assets and Liabilities

The instructional aspects of the AR learning experience aim to provide an overview of how teaching was conducted during the implementation as well as how it was perceived by the participants. Therefore, findings regarding instruction, facilitation, interface, material, delivery and tasks are presented with several suggestions and expectations for better future implementations (Table 4.5).

Table 4.5: Instructional Assets and Liabilities

Instructional Assets and Liabilities			
Instruction-related	Interface-related	Content-related	Delivery-related
direct instruction instructional support instructor's role	distraction dedicated devices orientation	challenge pedagogy quality content task preference	hybrid delivery pacing peer group interaction procedure

4.1.4.1. Instruction-related

The instructional model adopted in the AR learning course was an adapted version of *direct instruction*, that is to say, instructions for were initially guided by the instructor yet the details to understand the procedures and tasks followed on the AR learning interface so that the students would progressively become independent as they learn about new concepts. When the participants were asked if they experienced any issues while understanding the instructions about what they were supposed to do on a given AR task, they stated no concerns in this regard. After their first session of AR learning, which included a brief orientation into the interface and how-to-use guidelines, they kept following a standardized protocol by using their personal devices to complete the assigned tasks upon request. According to the participants' comments, the instructions were clear and easy to follow. They also enjoyed the opportunity of viewing the instructions either appearing on the material to be scanned or on the device screen as floating virtual texts. There was no challenge involved in understanding what to do as the steps on the interface were very intuitive. No complaints were recorded regarding the complexity of the instructions and accessing the learning content.

While the majority of the participants were satisfied with the way the instructions were given, some of them highlighted the importance and necessity of *instructional support* by particularly referring to the need for an orientation session on the first day of AR learning. A few participants even mentioned that without particular training or induction, some learners, if not all, might easily get confused and expect to hear the instructions from the instructor to make sure that they are doing the task correctly. Although these comments were speculations based on hypothetical situations regarding potential instruction-related problems, most participants reported that neither the application nor tasks did pose any risks in terms of understanding the topics in question as far as their experience was concerned.

The facilitation of the AR tasks was quite simple and straightforward for the instructor. As mentioned above, the *instructor's role* was to announce or draw students' attention to the AR tasks as a facilitator, and the rest of the learning procedures were self-sustained via the app. All the necessary resources, information, and support for the completion of a task were made available, so the instructor indeed took up a more standby role immediately after asking them to scan the relevant section of the book or a worksheet. Similar to the concerns raised for instructional support, two participants argued that

instructor's role as a facilitator or a learning coach is a definite requirement. Such a person, for instance, would not only provide support and guidance on the facilitation of the tasks, but also select and curate the learning content that is pedagogically tailored and served to the best interest of the learners. When technical or pedagogical challenges arise, the faciliator would then introduce a solution or an alternative plan to ensure that there are no interruptions for the students to keep learning by themselves while developing ownership of the learning processes at the same time.

4.1.4.2. Interface-related

Regarding the interface from an instructional point of view, one of the biggest concerns was *distraction* due to the fact that smart phones were chosen as the primary AR viewing medium. The notifications triggered by popular apps such as instant messengers or social network apps and drawn over the AR app being used for learning were initially considered a limitation which would result in participants' not staying focused, losing their attention or the tasks' being interrupted. All the participants had a few of these apps in their devices installed, and it was apparent that they were checking the notification panel every now and then for new content alerts, even in non-AR classes. Contrary to these concerns, most participants reported that there was no distraction in general while working on AR tasks as the experience was much more engaging than those notifications. Once the learners were started a task, they did not allow other apps to break the flow, rather stayed focused until the end. The full screen app window with a clean user interface served as a means to present the relevant content in an organized way, and by doing so, somehow distinguished the boundaries of the AR learning space from any distractive input, be it physical or virtual.

There were also some general remarks on distraction that it depended on several different factors, such as the task itself, learning content, or the eagerness of the learner. Using smartphones or other forms of new technologies, per se, would not make it any different. When the task is boring or the learning content is not so appealing, the learners would start doodling on a piece of paper, even in the absence of smart devices. Nevertheless, a few participants mentioned that when they received calls, there was no way of avoiding it and this inevitably interfered with the ongoing task and was therefore interrupting the pace of learning. As a result, it was suggested that the "do not disturb" mode of these devices could be activated to avoid such consequences.

Unlike the majority, one participant pointed to the necessity of *dedicated devices* as he argued that smart phones are distracting by their very nature anyway and they are not meant for learning. He justified his argument by noting that as soon as they were finished with a task, they were habitually hitting refresh buttons or pullling down the notification bars to peek at incoming messages or recent posts, which was not possible in traditional classes in which electronic devices were to be kept under their desks or in their backpacks. When he was asked for a possible solution, he said more dedicated devices, such as goggles or head units, could help minimize the amount of distraction caused by a multipurpose device.

Another major concern regarding the interface was *orientation,* similar to navigation, due to the fact that the learners would not be familiar with the AR learning interface as a learning environment and could lose their track easily. Unlike the conventional learning media, i.e. print books and the like, AR learning interface featured virtual content which required the learners' haptic input in response to appearing on-screen prompts in order to advance further in a task. It seems that the participants' familiarity with their personal smart devices helped eliminating the orientation challenges as they could easily transfer their existing technological skills to maintain learning. Therefore, using the interface to start a task or following the instructions from the beginning to the end of a task were not considered challenging at all. Thanks to the intuitive capacity of the interface, no extra effort is required to register user input, either. Participating in a task by submitting text answers or marking a choice in a poll were considered ordinary. Except for a few minor technical issues, such as device's being unresponsive due to OS related failures, the participants reported that they did not feel like they were lost or confused at all.

4.1.4.3. Content-related

Although the majority of the participants stated that they did not find the AR learning medium distracting nor difficult in the interviews, there were a few comments captured on the amount of *challenge* involved with some learning content in the learning journals. According to these comments, the learning content was challenging at times due to the fact that authentic language in the integrated audiovisuals was too fast and difficult to understand, accents were not clear, or some tasks required too much time investment and therefore staying focused had become an issue. Although there is no record of such a challenge experienced in the observation notes, i.e., none of the students approached the instructor with questions or the instructor noticed any significant comprehension issues while assessing, it is possible that

there was boredom and loss of attention related to the lengthy videos in some tasks. This shows that learning content plays a very important role in engaging the audience no matter what medium is in question, and if the amount of challenge is beyond a learner's expectation, it results in distraction, loss of attention, or difficulties to maintain focus.

Although most comments approached the content from a somewhat technological perspective, i.e., in terms of the relationship between AR medium and the learning content and how these would work together in the classroom, the need for sound *pedagogy* also revealed indirectly in the interviews. For instance, E09 shared his opinions in this regard by making comparisons to the ongoing smart board project at the time with reference to the issues in the deployment. He studied at a high school which was nominated as a piloting site for the nationwide smartboard project, which involved the deployment of smartboards in state schools with the expectation that this would expand learning opportunities and lead to desired learning outcomes at elementary and secondary level. He argued that their experience with smartboards as a high school student was somewhat disappointing due to lack of proper educational content tailored specifically for that medium, a specially designed curriculum allowing these media to augment the classroom learning experience, and more importantly, the teachers who were aware of the sound pedagogies to combine these components together, the project was destined to fail. This shows again that new technologies are often introduced with big claims or promises that they will revolutionize educational realms, yet when the required infrastructure is not set up appropriately, they will eventually fail.

In similar veins, AR as a new form of educational technology in the classroom sounds exciting at first, yet without *quality content*, it is difficult to sustain learning activities. The implementation period indicated that the wow effect of the technology vanishes in short term, and students have the tendency to develop a negative attitude when it becomes repetitive and turns into a monotonous practice. To maximize its efficiency as a learning medium and keep learners engaged, good quality content has to be prioritized, and material design has to be given more importance.

Closely related to the finding above, there seems to be a correlation between quality content and *task preference*. The participants were asked to rate most favored tasks and least favored tasks at the end of each unit. The results indicate that tasks that involve audiovisual content were rated as the most favorite and effective tasks, while tasks that require text

submission were among the least favorite. At first glance, this could be interpreted that it is either due to the amount of cognitive challenge and effort involved as glossary entries or forum posts requiring more concentration both in process and production stages. On second thought, however, this could also indicate that, as mentioned above, although short-term implementations of AR learning create the so-called wow effect, once it turns into a routine, it loses its appeal and becomes an arduous task for some individuals. For example, there were a few individual comments in the learning journals towards the end of the implementation that some students got used to the task formats, especially regarding the discussions, i.e., posting comments on the discussion board after listening to or watching extra content provided, and it became less and less exciting to participate in the discussions, mostly due to the larger amounts of content posted by the class members and/or the tasks' taking longer times and effort than expected.

4.1.4.4. Delivery-related

In terms of the delivery of learning content, although the primary delivery mode of the course was face-to-face, there were hybrid elements, such as an integrated LMS page for the coursebook media files and assignments to supplement the classroom teaching. With the incorporation of AR, however, the *hybrid delivery* gained a different momentum to an extent that some participants were questioning the role of the coursebook and teacher in comparison with the AR learning interface:

> G14: …it's like an assistive tool. There's still need for the instructor, you know, who will also teach, but after that, regarding some activities, some things on the internet, this is a helpful application supporting such.
> Interviewer: So you mean it wouldn't replace a person?
> G14: No, I don't think it would.
> Interviewer: Do you think it would substitute the instructor?
> G14: No, it wouldn't.
> Interviewer: How about the book?
> G14: This is debatable depending on the circumstances. Considering all, this is a medium in which information is delivered in some way, so is the book, I don't know, sometimes the instructor could be such a medium, too… (G14)

> *G14: ...böyle yardımcı araç gibi yine bir öğretmene ihtiyaç var, hani ders de anlatacak ama daha sonra işte bazı aktiviteler olsun, internet üzerinden bazı şeyler olsun, onu destekleyecek destekleyici bir uygulama bence.*
> *Araştırmacı: Yani birinin yerini almaz?*
> *G14: Yok bence almaz.*
> *Araştırmacı: Hocanın yerini alır mı sence?*
> *G14: Almaz.*

Araştırmacı: Kitabin yerini alır mı?
G14: Tartışılabilir bazı konularda, sonuçta şey, bilginin bir şekilde aktarıldığı bir ortam kitap da öyle bir ortam, ne bileyim, hoca da öyle bir ortam olabiliyor bazen... (G14)

In her commentary, although G14 makes statements that she sees AR learning as a supplement, and it would not necessarily replace the teacher, she later swifts to the idea that in terms of content delivery, there is not much difference. It may be argued that AR functions as a medium similar to the coursebook or the instructor at times. This shows that with technologies like AR, the boundaries between physical reality and virtual reality get blurred, and students share an augmented learning environment, in which the content is delivered in diverse formats.

When hybrid teaching is in question, *pacing* could be a matter of concern. Although the majority of the comments revealed no specific issues, there were some individual answers mentioning slight challenges at the very beginning, such as due to not being familiar with the app interface or not being able to catch up with the others in class as the app required the individual learner to adjust his/her pace. This, according to B18, interfered with the delivery of the content, yet did not last long. Although the interface has the potential to accommodate diverse pacing scenarios, i.e., instructor-led or self-paced task completion, it is difficult to maintain a synchronous progress in instructor-led tasks as in an actual face-to-face class where the content is delivered from a single source.

The *peer group interaction* is impacted by the delivery format as well. B18 commented that some tasks were so focusing on individual performance, and stronger students could finish faster than those who were not as fast completing the tasks. This resulted in suffering from boredom among the stronger ones because all the participants were given the same amount of time and told to wait for everyone to move on to the next task. Similarly, those who started late could not complete the task and they had to quit before reaching the end. Contrary to this opinion, in the observations, this situation was noted as an opportunity for peers to provide support for each other, not only technically by sharing devices or relevant equipment to help them catch up, but also academically by helping them understand the task. This sort of relationship among peers made them more engaged in the tasks and created a sense of responsibility, which lacks in instructor-led delivery format.

Another concern raised related to the delivery format was the *procedure* involved in doing the AR learning activities. That is, the content was delivered in the same arrangement: scan and view the explanations and guiding instructions about the task, tap on the screen to proceed to the actual content, listen to/watch/read, and finally tap again for the follow up task. B18, again, claimed that he could not help feeling as if this arrangement was not very efficient in terms of using the class time. For him, it would have been much faster if the instructor had given the instructions and presented the content using the projector in the room, and it would have been ideal if the AR tasks had been voluntary or optional to be done as leisure activity outside the class. As in his previous comments in the second round of interviews, it was clearly noticeable that he must have lost his interest and enthusiasm due to the incrementally accumulating pressure of the approaching exit test at the end of the semester, the result of which determined if they were going to stay another semester in the preparatory program or get promoted to be freshmen. Therefore, he would rather have a format that would focus on test preparation.

4.2. QUANTITATIVE FINDINGS: DESCRIPTIVE STATISTICS AND PRE/POST-TEST SCORES

This section reports the quantitative findings as descriptive statistics and pre-test /post-test scores of both groups in four sub-sections: demographics, participants' technological awareness and use of new technologies, participants' attitudes towards language learning with new technologies, and achievement test scores.

4.2.1. Participants' Technological Awareness and Use of New Technologies

The following table shows the group statistics of the participants both in Experimental Group (EG) and Control Group (CG) in terms of their awareness and use of new technologies at the beginning and towards the end of the implementation period (Table 4.6).

Table 4.6: Pre-test and post-test group statistics - Technological Awareness and Use of New Technologies

	Group	N	Mean	Sd
Tried/used desktop computer Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used desktop computer Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]

Tried/used notebook/netbook computer Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used notebook/netbook computer Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used tablet/iPad/PDA Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used tablet/iPad/PDA Post-test	EG	18	.94	.236
	CG	18	1.00	.000
Tried/used smart phone (Android, iOS, Windows, etc.) Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used smart phone (Android, iOS, Windows, etc.) Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Tried/used wearable technologies (Smart watch, glasses etc.) Pre-test	EG	18	.17	.383
	CG	18	.17	.383
Tried/used wearable technologies (Smart watch, glasses etc.) Post-test	EG	18	.11	.323
	CG	18	.17	.383
Owned desktop computer Pre-test	EG	18	.61	.502
	CG	18	.56	.511
Owned desktop computer Post-test	EG	18	.67	.485
	CG	18	.67	.485
Owned notebook/netbook computer Pre-test	EG	18	.89	.323
	CG	18	.89	.323
Owned notebook/netbook computer Post-test	EG	18	.94	.236
	CG	18	.89	.323
Owned tablet/iPad/PDA Pre-test	EG	18	.50	.514
	CG	18	.56	.511
Owned tablet/iPad/PDA Post-test	EG	18	.56	.511
	CG	18	.61	.502
Owned smart phone (Android, iOS, Windows, etc.) Pre-test	EG	18	.94	.236
	CG	18	1.00	.000
Owned smart phone (Android, iOS, Windows, etc.) Post-test	EG	18	.94	.236
	CG	18	1.00	.000
Owned wearable technologies (Smart watch, glasses etc.) Pre-test	EG	18	.06	.236
	CG	18	.06	.236
Owned wearable technologies (Smart watch, glasses etc.) Post-test	EG	18	.00	.000
	CG	18	.06	.236
Internet access at home/dorm Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Internet access at home/dorm Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Internet access at school Pre-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]

Internet access at school Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
App for everyday tasks Pre-test	EG	18	.89	.323
	CG	18	1.00	.000
App for everyday tasks Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
App for leisure activities Pre-test	EG	18	.94	.236
	CG	18	1.00	.000
App for leisure activities Post-test	EG	18	1.00	.000
	CG	18	.94	.236
App for school-related tasks Pre-test	EG	18	.94	.236
	CG	18	1.00	.000
App for school-related tasks Post-test	EG	18	1.00	.000[a]
	CG	18	1.00	.000[a]
Internet for communication Pre-test	EG	18	4.72	.575
	CG	18	4.78	.428
Internet for communication Post-test	EG	18	4.67	.767
	CG	18	4.83	.383
Internet for social networking Pre-test	EG	18	4.61	.608
	CG	18	4.22	.943
Internet for social networking Post-test	EG	18	4.50	.786
	CG	18	4.39	.979
Internet for gaming Pre-test	EG	18	1.78	.808
	CG	18	2.17	1.150
Internet for gaming Post-test	EG	18	1.78	.647
	CG	18	2.33	1.138
Internet for schoolwork Pre-test	EG	18	3.83	.786
	CG	18	4.11	.676
Internet for schoolwork Post-test	EG	18	3.94	.725
	CG	18	4.11	.758
More smart device use in class Pre-test	EG	18	4.11	.758
	CG	18	4.06	.802
More smart device use in class Post-test	EG	18	3.83	.857
	CG	18	3.72	.826
Prefer print resources to online resources for school project Pre-test	EG	18	3.17	1.150
	CG	18	3.33	1.085
Prefer print resources to online resources for school project Post-test	EG	18	3.22	1.166
	CG	18	3.06	1.259
Avoid using online resources unless I have to Pre-test	EG	18	2.78	1.263
	CG	18	2.72	1.127
Avoid using online resources unless I have to Post-test	EG	18	2.33	.686
	CG	18	2.61	1.092

Have problems finding my way around a smart device Pre-test	EG	18	2.61	1.195
	CG	18	3.11	1.023
Have problems finding my way around a smart device Post-test	EG	18	2.39	.979
	CG	18	3.06	.998
Learn using new technologies by trial-and-error Pre-test	EG	18	4.06	.639
	CG	18	3.94	.639
Learn using new technologies by trial-and-error Post-test	EG	18	4.11	.583
	CG	18	3.89	.832
Need assistance while using new technologies Pre-test	EG	18	2.72	1.179
	CG	18	3.39	1.037
Need assistance while using new technologies Post-test	EG	18	2.50	.786
	CG	18	3.00	.686
New technologies increase my interaction with other students in class Pre-test	EG	18	3.78	.808
	CG	18	3.67	.686
New technologies increase my interaction with other students in class Post-test	EG	18	3.61	.916
	CG	18	3.56	.922
New technologies increase my interaction with course materials in class Pre-test	EG	18	3.83	.707
	CG	18	4.00	.686
New technologies increase my interaction with course materials in class Post-test	EG	18	3.89	.471
	CG	18	3.78	.808
New technologies increase my interaction with instructor in class Pre-test	EG	18	3.83	.786
	CG	18	3.61	.850
New technologies increase my interaction with instructor in class Post-test	EG	18	3.56	.784
	CG	18	3.67	.840
Follow latest trends in technology and invest in new devices Pre-test	EG	18	3.56	.856
	CG	18	3.17	.924
Follow latest trends in technology and invest in new devices Post-test	EG	18	3.56	.705
	CG	18	3.22	.878
Solve problems with new device on my own Pre-test	EG	18	3.39	1.037
	CG	18	3.17	.985
Solve problems with new device on my own Post-test	EG	18	3.89	.583
	CG	18	3.39	.850
Feel confident about buying and using new technologies Pre-test	EG	18	3.83	.924
	CG	18	3.50	.786
Feel confident about buying and using new technologies Post-test	EG	18	4.00	.485
	CG	18	3.44	.856
Adjust new technologies to suit my needs Pre-test	EG	18	4.00	.343
	CG	18	4.17	.383
Adjust new technologies to suit my needs Post-test	EG	18	4.11	.323
	CG	18	4.06	.416

Table 4.6: Pre-test and post-test group statistics - Technological Awareness and Use of New Technologies (continued)

According to the group statistics, all the participants have used and/or owned a desktop computer, notebook computer, tablet, and smart phone. They seem to use these devices, interchangeably, to perform certain tasks on a daily basis. However, wearable technologies, such as smart watches or glasses/goggles, still appear to be new and the need for these devices have not been well defined yet. While six participants have the experience, only two of them have reported that they own a smartwatch.

Similarly, internet access is available both at home and school for everyone, either through the Wi-Fi on various campus locations, such as the classrooms, library, student center, and cafeteria, or the participants' individual high speed mobile data plans which they have already been subscribed to. Although some rare blind spots, i.e., areas where network reception is poor or does not exist, have been mentioned in the interviews verbally, they do not consider this as a major access issue.

Having mobile applications for everyday tasks (communication, calendar, organizer, shopping, bus schedule apps, etc.), leisure activities (photography, music/video editing, travel apps, games, etc.), and school-related tasks (educational, office apps, dictionary, etc.) is also becoming common among the participants. They seem to be aware of all the popular apps, have accounts in those apps or platforms, and actively use.

When it comes to the frequency, i.e., how often they use the internet for communication, i.e., instant messaging or calling friends or family members via apps like Skype, WhatsApp, and Facetime, their answers range between always, being the major choice, and several times a day. Social networking via popular platforms like Facebook, Twitter, Instagram, and the like, are used as often. Online gaming, however, have a lower frequency, i.e., an activity that takes place either once in a few days to once a week, for almost half of the participants, or does not take place at all, for the other half. Unlike gaming, using the internet for schoolwork via popular sites like ELC Online (departmental learning management system), Wikipedia, and TedTalks is very common, with the answers ranging between always and once in a few days.

The participants seem to be agreeing on the fact that they would like to use smart devices in classes more. However, they are not so sure about replacing the print materials with online resources for schoolwork yet although a reasonable number answered in favor of the online resources. Online learning resources, similarly, are accepted normal in the classroom,

except for a few participants, who did not agree at the beginning, but changed their opinions towards the end of the semester.

As for the basic computer/media literacy skills, the majority seem to know what to do when they are asked to use a specific learning technology as long as they are given the instructions; however, there are still a few individuals who reported that they may need extra support when they are about to use a new learning technology. Trial and error seems to be the most common approach while learning how to use a device or an application.

The majority of the participants believe that using new technologies increases their interaction with other students and the instructor, as well as course materials in class despite some who seem to be undecided or skeptical about the potential of technology increasing interactivity at the beginning, but later changed their minds agreeing with it at the end of the semester.

Following the latest trends in technology and trying to acquire latest devices seem to be common among the majority; however, almost one third of the participants are either undecided or disagree with it. Those who follow the trends seem to have a general understanding of what they need and feel confident about buying and using new technologies. There is; however, almost a unanimous view that they can adjust new technologies to suit their needs when needed.

The findings above (Table 4.6) show that the experimental group and the control group share similar backgrounds and experiences regarding their awareness levels and opinions on the use of new technologies. When the pre-test scores of both groups are compared using Mann-Whitney U Test, there is no significant difference between. This indicates that both groups were almost identical in their awareness and usage levels at the beginning of the implementation, and therefore, there were no individuals whose past experiences or knowledge would impact the results either in any significant way. However, when the post-test scores of both groups are analyzed, it is found out that there are three items that are statistically significant. The following tables show the Mann-Whitney U Test results of the post-test results of these significant items in the technological awareness use of new technologies category.

Table 4.7: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 22. "I have problems finding my way around a smart device."

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	16.17	291.00			
	CG	18	20.83	375.00			
	Total	36			120.000	-1.435	.151
Post-test Scores	EG	18	15.25	274.50			
	CG	18	21.75	391.50			
	Total	36			103.500	-2.006	.045

As seen in the table above (Table 4.7), there is a significant difference (p=.045) between the experimental and control groups at the end of the implementation period regarding Item 22: "I have problems finding my way around a smart device." The experimental group has a lower score and appears not to have as many problems as the control group finding their way around a smart device. It can be concluded that students' in-class experience must have contributed positively to their device using skills as well as their awareness levels. Due to the intensive use of smart devices in class to perform the AR tasks, they must have developed the strategies to cope with challenges posed by hardware or software. After several hours of exposure and hard work, the participants' smart devices or the mobile AR interface became virtually invisible. Therefore, they quit concentrating on the operation of the required components that make the AR learning experience possible; instead, they were busy with interacting with the content and learning. Whereas in the control group in which smart devices and apps were not part of their learning experience, students may not even have thought about it.

Table 4.8: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 24. "I need the assistance of others while using new technologies."

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	15.47	278.50			
	CG	18	21.53	387.50			
	Total	36			107.500	-1.779	.075
Post-test Scores	EG	18	15.28	275.00			

	CG	18	21.72	391.00			
	Total	36			104.000	-1.977	.048

Table 4.8: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 24. "I need the assistance of others while using new technologies." (continued)

The table above (Table 4.8) shows that there is a significant difference (p=.048) between the experimental and control groups for Item 24: "I need the assistance of others while using new technologies." Having a lower score than their counterparts in the control group, the participants in the experimental group seem to need less assistance while using new technologies. As mentioned in the previous finding, intensive use of smart devices not only provided students with problem-solving skills, but also made them relatively more independent of others. Therefore, one may conclude that AR learning encouraged the participants' use of new technologies by making them more autonomous at the same time.

Table 4.9: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 30. "I feel confident about buying and using new technologies."

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	20.89	376.00			
	CG	18	16.11	290.00			
	Total	36			119.000	-1.510	.131
Post-test Scores	EG	18	21.39	385.00			
	CG	18	15.61	281.00			
	Total	36			110.000	-2.088	.037

Table 4.9 reveals that at the end of the implementation, the scores of the experimental group significantly differs (p=.037) from the control group's in their level of confidence about buying and using new technologies. Again, parallel to the findings above, one can claim that the participants' AR learning experience must have contributed to their self-confidence and self-esteem in a positive way that they can make their own decisions when it comes to new technology ownership. Knowing what worked or did not work well first hand, they seemed to have developed the necessary know-how and expertise. Not only did this help with their becoming more autonomous learners, but it also helped them being conscious learners who

can think for themselves, make clear decisions about what they need for their own learning, and invest accordingly.

In addition to the three significant items from the comparison of the post-test scores of the two groups, within the experimental group, it can be seen that post-test scores have also increased. Although the increase in the individual scores do not stand out as statistically substantial, one item (Item 29) has been marked significant in the analysis. The following table shows the Wilcoxon Signed Rank Test results for this item.

Table 4.10: Pre-test and Post-test scores for experimental group analyzed by non-parametric Wilcoxon Signed Rank Test for Item 29 "When I have a problem using a new device, I usually solve it on my own."

	Ranks	N	Mean Rank	Sum of Ranks	z	p
Pre-test Scores	Negative Ranks	0[ck]	.00	.00		
	Positive Ranks	6[cl]	3.50	21.00		
Post-test Scores	Ties	12[cm]			-2.251[e]	.024
	Total	18				

The table above (Table 4.10) indicates that participants of the experimental group scored significantly higher (p=.024) in the post-test for Item 29: "When I have a problem using a new device, I usually solve it on my own." This item is very similar to Item 22 above, and it reinforces the previous interpretations that the participants' awareness and knowledge in using new technologies improved from the beginning of the implementation until the end that they feel more autonomous and conscious about the AR learning procedures.

4.2.2. Participants' Attitudes Towards Language Learning with New Technologies

The following table (Table 4.11) shows the pre-test and post-test group statistics of the participants' attitudes towards language learning with new technologies at the beginning and towards the end of the implementation period.

Table 4.11: Pre-test and post-test group statistics – Attitudes towards Language Learning with New Technologies

	Group	N	Mean	Sd
Looking up a word in an online dictionary Pre-test	EG	18	.83	.383

	CG	18	1.00	.000
Looking up a word in an online dictionary Post-test	EG	18	.94	.236
	CG	18	.94	.236
Searching for information on a website (Google, Wikipedia, etc.) Pre-test	EG	18	.78	.428
	CG	18	.72	.461
Searching for information on a website (Google, Wikipedia, etc.) Post-test	EG	18	.94	.236
	CG	18	.89	.323
Posting a comment in an online forum Pre-test	EG	18	.11	.323
	CG	18	.06	.236
Posting a comment in an online forum Post-test	EG	18	.50	.514
	CG	18	.17	.383
Taking notes Pre-test	EG	18	.28	.461
	CG	18	.28	.461
Taking notes Post-test	EG	18	.72	.461
	CG	18	.39	.502
Listening to/watching online audio/video clips Pre-test	EG	18	.39	.502
	CG	18	.17	.383
Listening to/watching online audio/video clips Post-test	EG	18	.89	.323
	CG	18	.44	.511
Favor using new technologies while learning a foreign language Pre-test	EG	18	3.83	.707
	CG	18	4.00	.594
Favor using new technologies while learning a foreign language Post-test	EG	18	3.83	.514
	CG	18	4.06	.639
Instructor's application of new technologies in English classes helps better learning Pre-test	EG	18	4.06	.725
	CG	18	3.67	.970
Instructor's application of new technologies in English classes helps better learning Post-test	EG	18	3.83	.707
	CG	18	3.94	.639
Grades might improve more when new technologies in English classes integrated Pre-test	EG	18	3.61	.608
	CG	18	3.67	.970
Grades might improve more when new technologies in English classes integrated Post-test	EG	18	3.67	.767
	CG	18	3.67	.594
English classes would get easier if instructors offered new technologies Pre-test	EG	18	3.78	.548
	CG	18	3.78	1.060
English classes would get easier if instructors offered new technologies Post-test	EG	18	3.83	.707
	CG	18	3.61	.608
Would like English classes more if instructor used more new technologies Pre-test	EG	18	3.61	.608
	CG	18	3.94	.998
Would like English classes more if instructor used more new technologies Post-test	EG	18	3.56	.856
	CG	18	3.44	.784

All English instructors should offer new technologies in teaching Pre-test	EG	18	3.72	.669
	CG	18	3.44	.922
All English instructors should offer new technologies in teaching Post-test	EG	18	3.44	.856
	CG	18	3.67	.767
Taking English classes through new technologies is more stimulating than the traditional, face-to-face classes Pre-test	EG	18	3.44	.922
	CG	18	3.11	1.231
Taking English classes through new technologies is more stimulating than the traditional, face-to-face classes Post-test	EG	18	3.61	.778
	CG	18	3.28	.895
Instructor's application of new technologies in English classes is a waste of time Pre-test	EG	18	2.50	.924
	CG	18	2.50	.985
Instructor's application of new technologies in English classes is a waste of time Post-test	EG	18	2.61	1.092
	CG	18	2.39	.698
English classes with new technologies make you feel more interested in English Pre-test	EG	18	3.56	.705
	CG	18	3.67	.767
English classes with new technologies make you feel more interested in English Post-test	EG	18	3.39	.778
	CG	18	3.67	.686
More interaction taking place in English with the instructor while using new technologies Pre-test	EG	18	3.61	.608
	CG	18	3.44	.922
More interaction taking place in English with the instructor while using new technologies Post-test	EG	18	3.50	.786
	CG	18	3.56	.784
More interaction taking place in English among students while using new technologies Pre-test	EG	18	3.44	.784
	CG	18	3.22	1.003
More interaction taking place in English among students while using new technologies Post-test	EG	18	3.50	.985
	CG	18	3.39	.698
Using new technologies in English classes also improve your IT (Information Technologies) skills Pre-test	EG	18	4.00	.485
	CG	18	3.89	.832
Using new technologies in English classes also improve your IT (Information Technologies) skills Post-test	EG	18	4.11	.471
	CG	18	4.00	.594
Can continue learning English by myself with the help of new technologies Pre-test	EG	18	3.44	.616
	CG	18	3.56	1.097
Can continue learning English by myself with the help of new technologies Post-test	EG	18	3.89	.758
	CG	18	3.94	.539

Table 4.11: Pre-test and post-test group statistics – Attitudes towards Language Learning with New Technologies (continued)

Pre-test scores of both groups in this section also suggest that the participants shared similar habits of language learning with new technologies at the beginning of the implementation. They use their mobile devices mostly for reference tasks, such as looking up a word in an online dictionary or searching for information on Google or Wikipedia.

However, productive tasks that require deeper levels of interaction and engagement, such as listening to or watching online audio/video clips on a specific topic, taking notes while listening or reading, or collaborative tasks that require working together in a virtual environment, such as participating in an online discussion by posting comments, seem to be very rare for both groups at the beginning of the implementation.

The items specifically focusing on the attitudes of the participants have been answered mostly in agreement, partially undecided, and very rarely in disagreement. Approximately two thirds are in favor of using new technologies while learning a foreign language, whereas one third are still undecided. Therefore, they believe that the instructor's application of new technologies in English classes help them learn better and think that their grades might even improve more when new technologies are integrated into their English classes.

A similar pattern is apparent in the following items. More than two thirds of the participants, for instance, believe that English classes would get easier if the instructor offered new technologies. Likewise, almost two thirds of the participants think that they would like English classes more if the instructor used more new technologies. All the English instructors, therefore, should offer new technologies in their teaching according to most of the participants.

When they were asked whether taking English classes through new technologies is more stimulating than the traditional, face-to-face classes, the majority expressed agreement, while only a few disagreed. They do not think that the instructor's application of new technologies in English classes is a waste of time despite some skepticism, i.e., some being undecided about it. More than half of the participants even think that English classes with new technologies make them feel more interested in English.

As for interaction, more than half of the participants believe that there is more interaction taking place in English with the instructor while using new technologies, while the others are undecided at the beginning, with some disagreeing towards the end of the implementation. When they were asked about the interaction taking place in English among students, the numbers increase in favor of agreement in the post-test, aside from two participants disagreeing both at the beginning and end of the implementation.

In line with the responses above, there is a common agreement upon the fact that using new technologies in English classes also improve their IT (Information Technologies) skills. Although it was more than one third of the participants who thought that they can continue learning English by themselves with the help of new technologies at the beginning of the implementation, it increased up to more than three fourths towards the end of the implementation.

Similar to the findings in the technological awareness and use of new technologies section, the pre-test scores of the groups do not show any significant difference. Their post-test scores, however, reveal that there are three items, Items 32c (p=.036), 32d (p=.047), and 32e (p=.005), which are statistically significant. The following table shows the Mann-Whitney U Test results of the post-test results of these significant items.

Table 4.12: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 32. "Which of the following tasks do you use your mobile device for in class?"

c) Posting a comment in an online forum

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	19.00	342.00			
	CG	18	18.00	324.00			
	Total	36			153.000	-.595	.552
Post-test Scores	EG	18	21.50	387.00			
	CG	18	15.50	279.00			
	Total	36			108.000	-2.092	.036

d) Taking notes

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	18.50	333.00			
	CG	18	18.50	333.00			
	Total	36			162.000	.000	1.000
Post-test Scores	EG	18	21.50	387.00			
	CG	18	15.50	279.00			

	Total	36		108.000	-1.984	.047

e) Listening to/watching online audio/video clips

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	20.50	369.00			
	CG	18	16.50	297.00			
	Total	36			126.000	-1.468	.142
Post-test Scores	EG	18	22.50	405.00			
	CG	18	14.50	261.00			
	Total	36			90.000	-2.789	.005

Table 4.12: Pre-test and post-test scores analyzed by non-parametric Mann-Whitney U Test for Item 32. "Which of the following tasks do you use your mobile device for in class?" (continued)

The table (Table 4.12) above shows that the experimental group developed the habit of using their mobile devices in class not only for receptive activities such as listening to audio materials and watching more authentic videos, but also for productive activities such as posting in discussion forums and taking notes. These results may suggest that AR learning made them gain new skills, expanded participants' opportunities for more practice and production in the target language, and provided them with a new set of interactive tools to get involved and express their ideas and opinions in and outside class.

As in the post the post-test scores comparison of the two groups (Table 4.13), the pre-test and post-test scores of the experimental group differ meaningfully as well. The three significant items above were also marked as significant (p=.020 for Item 32c), (p=.005 for Item 32d), and (p=.003 for Item 32e) in the Wilcoxon Signed Rank Test as shown in the following tables.

Table 4.13: Pre-test and post-test scores for experimental group analyzed by non-parametric Wilcoxon Signed Rank Test for Item 32. "Which of the following tasks do you use your mobile device for in class?"

c) Posting a comment in an online forum

	Ranks	N	Mean Rank	Sum of Ranks	z	p
Pre-test Scores	Negative Ranks	1[cz]	5.00	5.00		

	Positive Ranks	8[da]	5.00	40.00		
Post-test Scores	Ties	9[db]			-2.333[e]	.020
	Total	18				

d) Taking notes

	Ranks	N	Mean Rank	Sum of Ranks	z	P
Pre-test Scores	Negative Ranks	0[dc]	.00	.00		
	Positive Ranks	8[dd]	4.50	36.00		
Post-test Scores	Ties	10[de]			-2.828[e]	.005
	Total	18				

e) Listening to/watching online audio/video clips

	Ranks	N	Mean Rank	Sum of Ranks	z	P
Pre-test Scores	Negative Ranks	0[df]	.00	.00		
	Positive Ranks	9[dg]	5.00	45.00		
Post-test Scores	Ties	9[dh]			-3.000[e]	.003
	Total	18				

Table 4.13: Pre-test and post-test scores for experimental group analyzed by non-parametric Wilcoxon Signed Rank Test for Item 32. "Which of the following tasks do you use your mobile device for in class?" (continued)

Although it could be argued that the findings above is a natural consequence of a semester-long implementation, in which mobile devices were used comprehensively, the following finding complements by pointing to the fact that the participants significantly changed their opinion in favor of the new technologies in terms of the using them in their future learning more autonomously. The table (Table 4.14) below for Item 45: "Do you think you can continue learning by yourself with the help of new technologies?" shows the significant change in the post-test scores of the experimental group (p=.046).

Table 4.14: Pre-test and post-test scores for experimental group analyzed by non-parametric Wilcoxon Signed Rank Test for Item 45. "Do you think you can continue learning by yourself with the help of new technologies?"

	Ranks	N	Mean Rank	Sum of Ranks	z	p
Pre-test Scores	Negative Ranks	2[es]	4.50	9.00		
	Positive Ranks	8[et]	5.75	46.00		
Post-test Scores	Ties	8[eu]			-1.999[e]	.046
	Total	18				

All in all, the findings in this section contribute to this mixed-methods study by not only portraying the existing habits and attitudes of the participants towards language learning with new technologies, but also showing the change resulting from their learning experience with AR. It is absolutely difficult to interpret the results in favor of the AR learning experience and come to a clear conclusion by merely taking these findings into account. However, the findings in the following sections, i.e., the achievement tests as well as the qualitative findings, provide further insights, help corroborating the aforementioned interpretations, and therefore are complementary in understanding the AR learning experience.

4.2.3. Achievement Test

The table (4.15) below presents the descriptive statistics of the achievement tests taken by the participants of the experimental and control groups at the beginning and at the end of the implementation period.

Table 4.15: Descriptive statistics of the pre-test and post-test scores of experimental and control groups (Achievement Test)

	N	Mean	Std. Deviation	Minimum	Maximum
Pre-test Scores	36	6.3444	.67809	4.49	7.93
Post-test Scores	36	7.5442	.99744	2.92	8.89
Group	36	1.5000	.50709	1.00	2.00

The following table (Table 4.16) shows the pre-test and post-test group statistics of the participants' attitudes towards language learning with new technologies.

Table 4.16: Results of pre-test and post-test scores of experimental and control groups analyzed by non-parametric Mann-Whitney U Test (Achievement Test)

	Group	N	Mean Rank	Sum of Ranks	U	z	p
Pre-test Scores	EG	18	18.31	329.50			
	CG	18	18.69	336.50			
	Total	36			158.500	-.111	.912
Post-test Scores	EG	18	21.25	382.50			
	CG	18	15.75	283.50			
	Total	36			112.500	-1.567	.117

As seen in the tables above, there is statistically no significant difference between the groups when their achievement test scores, both pre-test and post-test scores, were analyzed with the non-parametric Mann-Whitney U Test. This might indicate that while the students in the experimental group think or believe that using AR improved their language learning experience, their test performance did not differ. This may suggest that students' holding positive opinions of new technologies, AR in particular, does not on its own ensure higher scores in tests and as a result translate into success in learning.

5. DISCUSSION

This qualitatively driven mixed method study aimed to explore and understand in what ways AR could be incorporated into the language classroom and how it was experienced and interpreted by language learners via their personal reflections as well as their classroom observations in a semester-long listening and speaking course. To better understand the participants' interactions with new technologies and clearly identify their profiles, the study also involved pre- and post-test questionnaires and achievement tests investigating their technological awareness levels, existing habits of using new technologies, and how they utilized such technologies in their learning in contrast to a control group's. There were four primary questions that set the foundations of this study:

1. How do learners describe their language learning experience with AR?
2. What do learners think about the role of AR in learning/practicing language skills (listening, speaking, reading, and writing) and aspects (grammar and vocabulary)?
3. What are learners' reflections on:
    a. the technical and instructional assets and liabilities AR holds in language learning?
    b. AR as an educational tool to language learners?
4. Is there a significant difference between the experimental (AR) group and the control (non-AR) group in terms of:
    a. technological awareness and use of new technologies?
    b. attitudes towards language learning with new technologies?
    c. achievement in language proficiency?

5.1. QUESTION 1: How do learners describe their learning experience with AR?

Regarding the first question, the findings suggest that AR is a future-promising, innovative learning tool that offers several affordances in language learning. In other words, the participants embraced the mobile AR interface as a novel educational medium and held positive opinions of it as far as their learning experience is concerned. Several attributive

qualities of AR learning were noted by the participants, and these were recurrently referred to while describing the learning experience.

Compared with the existing literature, the findings regarding this question seem to be consistent with the previous attempts to define and describe the AR learning experience as perceived by its users. To reiterate, AR, as a novel medium, is considered to have specific attributes that distinguish it from other new media. Combining the capacities and capabilities of several other forms of multimedia learning environments, AR enables learning in 3D via divergent learning interfaces that are tangible, interactive, multimodal, and collaborative. As mentioned in previous studies, it has high potential in promoting acquisition of new concepts and fostering comprehension (Bacca et al., 2014; Radu, 2014; Diegmann et al. 2015, Akcayir and Akcayir, 2016; Chen et al., 2017) by contextualizing learning content (Liu et al., 2007; Martín-Gutiérrez et al., 2010; Bower et al., 2014). The convenience of visual, aural, and haptic output modes in the AR interfaces expands content delivery in diverse formats. These medium-related attributes also create more opportunities for the inclusion of learners who have diverse learning needs (Marín-Díaz, 2017).

From the learners' perspective, there are several user-related attributes that specify the advantages over traditional text-based classroom learning. There is agreement on how enthusiastic, fascinated, entertained, and involved learners were while using an AR application as a learning tool, which seems to be the most common attributions of AR learning in the literature (Chen et al. 2007; Dünser, 2008; Dünser et al., 2012; Chen and Tsai, 2012; Redondo et al., 2013; Iwata et al., 2013; Furio et al. 2013; Chang et al., 2014; Ferrer-Torregrosa et al., 2015; Munoz-Cristobal et al., 2015; Lu and Liu, 2015; Han et al., 2015). In addition, learners valued guided practice opportunities as the medium is able to simulate or augment physical training scenarios. This kind of learning is argued to be innovative and inspiring as AR accommodates learning in various ways that were not possible before.

As Billinghurst (2002) notes, the three significant properties of AR, i.e. seamless interaction between real and virtual spaces, a tangible interface metaphor to interact with objects, and smooth transition between virtuality and reality, create new learning opportunities. A dynamic learning interface as such grants alternative ways of interacting with content, other learners, and the instructor in a virtually shared workspace. These are also coherent with the recent research efforts (Chao and Chen, 2009; Billinghurst and Dünser,

2012; Kamarainen et al., 2013; Zarraonandia et al., 2013; Wang et al., 2014). Moreover, when the fun and play elements are blended with the appeal in using technology for learning, learners reported that their mood is improved and curiosity levels are increased thanks to the virtual surprises superimposed onto physical objects in the learning environment. This aspect of AR in making learning processes compelling and therefore attractive has been identified in the previous studies as well (Liu and Chu, 2010; Juan et al., 2010; Di Serio et al., 2013; Safar et al., 2017).

Besides those user-related attributes above, the participants have indicated that learning with AR is useful and meaningful, that is, it makes sense to learn a foreign language in an AR-based course, and they would highly recommend language learning with AR-aided materials. They were highly satisfied with the instruction as they expressed that their learning needs were addressed properly, they were more attracted and willing to access the learning content, and they could concentrate better. These are particularly associated with motivational advantages of AR contributing to task engagement, involvement, and learning performance in a positive way (Dunleavy et al., 2009; O'Shea et al., 2009; Liu and Chu, 2010; Di Serio et al., 2013).

Last but not least, the AR-based tasks designed in this study allowed learners to meet and work together in an extended virtual setting to access shared resources or produce new content. These findings complement the previous studies featuring how AR promotes collaboration while introducing new learning concepts (Billinghurst and Kato, 2002; Kaufmann, 2003; Kaufmann and Schmalstieg 2003; Liarokapis, 2007; Liarokapis et al., 2009; Yoon et al., 2012; Ke and Hsu, 2015; Martin-Gutierrez et al., 2015). Because these collaborative tasks relinquished control and responsibility to learners, they became highly self-reliant in both accessing and producing content to improve their knowledge and skills. These findings on autonomy AR learning interfaces provide learners with have also been referred to in the existing literature (Di Serio et al., 2013; Martín-Gutiérrez et al., 2015; Elmunsyah et al., 2019). However, unlike some of the previous studies conducted on AR and its impact on academic success and achievement, no direct impact on learning outcomes has been found in this study.

5.2. QUESTION 2: What do learners think about the role of AR in learning/practicing language skills (listening, speaking, reading, and writing) and aspects (grammar and vocabulary)?

The second question involved the participants' engagement with language in AR learning. Although the classroom context stands out as a complex environment which involves several variables and therefore makes any interpretations extremely difficult, the participants' engagement with language was somewhat evident in their commentaries and manifested in the observations as well as the questionnaires. According to Svalberg's (2009) cognitive, affective and social domains criteria, the participants were actively working, alert and focused on task; eagerly, purposefully, and independently participating in the tasks; and constantly receiving and reflecting, and interacting with the content that was virtually present.

In the listening domain, the findings suggest that AR increases the possibility and frequency of exposure to authentic content, allows for task variation to model forms, provide context or check comprehension, creates a controlled immersion experience, and enhances listening comprehension. Paralell findings have been reported in the studies investigating the potential of AR in learning, but not specifically focusing on listening skills (Kirkley and Kirkley, 2005; Roy and Frandy, 2013; Dunleavy and Dede, 2014; Perry, 2015).

In the reading domain, there are two findings which are peculiar to AR: first one being multimodal reading, as in the decoding of signs, images or short instructions appearing on the AR interface overlaid on physical reality, and the second one being hyperlinked reading, as in annotations superimposed onto physical texts or onto margins, providing guidance by underlining main ideas, summarizing key points, or even posing guiding questions to promote critical thinking. These findings show that traditional reading medium, i.e. print, gains more dimensions via AR and transforms from a linear activity into a more organic, multifaceted activity. The previous studies on AR featured books or AR-aided reading tasks are also aligned with this new form of reading which stimulates interests among learners and fosters their comprehension (Vate-U-Lan, 2012; Yilmaz et al., 2017; Tobar- Muñoz et al., 2017)

In the speaking domain, the participants reported that AR provides coaching on phonological and phonetic features of language by virtually scaffolding the procedure with practical tips on correct pronunciation, intonation, rhythm, and stress patterns as well as English phonemes and their articulation with reference to the IPA chart. This specific practice also allowed students develop an awareness on their spoken performance. They could explore

the language in-depth by focusing on performance-related elements. The previous research on speaking is very limited and dealt with issues on improving listening and speaking skills (Liu, 2009) and reducing anxiety and promoting willingness to communicate using AR (Shea, 2014); however, there needs to be more studies to explore more.

Listening and speaking (oracy) are considered transient skills, and these skills could pose certain challenges to learners in real-world communications (Goh, 2017). In a traditional classroom environment, where micro and macro features of natural spoken language may not be modeled properly, learners lack the opportunity of practicing these skills extensively, not to mention developing an understanding of the cognitive processes involved. AR language learning contributes to this form of process-oriented teaching, in which traditional learning materials could be re-designed with virtual annotations that can be viewed via an AR interface. This increases learners' metacognitive awareness and inform them of strategies, and learners who are able to internalize such strategies in the classroom are inclined to transfer these to real-life situations (Zhang and Goh, 2006). Therefore, more efficient oracy lessons can be introduced, and learners' attention can be steered into the desired direction with the help of AR learning interfaces.

In the writing domain, although there were no explicit writing tasks assigned due to the fact that the implementation took place in a listening and speaking course, the participants mentioned that they benefited from the listening into writing tasks. These were short writing tasks either fused into preceding listening comprehension tasks as a follow-up to harvest their answers or performed as a preparatory activity before a group discussion via opinion polls or forum posts to help learners formulate their thoughts and ideas. Thanks to the AR interface developed for this study, learners could submit their input by either typing a short text into a pop-up window appearing on the display of their devices or selecting an option in an opinion poll that was triggered after tapping on the screen of their devices. Additionally, there were on-the-spot writing tasks that required learners reflecting on their learning experience after completing a task. This kind of writing gives learners the opportunity to practice the modelled language forms without any interruption or delay. The idea of writing on the AR interface is a significant step towards making AR interfaces not only ideal for receptive tasks but also for more productive tasks without leaving the virtually shared learning space while collaborating. Former studies concentrating on writing adopted interfaces either with limited functions or

investigated the impact and efficiency of AR in understanding the linguistic and content knowledge before producing a text (Liu and Tsai, 2013; Wang, 2017).

In the vocabulary and grammar domain, the findings indicate that AR fosters internalization and long-term retention of new forms by creating more opportunities to form meaningful associations while interacting with them. This also helps recalling those language items by giving fine details about them. This finding builds upon the previous studies on using AR for vocabulary teaching (Barreira et al., 2012; Chen and Wang, 2015; Solak and Çakır, 2015; Doğan, 2016; Santos et al., 2016; Tsai, 2020). Besides those, it was also noted that AR helps multi-layered vocabulary learning. Learning new vocabulary is different from looking up a word in a print dictionary as the interface allows interaction with a word or phrase at all levels, i.e., phonetic/phonological, morphological, syntactic, semantic, and pragmatic levels. Finally, it was found out that AR gives language learners the opportunity to acquire information about language and its speakers through authentic immersive virtual content embedded into words on a print page, and by doing so brings about an intercultural awareness which enables learners to develop the ability to understand the other and become aware of their values, beliefs, and perceptions through the language they speak. This potential of AR for teaching and learning intercultural competence is also aligned with previous studies (Sykes, 2017).

The qualitative findings under the engagement with language category indicated that while listening and speaking skills stood out as the most appropriate and supported skills by AR, reading and writing skills were considered to be improving when enough focus and attention were given. The quantitative findings, however, revealed that the AR group used their mobile devices significantly more for comment writing, note-taking, and listening to/watching online audio/video clips than the control group. There was no explicit reference to grammar instruction, yet there were a few indirect references to the consciousness raising tasks which led to modeling and acquisition of certain forms and expressions. Vocabulary tasks were rated among the most effective and appealing tasks as well as the most favored ones, ensuring higher levels of engagement with language. It can be argued that AR provided a new interface which was more flexible and offered practical solutions to the technical and instructional challenges involved in several different stages of instruction. The learners could develop a greater awareness of how natural spoken language works at different levels and understand how the spoken features of the language are different from the written features.

They had a chance to explore natural speech in various kinds of contexts and levels, and this helped them reflect on their own performance as they had a more thorough understanding how communication takes place in reality.

5.3. QUESTION 3: What are learners' reflections on (a) the technical and instructional assets and liabilities AR holds in language learning, and (b) AR as an educational tool to language learners?

As for the third question, findings suggest that there are various technical and instructional assets and liabilities that need to be considered before, while, and after teaching and learning with AR. Although the participants did not directly suffer from a severe and persistent technical problem, nor did they raise instructional issues as a hindrance to their learning, several insights were drawn for the quality learning experience regarding the technical infrastructure and instructional activities.

In the technical assets and liabilities domain, hardware-, software- and network-related findings complement the existing literature by contributing to the best practices for deployment of AR in a formal educational setting. The participants' technological awareness and use of new technologies questionnaire results show that learners have the personal technologies, i.e. their smartphones or tablets, available for the deployment of AR learning and they are ready and willing to invest their personal resources as long as they are provided with a working AR learning structure. However, for emergencies or unpredicted component failures, personal technologies need to be supported by spare devices made available by institutions. Although smart phones offer VST (video-see-through) AR experience, for more realistic and natural immersion experience OST (optical-see-through) is required. However, current personal technologies are not compatible with OST yet. Likewise, earphones are currently the most convenient and affordable pieces of hardware to deliver the individualized audio content compared to the loudspeakers of devices, yet this method isolates or detaches the individual from the physical aural space. Therefore, alternative solutions, such as bone conduction, should be considered. Based on the outcomes of both quantitative and qualitative data of this study, the ideal AR learning infrastructure should have the following technical specifications. The smart devices used for AR learning should be equipped with faster processors with low energy requirement, high memory and storage, sharper cameras and bigger displays with high resolution, and enough power capacity to ensure an uninterrupted experience. Ideally, there should be more integrated technologies made available to learners,

such as wearable HUDs (head-up display) or goggles, for a more comprehensive and compelling multimodal exposure.

Regarding the AR software, the AR application's user interface could be simple yet functional as in the application used in this study, running across multiple platforms, and can be plugged into an existing digital ecosystem. This is key for an effective user experience, which will promote the design of meaningful learning scenarios and the continuity and sustainability of the learning experience. AR learning with intervals on independent platforms with limited capacities may not necessarily be representative of the real potential of AR and may even be counterproductive. Therefore, the interoperability capacity of the AR software is also required for further processes, such as the assessment of learners' progress via connected applications.

The need for hardware and software to run AR learning interfaces in educational settings is being compensated by personal technologies, mostly smart phones or tablets learners own. Current reviews on AR in language learning also show that there is a growing trend of using mobile-based AR. According to Reinders and Pegrum (2017), this is partly due to the affordances and ease of use of smart handheld devices, which foster mobility, social interaction, contextualization, connection, access, and individualized learning in formal and informal learning environments. Therefore, mobile platforms seem to and will have more potential for learners in AR learning. As found out in this study, the existing technology awareness and usage habits as well as personal technology ownership of the participants have consequently contributed to the faster deployment and a smooth implementation.

Network, being a fundamental component of AR learning, must be broadband and high-speed for a seamless connection and uninterrupted access experience as well as faster transition rates for viewing/streaming and submitting content. A satisfying AR learning experience highly depends on the stability and speed of the connection according to the findings of this study. Although it is technically possible to run AR applications offline, maintaining the dynamic learning content on learners' devices, keeping them up-to-date, and most importantly sharing the same workspace to collaborate real-time on a specific task would not be possible. To ensure connectivity, occasional use of mobile data, if possible, needs to be considered whenever technical issues are encountered with the wireless internet

connection, which is by far the most convenient and affordable network service provided by most educational institutions.

In the instructional assets and liabilities domain, the instruction-, interface-, content-, and delivery-related findings contribute to the efforts in exploring teaching or learning via AR. When the general instruction considered, the teaching model adopted in this study, unlike other studies such as game-based (Squire and Jan, 2007; Freitas and Campos, 2008; Rees, 2010; Liarokapis et al., 2009; Folta, 2010; Liu and Chu, 2010; Bressler and Bodzin, 2013), design-based (Bower et al., 2014) or inquiry-based learning (Chiang et al., 2014), adopted a modified version of direct instruction, which is still the dominating instruction model in a semester-long classroom-based course in higher education. That is, new language is modelled via rich and authentic content, learners practice newly learned concepts by performing tasks to apply their knowledge and skills, and finally they produce independently. Therefore, learners require clear instructions, frequently given by an instructor, appearing on the material to be scanned or on the display of the smart device attached to the AR content to purposefully guide the learning procedure. At this point, although the qualitative findings infer that without particular training or induction, users could easily get confused and expect instructor's interference and mediation, the quantitative findings show that learners have gradually gained more confidence and autonomy not only in their learning, but also solving technical problems, being independent and self-sufficient learners, and making investment decisions regarding learning with new technologies. This sets the role of the instructor as a guide on the side, standing by learners yet not only providing support and guidance on the tasks when needed, but also selecting and curating the learning content that is pedagogically tailored and served to the best interest of the learners.

Regarding the learning interface, i.e. the AR application running on a smart device, no major issues have been noted. That is to say, learners reported that there was no distraction in general while working on tasks as the AR experience is much more engaging than notifications on a multipurpose device. To minimize or eliminate the distraction concern, per se, dedicated AR glasses, goggles or head units could be of assistance. In terms of orientation or navigation in the learning interface, there are no challenges posed while following the task instructions or learning content, and no issues regarding losing track of time and place have been specified.

Content needs to be selected and adjusted well as is the case in most learning situations. When challenge is beyond a learner's expectation, such as being too authentic, it results in distraction or difficulties to maintain focus. Therefore, the learning content must be designed or reviewed by educators with pedagogical concerns, and there needs to be special attention paid on quality educational content. This also reminds the fact that material design has to be given more priority to ensure quality towards desired learning outcomes. It appears that while the tasks involving audiovisual content were rated as the most favorite and effective tasks by the participants, those requiring text submission were among the least favorite.

Finally, in terms of delivery-related matters, a hybrid delivery model is considered to be ideal in AR-based instruction. In other words, AR-based learning environments may not replace the teacher or fully substitute classroom learning. Additionally, when looked in detail at individual comments, some concerns have been raised that are worth considering as well. For instance, pacing becomes an issue as those who may not access the AR content simultaneously will not be able to catch up with others in class due to highly individualized delivery format, especially in longer tasks. When all learners attempt working on the same content at varying starting times, it becomes difficult to manage who is doing what. This impacts peer group interaction and needs to be addressed at the task design stage. Similarly, common procedures in delivery are found to be monotonous and repetitive after some time, and there needs to be an option to skip these procedural segments if the task is familiar.

All in all, the following suggestions were made for an optimal classroom implementation. Although AR learning supports self-paced learning scenarios very well, in the classroom setting, a facilitator is needed, especially at the beginning to provide the students with basic training to use the interface and perform tasks. Contrary to popular belief, using mobile devices in AR learning is not distractive and disruptive as in traditional teaching contexts. They rather promote and contribute to engagement and involvement in AR learning. The quality of the learning content is so important that the quality of the overall learning experience highly depends on it. The learning content must be pedagogically structured, especially if learning takes place at lower proficiency levels.

As for what AR means as an educational tool in language learning contexts, there is no doubt that AR opens the doors to new realms that are beyond the perceived world that

surrounds us, and therefore, introduces diverse opportunities for educators as well as learners as it has the capability of not only augmenting the existing teaching and learning practices but also creating new ones. Sophisticated learning scenarios can be easily designed to contextualize complex topics, simulate situations or conditions that are difficult or impossible to replicate in the physical world, or blend virtual and real spaces in a way that interaction and collaboration take a new form as the restrictions of time and space are no longer a variable. While making all of these possible, AR also provides elements of gamification, and therefore, increases the appeal of the overall learning experience. These assets appear to be ideal for an educational tool, especially in language teaching, which requires immersion to diverse contexts to acquire language, access to rich multimedia resources to practice it, and interaction and collaboration among speakers to perform in it.

Although the idea of incorporating the above features of AR into educational settings sounds revolutionizing, current practices show that the technology has not matured to a level that low-cost, larger-scale deployments are possible, especially in educational contexts yet. There have been recently several applications and devices launched by renowned tech companies with great promises, yet they are still considered prototypes that are limited to showcasing the potential and basic features of AR and only available to a relatively small group of early adopters. Besides those, there are also those freely available mobile applications, which are becoming more and more capable than ever and are reasonably successful in performing basic operations, such as enabling the viewing or hearing of any virtual content superimposed or dropped onto a predefined object or location. Speaking of AR learning, however, considering the available AR technologies for the end consumer, will remain a challenging task as well as a demanding effort for tech savvy educators until more critical use cases appear via affordable AR applications and/or devices developed for learning, and finally learners start thinking that it is worth investing their resources, e.g. time, energy, and money. Until then, custom solutions, such as repurposing existing applications to adjust them for specific learning needs will be required for implementations like the one in this study, yet they will not be sustainable. Therefore, the question in this section is answered with reference to the AR learning interface used in this study, so the perspective of the instructor researcher contributes to the existing collection of research.

To cover all aspects of AR learning as an e-learning tool, the criteria in the Rubric for Evaluating E-Learning Tools in Higher Education (Anstey and Watson, 2018) will be

adapted. This rubric provides a multi-dimensional evaluation framework which focuses on functional, technical, and pedagogical aspects of the tool selected for learning, particularly intended to be used in the classroom contexts:

In terms of functionality and accessibility, the AR learning interface is very scalable and flexible, and it can accommodate any size class within formal education contexts as long as the network infrastructure supports. The mobile app has a plain interface, and this was well embraced by the students as it was easy for them to navigate through independently and intuitively. There was no technical support platform provided by the application developer, yet the instructor assisted students in troubleshooting tasks or solving problems during the implementation period. The support provided by the instructor who is also the facilitator of the AR tasks, made users feel comfortable and competent with their devices. The interface supports user-focused participation as described by Universal Design for Learning Guidelines (2018), that is, it engages by stimulating interest and motivation for learning, allows presentation of information and content in different ways, and caters for the needs of diverse users and their capabilities by introducing alternative ways of participation in learning. Proper and regular use does not require equipment beyond what is typically available to instructors and students (smart phones, tablets, earphones, free mobile app, internet connection, etc.), and there are no additional costs during learning except for the personal technology costs as well as institutional infrastructural investment. As long as students have the official subscription link to the AR channel provided by the instructor, they can access materials.

In terms of technical and design aspects, integration of the AR learning interface with an LMS or a third-party source is possible while maintaining the full functionality. Students can successfully utilize it on Android and iOS platforms without having to download and install additional software or extensions. The application is readily available in the app stores of both platforms and can be downloaded free of charge. Although students have smart devices at varying sizes, the interface is adjusted itself to any screen size without limiting accessibility. There is no offline access mode, and it cannot be used in any capacity when there is no internet connection.

In terms of pedagogical aspects, social, teaching, and cognitive presences (Garrison, 2011) are supported. The AR learning interface fosters collaboration by establishing a community of learning at asynchronous and synchronous levels for interaction and exchange

of information. Instructors can monitor and control learner anonymity. When needed, there are technical solutions for holding learners accountable for their actions. Although the app is not widely known, most learners can get familiar with its intuitive interface and develop technical competence with its functions in a short period of time. The app has an easy-to-use developer studio, accessible via a web browser, and it significantly improves an instructor's ability to design learning tasks. It has the capability to adapt itself to its environment, i.e. customizable to address various learning contexts and planned learning outcomes. Learners' performance can be monitored on a variety of responsive measures. These measures can be accessed through a user-friendly dashboard. Besides these, the AR learning interface has the ability to enhance engagement in targeted cognitive task(s) that are overly complex or inconceivable through other means. When design, facilitation, and direction from instructor aspects are considered, AR learning can be set up in a way that it fosters facilitation of learners to exercise higher order thinking skills. The interface allows learners to receive formative feedback on learning via tracking their performance, monitoring their progress, testing their knowledge and skills.

5.4. QUESTION 4: Is there a significant difference between the experimental (AR) group and the control (non-AR) group in terms of (a) technological awareness and use of new technologies, (b) attitudes towards language learning with new technologies, and (c) achievement in language proficiency?

Considering the last question, the findings from the pre-tests of both groups revealed that at the beginning of the implementation, the learners shared similar backgrounds and experiences regarding their awareness levels and opinions on the use of new technologies. However, at the end of the implementation, three significant findings from the post-test comparison show that the AR group could develop autonomy in using new technologies, become independent learners who can deal with technical and instructional challenges, and adjust themselves to be aware of and use new technologies in their learning. Gaining in-depth experiences on AR learning for one semester, the learners also indicated that they feel confident about making decisions when it comes to investing in new technologies and using them. Likewise, one significant finding from the post-test results of the AR group shows the change in the positive attitudes and awareness levels in favor of the learners in the AR group and supports the aforementioned findings. These findings are aligned with the findings regarding improved learner autonomy, consciousness, confidence, and encouraging learning

via new technologies in the literature (Di Serio et al., 2013; Martín-Gutiérrez et al., 2015; Elmunsyah et al., 2019; Khan et al., 2019).

In terms of the attitudes towards language learning with new technologies, although there is no significant difference in the pre-test scores of the learners in both groups, AR group scored significantly higher in three items in the post-test. These finding suggest that AR group could develop new skills to get more involved in learning and express their ideas and opinions by means of interactive devices and tasks for more practice and production in the target language. In addition to the significant change across the two groups, the post-test scores of the AR group for the same items were also marked significant, supporting the previous finding. These findings complement the studies emphasizing impact of new technologies like AR in promoting productive skills (Liu and Tsai, 2013; Lin et al., 2020). One last significant finding in this category consolidates the previous findings as the learners in the AR group indicated that they could continue learning by themselves with the help of new technologies. After a semester-long implementation, it seems that the opinions of the learners changed significantly in favor of AR learning (Chen and Tsai, 2012; Hsiao et al. 2012; Martín-Gutiérrez et al., 2015).

When it comes to learner achievements, i.e., fulfilling the course objectives with improved listening skills and long-term retention of the vocabulary items, no significant variation in the pretest and post-test scores of the learners has been found in this study. That is, unlike some studies on AR's positive impact on learner achievement (Freitas and Campos, 2008; Wu et al., 2018; Chu et al., 2019; Chen, 2020), AR learning did not lead to higher scores in the achievement test given to both AR and non-AR groups. This might be due to the circumstances that were present in the research environment, such as the format of the achievement test representing a more traditional assessment which students in both groups are accustomed to and prepared for, or the progress of both groups being in close line with the mainstream program to achieve the exit test at the end of the semester. Nevertheless, the participants' reflections were found to be contradicting with this finding

6. CONCLUSION

The present study has aimed to explore and showcase the potential of Augmented Reality in the language classroom via learners' reflections on their learning experience, derive insights for the design and development of innovative learning tools and techniques, and contribute to the existing research efforts in the field by adopting a qualitatively driven mixed methods design. It has provided a detailed account of how AR is perceived and defined by learners, how it is experienced in specific language learning contexts, what some technical and instructional considerations are regarding its use, and finally what it offers as an educational tool. Complimentary to the intense reflective aspect, this study has also adopted an experimental design to investigate how AR learning varied from a mainstream classroom learning in terms of learners' awareness and use of new technologies, their attitudes towards language learning with new technologies, and AR's impact on their achievement after a fourteen-week long implementation.

Additionally, this study has challenged conventional practices in the language classroom by offering valuable solutions for content building and introducing alternative ways of delivering learning content. It has fostered engagement and interaction, encouraged collaboration among learners, and expanded the boundaries of technology integration via a mobile-based Augmented Reality learning interface.

Opening a pathway in digital turn in education, especially in the postpandemic era, this study has contributed to the current literature by presenting a model AR learning scheme and interface. It has also demonstrated the design and deployment of a semester-long AR-based course that enriched the language learning experience of tertiary level learners by supporting multiple language skills and aspects both at receptive and productive levels. The AR learning interface has enhanced the multimodalities that were actively present in the creation and delivery of the learning content to make this learning experience more authentic and worthwhile for learners.

Furthermore, the study has contributed to learners' 21st century skills. Having completed a semester taking an AR-based course, they have become more autonomous and confident in using new technologies in their own learning. They could use their personal

technologies to communicate and collaborate in real and virtual workspaces, switching between the two realms without being lost.

All in all, the following points need to be considered to ensure smooth and successful implementations in the future based on these conclusions:

First of all, the selection of the appropriate AR interface is crucial as material design and task creation are highly restricted with the capabilities of the software and hardware available; therefore, the selection procedures need to be conducted carefully by taking the learning needs into consideration. If need be, the application and hardware need to be piloted beforehand to experience the affordances and constraints first hand.

Related to the point above, plug-and-play AR apps have limited built-in content libraries. These apps have the potential to showcase some aspects of AR in vocabulary teaching, yet other skills and subskills are underrepresented or cannot be implemented. There needs to be newer apps which are specifically designed for language learning scenarios promoting more engagement, interaction, communication, and collaboration through which learners will be able to improve their competences and skills.

Another important point to be considered is that augmentation should not be limited to visual, audio, and haptic feedback or output formats. Any form of sensory response will enhance the quality of the immersion experience. Considering the accesibility standards, AR learning interfaces have the capacity to become available to learners from diverse backgrounds or with disabilities, and it can create equal opportunities for them by making them participate in the same shared learning spaces and work together.

Next, language educators need to be more involved in the instructional design procedures. They should have a clear understanding of the learning goals and objectives as well as the AR interface to be deployed. Some application interfaces grant access to a user-friendly, intuitive, web-based developer platforms, which allow the creation and delivery of interactive learning content more independently on a GUI.

While designing content for AR language learning, tasks design and diversity are two crucial elements. In terms of design, the tasks should not only concentrate on receptive skills, but also foster the use of productive skills on the interface in order for continuous immersion

and a holistic learning experience. Introducing gestures through finger or hand movements or tapping on device screens to control the virtual content will promote interactivity and autonomy. As for the diversity, different task formats should be defined in advance and deployed with intervals to avoid monotony.

Because there is no AR learning interface that has fully matured yet and become a standard choice as of now, the time, money, and energy investment has to be considered carefully. Custom deployments with open-source AR interfaces are time and labor intensive and difficult to replicate; however, they prove to be very effective in tackling specific learning scenarios and more cost-efficient considering the limited finances of language educators until AR becomes an invisible technology.

AR learning should be promoted at macro and micro levels in the field of education, and integration of AR interfaces into existing digital ecosystems should be considered for meaningful use cases. When physical presence of teachers and learners in closed settings becomes a point of concern, collaborative AR interfaces integrated with other campus or classroom solutions, e.g. an LMS, could be ideal as they extend the limits of physical learning spaces at the ease and comfort of users' preferred learning spaces without having to compensate from the quality of learning experience.

In similar veins, the incorporation of AR learning into the classroom ecosystems need to be supported with a top-down approach unlike the current bottom-up approach. That means, there needs to be set policies ensuring not only the standards of good quality AR learning experience, but also the funding required for further development and deployment of unique learning experiences. Without an official status, AR implementations will not go beyond the voluntary efforts of interested educators.

These being said, further research in AR language learning could concentrate on identifying the actual usage patterns regarding the existing AR interfaces and expectations of teachers and learners from AR as an educational medium. Language teachers' experiences not only as content developers but also as facilitators would help understand how their epistemologies manifest when AR is used in their teaching. Such studies would contribute to the development of a dedicated AR interface for language learning. Similarly, future studies could focus on AR-based, process-oriented language courses combining multiple skills and aspects with more participants for longer periods of time. Measuring the effects of AR

learning at classroom level, school level, and wider level implementations is also necessary to suggest necessary policies for regular use.

As far as the AR research concerned, future studies are needed to find ways to enable natural interaction with virtual content on AR interfaces, e.g., using gestures or bodily movements. This could be possible when the processing of rich multimedia content on smaller and invisible interfaces via OST displays, e.g., glasses or contact lenses, is improved. In terms of functionality, next generation AR learning interfaces could concentrate on enabling active collaboration and content creation by users in remote communication and information exchange scenarios. Such built-in communication and collaboration tools could help multiple users to work together on shared virtual content from remote destinations in real time.

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APPENDICES

APPENDIX 1: AURA LOG

UNIT 1

AR Task #01 – Unit Preview (p. 3)

Trigger image:

AR overlay: Audio – *Unit Q Listening – Unit 1*

Overlay follow-up action: Poll submission – *Have you formed a first impression of someone at the beginning of this semester?*

AR Task #02 – Vocabulary (p. 5)

Trigger image:

AR overlay: Animation – *AR class glossary animation with instructions*

Overlay follow-up action: Glossary entry – *Please add entries for the new vocabulary items you have learned today!*

AR Task #03 – Speaking (p. 7)

Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *In what kinds of situations do you think first impressions are usually accurate? Give examples.*

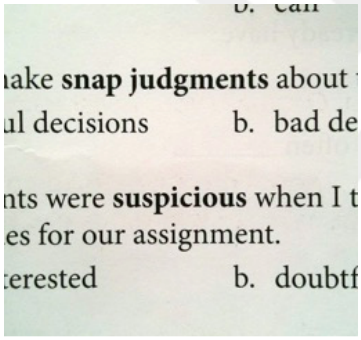
AR Task #04 – Listening (p. 7)

Trigger image:

AR overlay: Video – *How do first impressions work?* (https://www.youtube.com/watch?v=g513EUHqkfw)
Overlay follow-up action: Listening comprehension worksheet – *T/F questions*

AR Task #05 –Vocabulary (p. 9)

Trigger image:



AR overlay: Video – *PSA "suspicious"* (http://www.youtube.com/watch?v=VRljI26tos0)

Overlay follow-up action: Vocabulary practice – *Form a sentence with new vocabulary item*

AR Task #06 – Listening (p. 11)

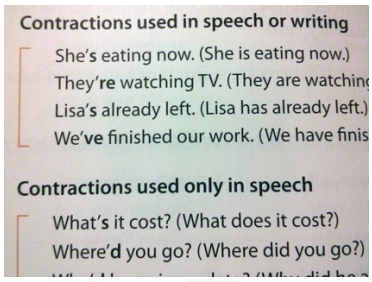
Trigger image:

AR overlay: Video – *TED The science of first impressions* (https://www.ted.com/talks/peter_mende_siedlecki_should_you_trust_your_first_impression?language=en)

Overlay follow-up action: Listening comprehension worksheet – *T/F and open-ended questions*

AR Task #07 – Pronunciation (p. 16)

Trigger image:



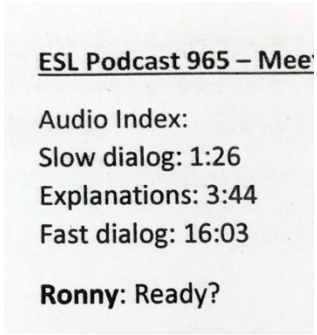
AR overlay: Video – *Contractions* (https://rachelsenglish.com/pronounce-contractions/)

Overlay follow-up action: Pronunciation practice – *Mimicking the speaker*

Extra:

AR Task #08 – Listening

Trigger image:



AR overlay: Audio – *ESL Podcast 965 – Meeting Your Boyfriend's-Girlfriend's Parents* (http://libsyn.com/media/eslpod/ESLPod965.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 2

AR Task #09 – Preview (p. 23)

Trigger image:

AR overlay: Audio – *Unit Q Listening – Unit 2*

Overlay follow-up action: Poll submission – *Listen to the audio clip and answer the question: What's more important: taste or nutrition?*

AR Task #10 – Vocabulary (p. 25)

Trigger image:

AR overlay: AR class glossary animation with instructions

Overlay follow-up action: Add a new entry into the glossary – *Please add entries for the new vocabulary items you have learned today!*

AR Task #11 – Speaking (p. 27)

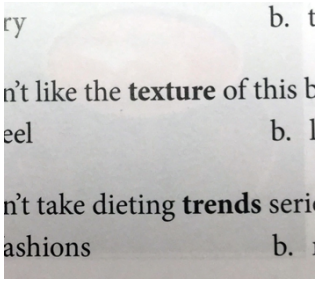
Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *Do you agree that "you are what you eat"?*

AR Task #12 – Vocabulary (p. 30)

Trigger image:



AR overlay: Video – *Food Texture: The Great British Space Dinner* (http://www.youtube.com/watch?v=pi5vz7nR_DE)

Overlay follow-up action: Vocabulary practice – *Form a sentence with new vocabulary item*

AR Task #13 – Listening (p. 32)

Trigger image:

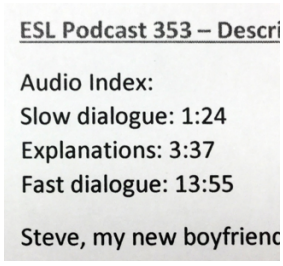
AR overlay: Video – *TED Talks: Jamie Oliver – Teach every child about food* (https://www.youtube.com/watch?v=go_QOzc79Uc)

Overlay follow-up action: Listening comprehension worksheet – *T/F and multiple choice questions*

Extra:

AR Task #14 Listening

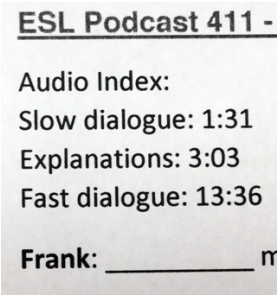
Trigger image:



AR overlay: Audio – *ESL Podcast 353 – Describing the Taste of Food* (http://media.libsyn.com/media/eslpod/ESLPod353.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

AR Task #15 Listening

Trigger image:

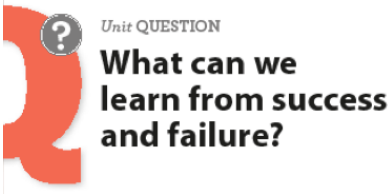


AR overlay: Audio – *ESL Podcast 411 – Eating Junk Food* (http://media.libsyn.com/media/eslpod/ESLPod411.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 3

AR Task #16 – Preview (p. 45)

Trigger image:



AR overlay: Audio – *Unit Q Listening – Unit 3*

Overlay follow-up action: Poll submission – *For me success means...*

AR Task #17 – Vocabulary (p. 47)

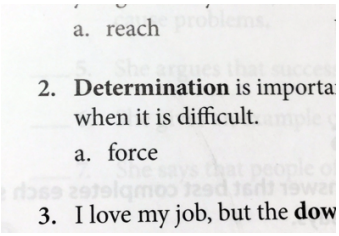
Trigger image:

AR overlay: AR class glossary animation with instructions

Overlay follow-up action: Add a new entry into the glossary – *Please add entries for the new vocabulary items you have learned today!*

AR Task #18 – Vocabulary (p. 47)

Trigger image:


a. reach

2. **Determination** is importa
when it is difficult.
a. force
3. I love my job, but the **dow**

AR overlay: Video – *Song by Thomas the Train: Determination (http://www.youtube.com/watch?v=rvGExrh80ZA)*

Overlay follow-up action: Vocabulary practice – *Use new vocabulary in alternative contexts*

AR Task #19 – Speaking (p. 49)

Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *Discuss what success means to you with reference to the quote below:*

"Success is not the key to happiness. Happiness is the key to success. If you love what you are doing, you will be successful." Albert Schweitzer, German philosopher

AR Task #20 – Listening (p. 49)

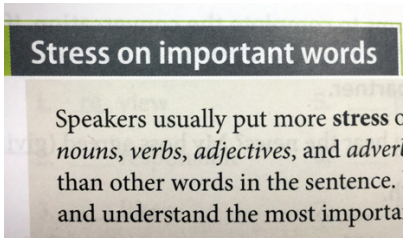
Trigger image:

AR overlay: Video – *TED Talks: Richard St. John – Success is a continuous journey* (https://www.youtube.com/watch?v=CgNx9Bgac1I)

Overlay follow-up action: Listening comprehension worksheet – *T/F questions*

AR Task #21 – Pronunciation (p. 56)

Trigger image:

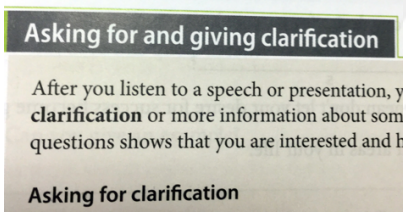


AR overlay: Video – *Word Stress and Verbs American English Pronunciation*

Overlay follow-up action: Pronunciation practice – *Recognizing stress and emphasis*

AR Task #22 – Speaking (p. 57)

Trigger image:



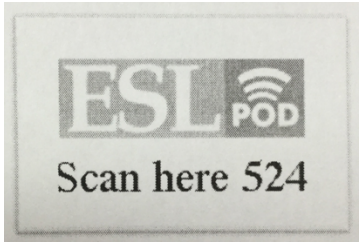
AR overlay: Video – Intonation Requesting Clarification or Repetition

Overlay follow-up action: Pronunciation practice – *Intonating questions*

Extra:

AR Task #23 Listening

Trigger image:



AR overlay: Audio – *ESL Podcast 524 – Talking About Failure* (http://media.libsyn.com/media/eslpod/ESLPod524.mp3)

Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 5

AR Task #24 – Preview (p. 85)

Trigger image:

AR overlay: Audio – *Unit Q Listening – Unit 4*

Overlay follow-up action: Poll submission – *Should we be responsible as individuals, or should we have the government take over some responsibility? Why?*

AR Task #25 – Speaking (p. 89)

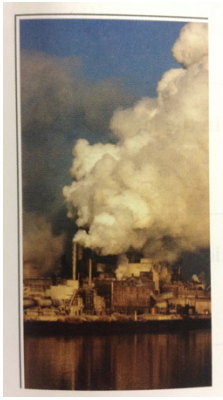
Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *At what age do you think someone becomes responsible for his or her actions (for example, behaving well in public, doing chores, or handling money)? Explain.*

AR Task #26 – Listening (p. 93)

Trigger image:

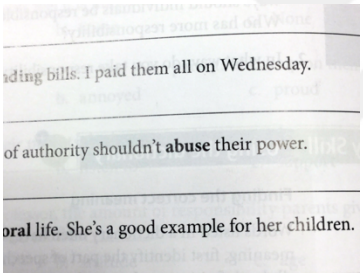


AR overlay: Video – *TED Talks: Pam Warhurst – How we can eat our landscapes* (https://www.youtube.com/watch?v=vqhx4Etdvr0)

Overlay follow-up action: Listening comprehension worksheet – *Open-ended questions*

AR Task #27 – (p. 95) Vocabulary

Trigger image:

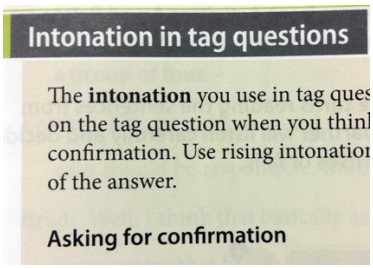


AR overlay: Video – *PSA Stop Animal Abuse* (http://www.youtube.com/watch?v=TyuXkdqvJpw)

Overlay follow-up action: Vocabulary practice – *Discuss alternative meanings of new vocabulary*

AR Task #28 – Pronunciation (p. 97)

Trigger image:



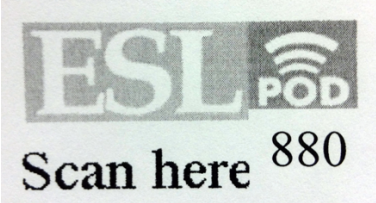
AR overlay: Video – Questions and Intonation Up or Down

Overlay follow-up action: Pronunciation practice – *Intonating questions*

Extra:

AR Task #29 Listening

Trigger image:



AR overlay: Audio – *ESLPod880 Forming a Union* (http://libsyn.com/media/eslpod/ESLPod880.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 6

AR Task #30 – Preview (p. 105)

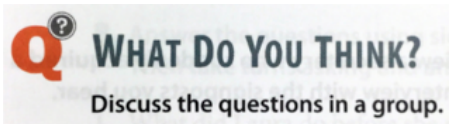
Trigger image:

AR overlay: Audio – *Unit Q Listening – Unit 6*

Overlay follow-up action: Poll submission – *Post the URL of your favorite advertisement and tell us why it is your favorite.*

AR Task #31 – Speaking (p. 109)

Trigger image:

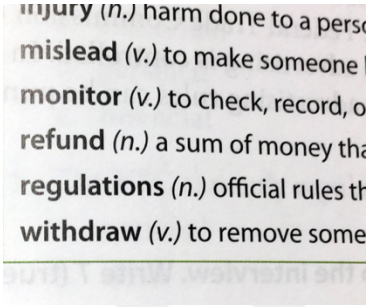


AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *Which groups in society do you think are easy for advertisers to influence: children, teenagers, men, or women? Should advertising regulations be made stronger to protect these groups?*

AR Task #32 – Vocabulary (p. 111)

Trigger image:



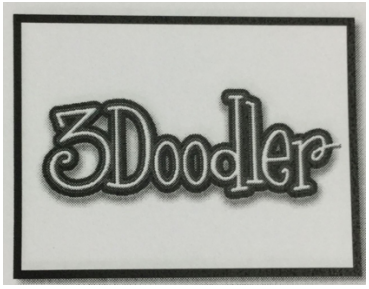
AR overlay: Video – *Song by Thomas the Train: Rules and Regulations* (http://www.youtube.com/watch?v=EN0UJxDF-zs)

Overlay follow-up action: Vocabulary practice – *Use new vocabulary in alternative contexts*

Extra:

AR Task #33 Listening

Trigger image:



AR overlay: Video – *3D Doodler Ad* (https://www.youtube.com/watch?v=emUlHFWcHck)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

AR Task #34 Listening

Trigger image:

AR overlay: Audio – *ESL Podcast 280 – Viral Marketing* (http://media.libsyn.com/media/eslpod/ESLPod280.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

AR Task #35 Listening

Trigger image:

AR overlay: Audio – *ESL Podcast 540 – Promoting a New Product* (http://media.libsyn.com/media/eslpod/ESLPod540.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

AR Task #36 Listening

Trigger image:

AR overlay: Audio – *ESL Podcast 652 – Outdoor Advertising* (http://media.libsyn.com/media/eslpod/ESLPod652.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

AR Task #37 Listening

Trigger image:

AR overlay: Audio – *ESL Podcast 888 – Advertising in TV and Movies* (http://media.libsyn.com/media/eslpod/ESLPod888.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 7

AR Task #38 – Preview (p. 125)

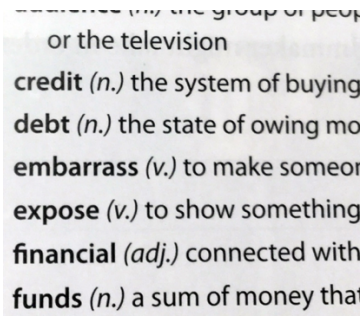
Trigger image:

AR overlay: Audio – *Unit Q Listening – Unit 7*

Overlay follow-up action: Poll submission – *What is the biggest risk that you have ever taken or will soon take? What makes you think that this was/will be risky?*

AR Task #39 – Vocabulary (p. 127)

Trigger image:



AR overlay: Video – *10 Countries in the Most Debt* (http://www.youtube.com/watch?v=BIdD-31otWQ)

Overlay follow-up action: Vocabulary practice – *Discuss associated words and phrases with new vocabulary*

AR Task #40 – Speaking (p. 129)

Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *Do you have any dreams or goals that might require you to take risks? What are they? What are some of the risks you might have to take to achieve them?*

AR Task #41 – Listening (p. 133)

Trigger image:

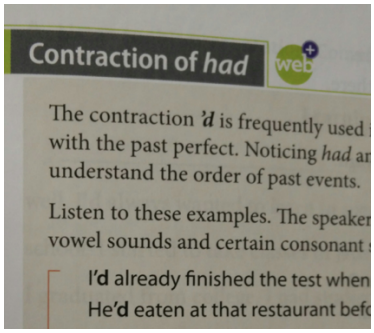
The Loch Ness Monster

AR overlay: Video – *VOA News – Experts Say Belief in Paranormal Common in US* (https://www.voanews.com/a/experts-say-belief-in-paranormal-common-in-us-127497953/163612.html)

Overlay follow-up action: Listening comprehension worksheet – *Open-ended questions*

AR Task #42 – Pronunciation (p. 139)

Trigger image:



AR overlay: Video – *How to Pronounce 'Gonna' and 'Wanna' American English*

Overlay follow-up action: Pronunciation practice – *Recognizing patterns in spoken language*

Extra:

AR Task #43 Listening

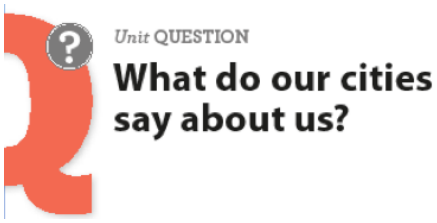
Trigger image:

AR overlay: Audio – *ESL Podcast 476 – Taking Chances in Business* (http://media.libsyn.com/media/eslpod/ESLPod476.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

UNIT 8

AR Task #44 – Preview (p. 147)

Trigger image:

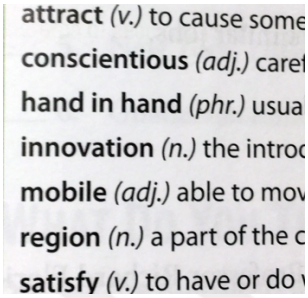


AR overlay: Audio – *Unit Q Listening – Unit 8*

Overlay follow-up action: Poll submission – *What city in the world do you think you might want to live in? Why?*

AR Task #45 – Vocabulary (p. 149)

Trigger image:



AR overlay: Video – "innovation" (http://www.youtube.com/watch?v=5Uh1KxcpWz0)

Overlay follow-up action: Vocabulary practice – *Discuss associated words and phrases with new vocabulary*

AR Task #46 – Speaking (p. 151)

Trigger image:

AR overlay: Animation – *Discussion animation with visual instructions*

Overlay follow-up action: Forum discussion – *What do you like or dislike about the city you live in? Why?*

AR Task #47 – Listening

Trigger image:

AR overlay: Video – *TED Talks: Stewart Brand – What squatter cities can teach us* (https://www.youtube.com/watch?v=OvHjQdc3oNo)

Overlay follow-up action: Listening comprehension worksheet – *Note-taking and open-ended questions*

Extra:

AR Task #48 Listening

Trigger image:

AR overlay: Audio – *ESLPodcast 47 - A Trip to New York City* (http://media.libsyn.com/media/eslpod/ESLPod47n.mp3)
Overlay follow-up action: While listening worksheet – *Listen to the dialog and fill in the blanks*

APPENDIX 2: QUESTIONNAIRE

QUESTIONNAIRE

This questionnaire has been designed to measure the attitudes and beliefs of English learners towards the impact of new technologies in English classes in higher education contexts.

Your participation in this study is completely voluntary; your answers will be kept anonymous and used only for the purposes of this research. Please see the "ETHICS COMMITTEE FOR CLINICAL STUDIES DECISION" here.

Completing the entire questionnaire should not take more than 15-20 minutes. Please try to answer all the questions and note that there are no right or wrong answers.

Thank you very much for your time and contribution.

For more information about this research, please contact:

Ozan VARLI

Instructor/Educational Technologist

Part I: Personal Information

1) How old are you?
   a) 17 or younger
   b) 18
   c) 19
   d) 20
   e) 21 or older
2) What is your sex?
   a) Male
   b) Female
3) What is your major?
   …..
4) Are you on a scholarship?
   a) Yes
   b) No
5) How long have you been studying English?
   a) 0-4 years
   b) 5-9 years
   c) 10-14 years
   d) 15 or more years
6) What is your most recent English proficiency score (TOEFL, IELTS, etc)?
   …..
7) What is your most recent GPA?
   ….

Part II: Technological Awareness and Use of New Technologies

	Desktop computer	Notebook/ laptop computer	Tablet/iPad/ PDA	Smart phone (Android, iOS, Windows etc.)	Wearable technologies (Smart watch, glasses etc.)
8) Which one of the following devices have you ever tried/used? (You can choose more than one answer)					
9) Which one of the following devices have you ever owned? (You can choose more than one answer)					

	Yes	No
10) Do you have access to the Internet where you are currently living (at home/in your dorm)?		

11) Do you have access to the Internet in various locations at school (classrooms, library, student center, cafeteria, etc.)?		
12) Do you have an app for most everyday tasks (communication, calendar, organizer, shopping, bus schedule apps, etc.) on your smart phone?		
13) Do you have an app for most leisure activities (photography, music/video editing, travel apps, games, etc.) on your smart phone?		
14) Do you have an app for many school-related tasks (educational, productivity, dictionary/thesaurus apps, etc.) on your smart phone?		

	Always online	Several times a day	Once in a few days	Once a week	Never
15) How often do you use the Internet for communication (Skype, WhatsApp, Facetime, etc.)?					
16) How often do you use the Internet for social networking (Facebook, Twitter, Instagram, etc.)?					
17) How often do you use the Internet for gaming (Clash of Clans, Candy Crush, 2048, etc.)?					
18) How often do you use the Internet for school work (ELC Online, Wikipedia, TED Talks, etc.)?					

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
19) I would like to use smart devices in classes more.					
20) If given a choice, I would prefer a print material to find information for a school project before I prefer an online resource.					
21) I avoid using online resources unless I have to.					
22) I have problems finding my way around a smart device.					
23) I learn to use new technologies by trial and error.					
24) I need the assistance of others while using new technologies.					
25) Using new technologies increases my interaction with other students in class.					

26) Using new technologies increases my interaction with course materials in class.					
27) Using new technologies increases my interaction with the instructor in class.					
28) I follow the latest trends in technology and try to invest in new devices.					
29) When I have a problem with a new device, I usually solve it on my own.					
30) I feel confident about buying and using new technologies.					
31) I can adjust new technologies to suit my needs.					

Part III: Attitudes towards Language Learning with New Technologies

32) Which of the following tasks do you use your mobile device for in class?
   a) Looking up a word in an online dictionary
   b) Searching for information on Google or Wikipedia
   c) Posting a comment in an online forum
   d) Taking notes
   e) Listening to/watching online audio/video clips
   f) Other (Please specify) …

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
33) Are you in favor of using new technologies while learning a foreign language?					
34) Do you think your instructor's application of new technologies in English classes helps you learn better?					
35) Do you think your grades might improve when you integrate new technologies in your English classes?					
36) Do you think your English classes would get easier if your instructors offered using new technologies?					
37) Do you think you would like your English classes more if your instructor used more new technologies?					
38) Do you think all the English instructors should offer new technologies in					

their teaching?					
39) Do you think taking English classes through new technologies is more stimulating than the traditional, face-to-face classes?					
40) Do you think your instructor's application of new technologies in English classes is a waste of time?					
41) Do you think English classes with new technologies make you feel more interested in English?					
42) Do you think there is more interaction with the instructor while using new technologies?					
43) Do you think there is more interaction among students while using new technologies?					
44) Do you think using new technologies in English classes also improve your IT skills?					
45) Do you think you can continue learning by yourself with the help of new technologies?					

APPENDIX 3: ACHIEVEMENT TEST

Questions Testing Listening Objectives

PAGE 1 - *Listen for main ideas and details*

In this section, you will hear a monologue.

Click "play" to start the audio clip and choose the best answer.

(Adapted from Q Listening and Speaking 3 Test Materials, Craven and Sherman, 2011)

TRANSCRIPT: In class today, I'll be discussing how we form our impressions of food. First, let's review the five senses that contribute to our perceptions of everything around us. Remember, those senses are sight, smell, hearing, touch, and taste. Immediately, most of us think of taste as the primary sense that affects our impression of foods and whether or not we like them. However, think about the information we get before we even put food in our mouths. It may be that other senses are more reliable.

Let's start with some typical experiences. Imagine I'm a student home for vacation. I've just finished my final exams and wake up anxious for a homemade breakfast. Probably while I'm lying in bed, I smell the coffee. The smell actually helps me get out of bed. Perhaps I heard my father grinding the coffee beans first. I assume the coffee will be better than the instant coffee I make in my dorm room. So here the smell has influenced my impression of the coffee even before I taste it.

Do you think you can form a negative impression of a food from hearing its name? Well, ask yourself if your first impression of a fish called 'spotted weakfish' or 'bigmouth sleeper' is a positive one. They do not sound very appetizing, do they? That's one way hearing might influence the foods we select. And of course just the sound of food cooking, such as a sizzling stir-fry, can make our mouths water.

Touch and sight also play a role. While some people love sushi, others refuse to eat it because they don't like the way it feels in their mouths. Some eaters say that a lot of food piled on a plate makes them lose their appetite. Others may be suspicious of a bowl of meat covered with a sauce they are not familiar with. Now many menus show pictures of food. Chefs are worried about the presentation. If the plate looks beautiful, we believe that the food will be delicious.

Now let's get back to the sense that we all thought was the most important, taste. You can see that many other senses have come into play before we actually taste the food. The food may taste better or worse than we thought based on the way it sounded, looked, felt, or smelled. Did we make a snap judgment? So maybe taste is not the most important sense in creating our first impressions. It just confirms them. And of course, taste may influence our future choices - we may decide we love Thai food because it is spicy or we hate English food because it isn't. I'll end with an interesting example. The durian, an Asian fruit, has a sharp pointy exterior and an awful smell. However, many are able to get past their first impressions and enjoy the taste of this unusual fruit.

The speaker believes that

A. many senses contribute to our first impressions of food

B. our first impressions of food are based on taste

C. sight is becoming less important in our impressions of food

The smell of coffee gave the college student

A. a positive feeling about his breakfast

B. a negative feeling about having to wake up

C. a good memory about college life

Taste is the _____ sense in forming our first impressions of food.

A. most important

B. last used

C. least important

PAGE 2 - *Listen for the exact words and phrases to improve word recognition*

In this section, you will hear a conversation.

Click "play" to start the audio clip and type the missing words in the blanks as you listen.

(Adapted from Daily English 353 - Describing the Taste of Food: https://secure3.eslpod.com/podcast/esl-podcast-353-describing-the-taste-of-food/)

TRANSCRIPT:

When Steve served the main course, a baked chicken, he asked,
Steve: What do you think of the chicken? Is it too salty or spicy?
I thought: Yes! It's too salty and it's so spicy I can hardly eat it without breathing fire. The outside of the chicken is overcooked and the inside is raw! But out loud, I said,
Elaine: No, not at all! It has an interesting texture and I'm enjoying every bite.

When Steve served the main (1) _____, a baked chicken, he asked,
Steve: What do you think of the chicken? Is it too salty or (2) _____?
I thought: Yes! It's too salty and it's so (3) _____ I can hardly eat it without breathing fire. The outside of the chicken is (4) _____ and the inside is (5) _____! But out loud, I said,
Elaine: No, not at all! It has an interesting (6) _____ and I'm enjoying every (7) _____.

PAGE 3

In this section, you will hear a conversation.

Click "play" to start the audio clip and type the missing words in the blanks as you listen.

(Adapted from Daily English 280 – Viral Marketing: https://secure3.eslpod.com/podcast/esl-podcast-280-viral-marketing/)

TRANSCRIPT:

Jayna: I have an idea for creating buzz about our new product.
Maksym: What is it?

Jayna: I think we should use viral marketing. We can spread information about the product quickly and among the most likely customers.
Maksym: I really don't understand it. How would we do…

Jayna: I have an idea for creating (1) _____ about our new product.
Maksym: What is it?
Jayna: I think we should use (2) _____ marketing. We can (3) _____ information about the product quickly and among the most likely (4) _____.
Maksym: I really don't understand it. How would we do...

Questions Testing Pronunciation Objectives

PAGE 4 - ***Use contractions and correctly place stress on important words in sentences***

In this section, you will hear a conversation.

Click "play" to start the audio clip and type the missing contractions (full versions as in am, is, are, have, has, did, and does) in the blanks as you listen.

(Adapted from Q Listening and Speaking 3 Test Materials, Craven and Sherman, 2011)

TRANSCRIPT:

Maria: Hi, Tam. I have just met our teacher. Have you met her yet?

Tam: No, not yet. What is she like?

Maria: Well, she is very friendly. And she has taught for a long time, so I guess she has got a lot of experience.

Tam: But she is new to this school, right? Where did she teach before?

Maria: I am not sure, but she has lived in South America and Asia.

Tam: How did you find that out?

Maria: Aziz told me. We are taking the same math class.

Tam: Really? When does it meet? I need a math class!

it.

Maria: Hi, Tam. I (1) _____ just met our teacher. (2) _____ you met her yet?

Tam: No, not yet. What (3) _____ she like?

Maria: Well, she (4) _____ very friendly. And she (5) _____ taught for a long time, so I guess she (6) _____ got a lot of experience.

Tam: But she (7) _____ new to this school, right? Where (8) _____ she teach before?

Maria: I (9) _____ not sure, but she (10) _____ lived in South America and Asia.

Tam: How (11) _____ you find that out?

Maria: Aziz told me. We (12) _____ taking the same math class.

Tam: Really? When (13) _____ it meet? I need a math class!

PAGE 5 - ***Effectively use intonation in different sentence types***

Listen to each audio clip. Choose the type of sentence according to the intonation you hear.

(Adapted from Q Listening and Speaking 3 Test Materials, Craven and Sherman, 2011)

TRANSCRIPT: I can't find my new book.

Select one:

a. Declarative sentence (a statement)
b. Interrogative sentence (a question)
c. Imperative sentence (a direction or command)
d. Exclamatory sentence (an exclamation)

TRANSCRIPT: That's amazing.

Select one:

a. Declarative sentence (a statement)
b. Interrogative sentence (a question)
c. Imperative sentence (a direction or command)
d. Exclamatory sentence (an exclamation)

TRANSCRIPT: Bring the newspaper over here.

Select one:

a. Declarative sentence (a statement)
b. Interrogative sentence (a question)
c. Imperative sentence (a direction or command)
d. Exclamatory sentence (an exclamation)

TRANSCRIPT: Why isn't he in class today?

Select one:

a. Declarative sentence (a statement)
b. Interrogative sentence (a question)
c. Imperative sentence (a direction or command)
d. Exclamatory sentence (an exclamation)

Questions Testing Speaking Objectives

PAGE 6 - ***Provide clarification so others understand difficult concepts, give reasons and examples to support opinions you express, use sequence expressions to clarify the order of events in a presentation***

(Adapted from Q Listening and Speaking 3 Test Materials, Craven and Sherman, 2011)

To show you are interested in what someone is saying, you can say

A. What did you do next?
B. Well!
C. I'm not so sure.

To make things clearer you might begin with the phrase "_____".

A. What I'm trying to say
B. Listen carefully
C. Do you see what I mean?

To introduce an example, you might use the phrase "_____".

A. such as
B. what I mean is
C. as I said

Which phrase can you use when asking for reasons?

A. "Explain yourself better, please."
B. "What are you talking about?"
C. "Can you explain why?"

When you come to the end of what you have to say, you can use the word/phrase "_____".

A. At last
B. Later
C. Finally

If you agree with what someone has said, you can use the phrase "_____".

A. That's a good point.
B. Oh, come on!
C. You're kidding!

Which of the following ways of disagreeing is the least formal?

A. No way!
B. I don't feel the same way.
C. I disagree.

Questions Testing Vocabulary Objectives

PAGE 7 - *Understand and use collocations of adjectives with nouns*

Take a look at the words below and choose the option that best describes your current experience with the word.

"**suspicious**"

a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**texture**"

a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**determination**"

a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**crisis**"

a. I know the meaning of the word and I can use it easily.

b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**abuse**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**regulation**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**debt**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**innovation**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**destructive**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

"**off the top of my head**"
a. I know the meaning of the word and I can use it easily.
b. I have seen this word before and I am familiar with it, but I can't use it correctly.
c. I have no idea about what this word means.

PAGE 8 - ***Use context to understand the meanings of unfamiliar words and phrases.***

Read the sentences below and match the words that best fit in the context.

1. suspicious
2. texture
3. determination
4. crisis
5. abuse
6. regulations
7. debt
8. innovation
9. destructive
10. off the top of my head

A. I am _____ of people who say they are always happy.
B. You can think of losing your current job as either a _____ or an opportunity.
C. The child showed physical signs of _____ at the police station.
D. Most European countries have strict rules and _____ in order to protect Human Rights.
E. After all those years away from school, Mike returned with a _____ to finish.
F. Sandy doesn't like the _____ of raw fish in sushi; so she can only eat vegetable rolls.

G. He doesn't earn enough to pay off his _____.

H. Because most people tend to resist changing their routines, bringing _____ to an institution has always been a painful process

I. Political instability could be _____ to a country's economy.

J. I am not sure how much this car would be worth, but, _____, I would say $5,000 at least.

APPENDIX 4: OBSERVATION NOTES

11/02/2015, Wednesday, 9:30 - 11:20 session, (18 present, 1 absent)

The first and second day of classes (three class hours) were spared to activities such as giving basic introduction to the course, going over the course syllabus, grading policy and texts to be covered. After settling down and getting to know each other better, I decided to share more details about the implementation today.

Before the semester started, I had already created the Aurasma download and subscription link (Figure 1) and made it available on the course page on ELC Online. However, I had not revealed the link as I wanted to walk together with the students throughout the download and subscription processes. This was going to prevent most of the confusion and let me assist to those who might have trouble while getting on board.

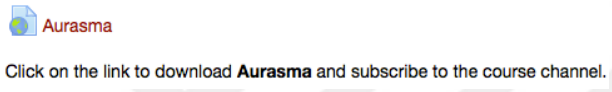


Figure 1. Aurasma link

I reflected the course page on the board, revealed the link and told the students to click on the link to download the application (both on iOS https://itunes.apple.com/tr/app/aurasma/id432526396?mt=8 and Android https://play.google.com/store/apps/details?id=com.aurasma.aurasma&hl=en markets). After downloading the app, I told them to follow the link in the description (http://auras.ma/s/lzpEo) to subscribe to the university channel so that they could scan the pre-defined images and view the content using their devices.

Out of 18 students present on that day, 15 could easily download and subscribe to the channel feed by following my instructions without any further effort. After spending about 5 minutes, almost all the students in the class were subscribed and ready to scan the first unit preview image for the extra listening and the poll activity that I had designed for that day.

However, there were some students facing technical problems:

2 students complained about having slow internet connection although campus wide wireless internet speed was claimed to be 300mbps at that time, and most students had 3G data plans. However, later we figured out that there were some poor network signal spots in the room and that caused the problem.
3 students reported that they did not have enough space/memory to download the Aurasma app (18MB). They had to delete some of the media content they had on their

devices (i.e., photographs, music, and video) and uninstall some of the apps they rarely used. This fixed the problem temporarily, but in order not to lose more time, I gave 2 of these students the iPad (Air 2) and iPod touch (5th generation) I had in my possession, and the other one borrowed her friend's phone to start the activity.

Today's AR activity featured the preview listening of Unit 1 that was followed by a live poll afterward. They scanned the unit preview picture (Figure 2) in their books, clicked on the animation appeared to proceed to listen to the discussion audio (Figure 3) and the poll question (Figure 4), and submitted their choice. While they were busy submitting their choices, I reflected the live poll results (Figure 5) on the board. This made the interaction more engaging as we could see all the choices and we discussed the results.

Figure 2. Unit 1 Preview aura

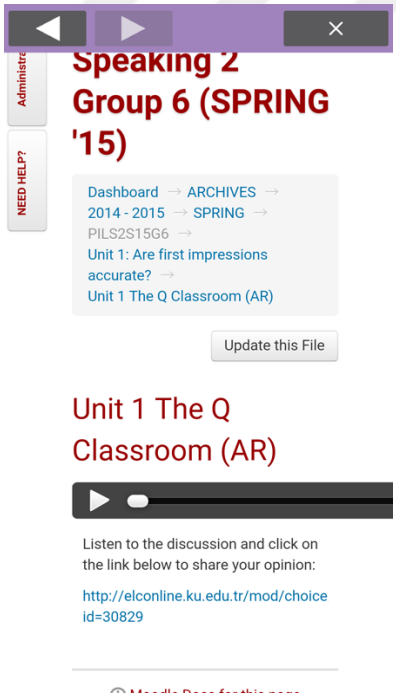


Figure 3. Discussion audio

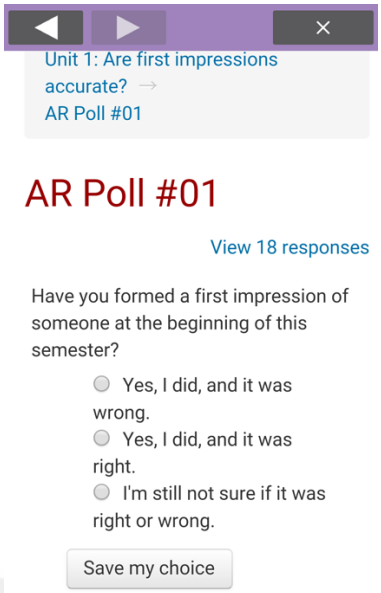


Figure 4. Poll question

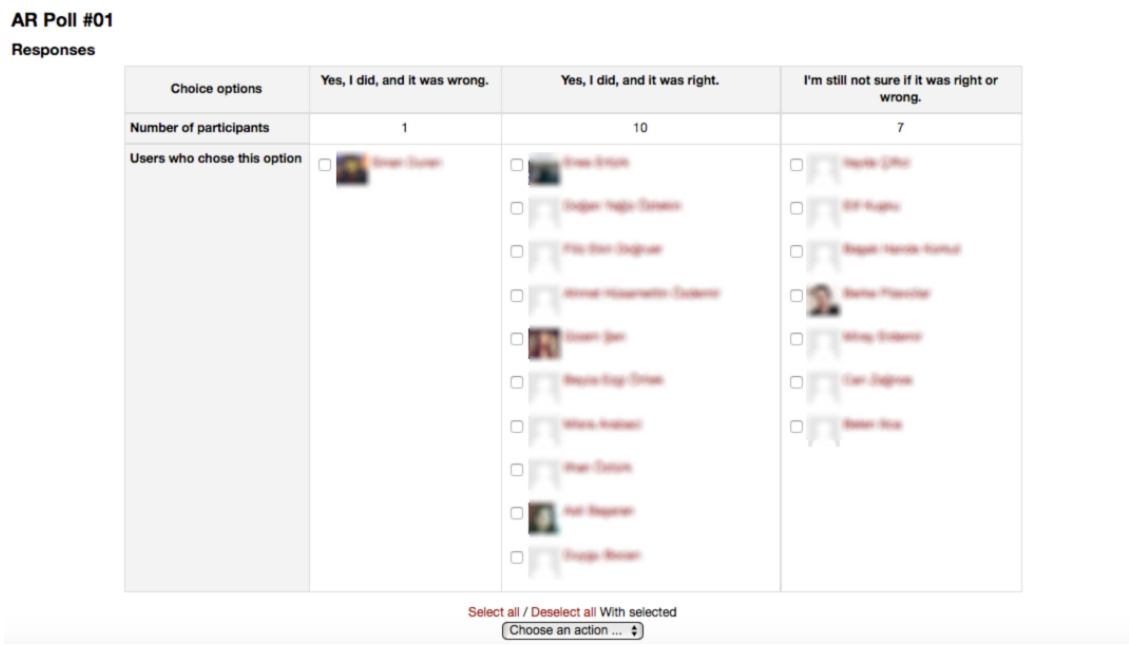


Figure 5. Live poll results

12/02/2015, Thursday, 9:30 - 11:20 session (18 present, 1 absent)

Today's AR activity was in the vocabulary section. I assigned each word randomly to student pairs and told them to scan the area on top of the page (Figure 6) to add an entry for the new words in the class glossary by including a definition, part of speech, and an example sentence. There were already 9 entries in the first 3 minutes (Figure 7). There were only two pairs who couldn't do it due to some technical problems; however, they managed to do it during the break.

Figure 6. Glossary trigger image

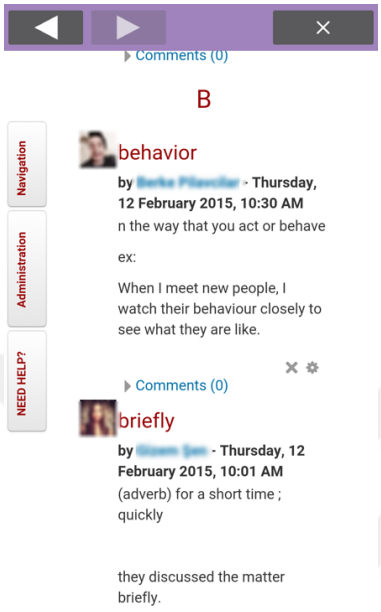


Figure 7. Glossary entries

There were occasional problems regarding the light reflecting on the paper (Figure 8), device cameras' not being able to focus on the print material properly, and interruptions in wireless connection.

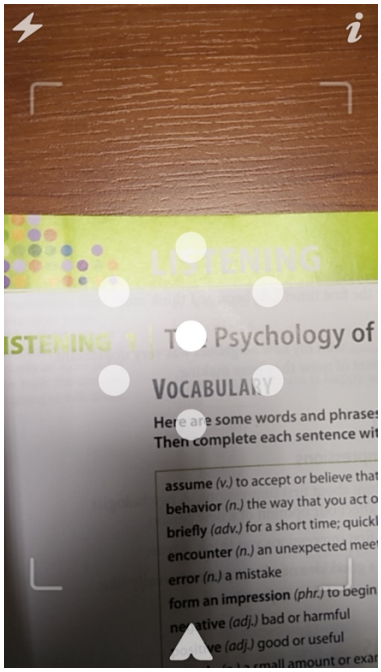


Figure 8. Light reflecting on the print material

Once we finished the vocabulary activity, we moved on to the listening and note taking section and did the activities there in a more conventional way, following the outline in the book.

To provoke more thoughts in the “What do you think?” section, I told them to scan the image at the bottom of page 7 and follow the directions as they show up. They scanned and started watching a 2-minute video clip on “forming first impressions” (Figure 9 and 10).

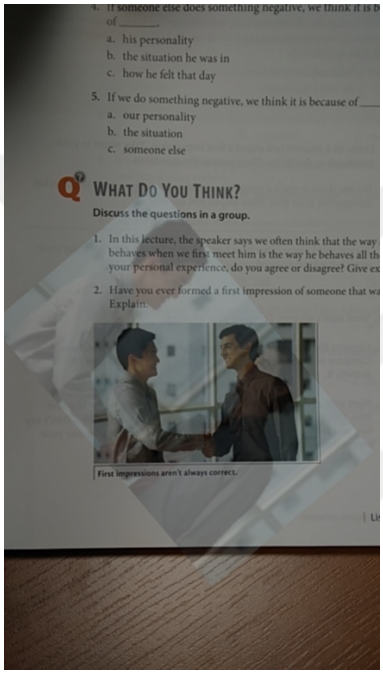


Figure 9. Forming first impressions video loading

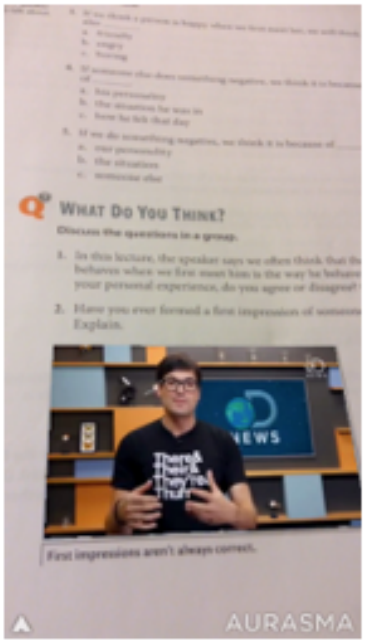


Figure 10. Forming first impressions video playing

Some of them did not have earphones/headsets with them (Figure 11), which caused a little bit of noise. Next time, I should send a reminder about this. However, students did not seem to be complaining about this situation as they were all ears, fully engaged with the content, trying to understand. It was interesting to see that once they started viewing the content they could easily concentrate not necessarily worrying about any physical interruption. When we do such an activity in class, I mean, using the projector to reflect on the board, some students are usually busy with their phones, checking mail/texting, or doodling on their notebooks. However, when the content was personalized and delivered through their devices, the level of attention and engagement was noticeably high (Figure 12).

Figure 11. Student doing the activity without earphones

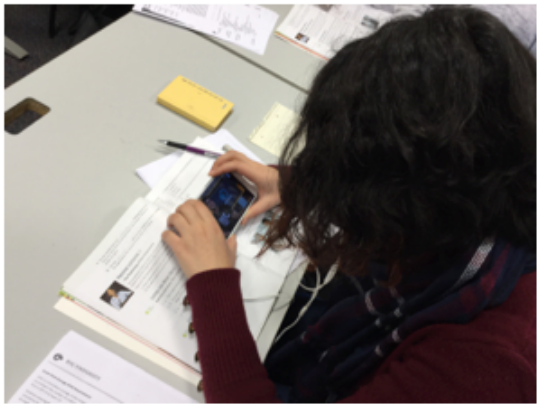


Figure 12. Student fully engaged in the activity

There were comments about the speaker's being fast and not very easy to understand, so watching it just once might not guarantee comprehension, but when I told them that they could watch it as many times as they want, they were relieved.

There were 2 students who did not bring their books on that day, but they could still scan the trigger images and participate in the activities without having any problem. This was also very convenient.

After watching the video, they tapped on it to proceed to the discussion board in the class forum (Figure 13) to share their insights based on the issues handled in the listening and note-taking activity along with the AR video clip activity. Although the class was over, there were 3 students who could post in the forum. I told them to submit their comments tonight and post to another friend's comment for better interaction. They agreed.

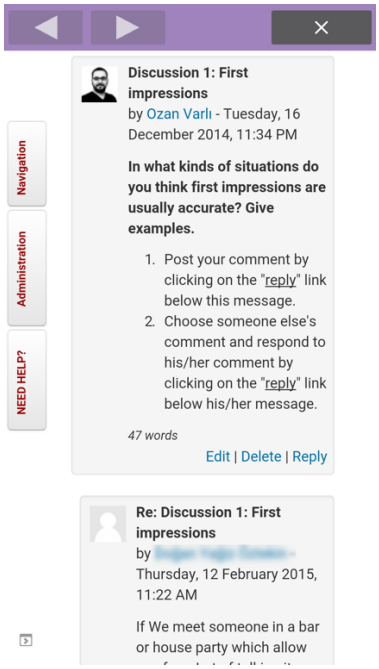


Figure 13. Discussion board

17/02/2015, Tuesday, 9:30 - 10:20 session (19 present)

After finishing the first half of the unit, I assigned a while-listening worksheet (Figure 14) and told them that they should scan the title of the text to trigger the audio. Most of the students started right away, without having any issues. However, some, about 4 students, had difficulty accessing the material at the beginning. I gave them the spare devices immediately and they could catch up with the others.

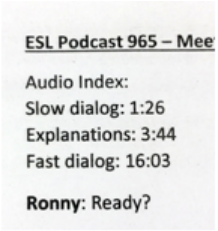


Figure 14. While-listening worksheet trigger image (retrieved from ESLPod.com)

The overall activity took 6 minutes (original listening is 2 minutes and 18 seconds long). At the end of the 6th minute, two students were still taking their time listening to the material. Just as I started asking basic comprehension questions about the listening, they finished and joined us. It was great to see how convenient this activity became as they could just scan a traditional worksheet and listen to it individually. Additionally, it provided a great level of flexibility as they had the time to rewind the clip and listen to the challenging parts again and again until they fully understood and wrote down the missing phrases.

While we were checking the answers together in class, the result surprised me a lot. They could have written down all the words but the word “gauntlet” in the phrase “running the gauntlet”, which was not a very big deal at all. I explained what it meant, and they noted down. As an extension to the activity, I told them to listen to further explanations and practice the pronunciation of the words by repeating after the speaker at home.

23/02/2015, Monday, 13:30 - 15:20 session (15 present, 4 absent)

Because the number of the students at the beginning of the class was very low, I thought I could skip the AR activity on word “suspicious” and would do tomorrow. Therefore, I went on to the next activity, unit listening, and spend more time on that. This activity was carried out in a traditional way again.

After the listening activity, we had a short discussion while answering the post-listening questions. However, to deepen the students’ understanding of the topic and

create more opportunities for them to practice the newly learned words and expressions, in the “what do you think?” section, I designed another AR discussion activity. This time, I told the students to scan the picture at the bottom of page 11 (Figure 15) and take notes on the video while watching. Most students did without having any technical issues this time. The scanning was quick. There were some missing earphones, but it worked out fine. The activity required them to take notes and answer some T/F questions along with some “What do you think?” questions (Figure 16). Because the activity required individual performance, all the students were taking notes and trying to answer the questions.

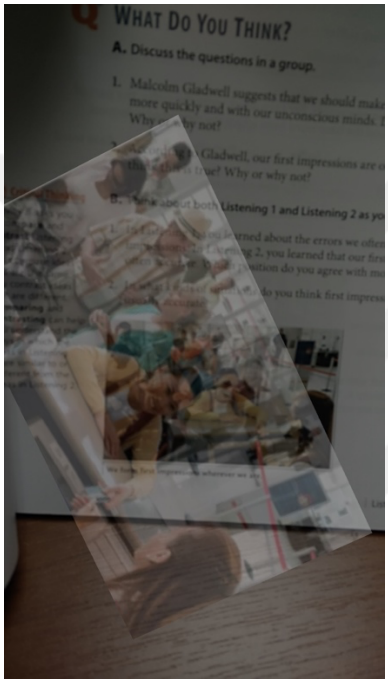


Figure 15. The science of first impressions video

Figure 16. Student notetaking and answering T/F and open-ended questions

25/02/2015 Wednesday, 9:30 - 10:20 session (18 present, 1 absent)
Because of not having enough participation at the time of the vocabulary activity in our previous class, we started with the word “suspicious” as a warm-up activity. I asked the students to scan the word suspicious on page 9 (Figure 17) and watch the PSA that provides more detailed context of the word. After watching the video clip, I asked them to make sentences with the word suspicious. They all made their sentences and shared with the rest of the class. We corrected the grammatical mistakes as an in-class activity and finalized it without further comments.

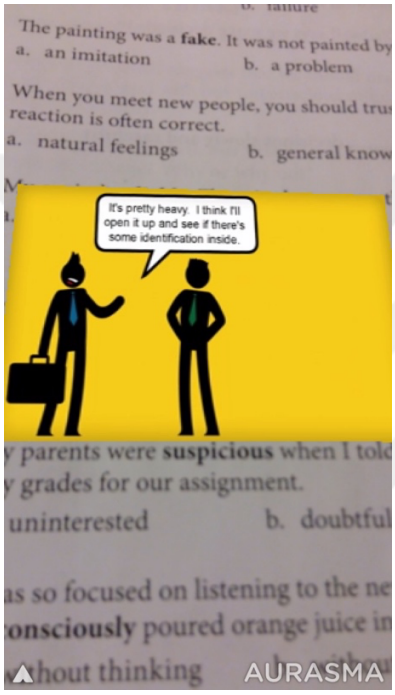


Figure 17. PSA contextualizing the word “suspicious”

At the end of the same session, we were talking about the contractions and how they were pronounced. We briefly discussed when and where we prefer the contracted forms and how they actually work. After this brief introduction, I told them to scan the related part in their books and view the video content. The video (Figure 18) was about the common contracted forms and how they were pronounced with detailed examples. They watched it once and had no problems at all. It seemed that the more they used this technology, the easier it got for them to view the content.

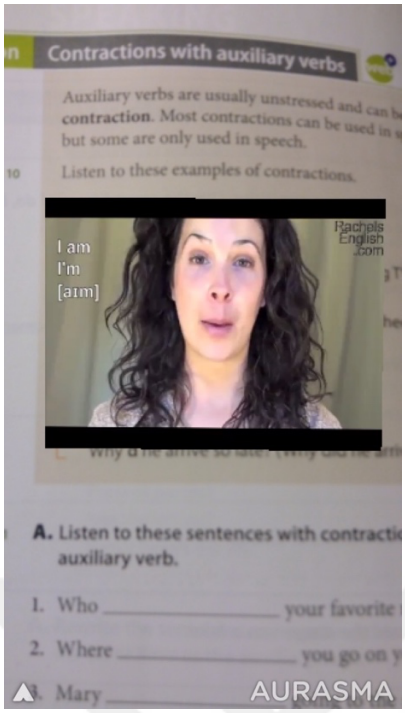


Figure 18. Contractions video (retrieved from RachelsEnglish.com)

There were only 3 students who needed support with scanning the material. Thankfully, the internet connection was seamless, and there were no interruptions while watching it. This time they all had their earphones except for 2 students, who later told me that they had forgotten their earphones at home.

While they were viewing the video, I told them to mimic the speaker, and imitate the way she pronounces the contracted forms at the same time. Although they were a bit hesitant and somehow shy at the beginning, after some encouragement, they started to repeat after the person in the video. One could easily recognize the sounds that most speaking teachers would like to have in his/her session. Surprisingly, most of the students admitted that it was their first time doing a lip/mouth training activity. They all seemed very interested and engaged.

The activity was later followed by a while listening activity, which required them to fill in the missing contractions and find out about the regular versions of those forms.

26/02/2015, Thursday, 9:30 - 11:20 session (17 present, 2 absent)

We started Unit 2 with a 3–4-minute brief discussion on the unit photo that was about coffee tasters. Then, we went on discussing the unit preview questions. The level of participation was not very high as most students were reluctant to speak about a new topic for the first time. I did my best to lead the discussion and engage the entire class, but there were only 5-6 students actively participating. The rest of them were either nodding their heads or saying “yes” or “no” occasionally.

To get out of the class routine, I told them that there was an AR version of the same discussion available, regarding the unit question “What is more important: taste or nutrition?”. Some students immediately asked about the meaning of the word “nutrition” and I told them once they listen to the audio clip that is integrated in the activity, they were going to get the meaning from the context easily. Without looking up the word in their dictionaries, the scanned the unit preview discussion, started listening to it, and in the meantime, some told me that they understood then.

This time 2 students had problems while scanning the trigger image. The first student reported that she had just lost her phone and bought a new one, but forgot to download the app and log in. The second one had rather a software-related problem on his phone. His device did not support the audio codec that was used while encoding the audio file. Therefore, I gave them the spare devices I had available on my desk, and they could then catch up with the other students without losing time and having further issues. There were 2 students who, again, did not bring their earphones to class. However, they came up with a quick solution by sharing earphones with their desk mates (Figure 19).

Figure 19. Students sharing earphones

The activity required the students to listen to a conversation of a group of college students in a class discussing the unit question, and after that, they were supposed to submit their own response on the general class discussion page. I told them that they should be listening to the audio very carefully and even taking notes as they might get some good arguments from the listening material to back up their responses.

After following the steps and listening to the audio content, they started typing their responses using the keyboards on their smart devices (Figure 20), and in the meantime, they were asking me questions regarding the correct use of vocabulary and grammar in their posts.

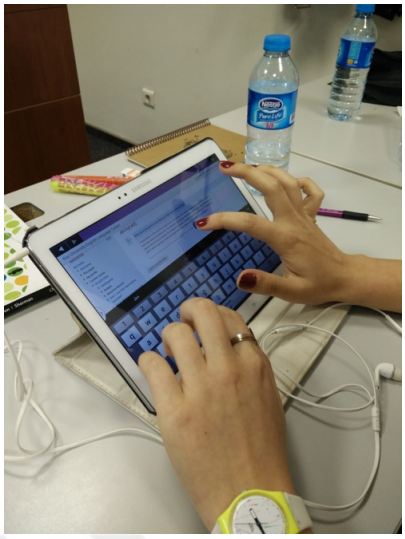


Figure 20. Student posting a comment

I could easily help them without distracting the others. Overall, it took about 5 minutes to listen to and post their comments. In the end, I reflected all the posts on the board, and we went over everyone's comments and tried to further interpret what they actually meant. Individually, they stood up and elaborated more. They all seemed very responsible and felt the urge to explain more as their names were called in. When the activity was over, I asked briefly what is more important again: taste or nutrition. It was interesting to see that this time they were so willing to raise their hands and contribute to the conversation.

02/03/2015, Monday, 13:30 - 15:20 session (15 present, 4 absent)

Although I told the students to give their overall feedback on Unit 1 and evaluate the related AR activities in the AR Learning Journal (Figure 21) as soon as they got home, there was only one person who could do it. When I asked why they skipped, their excuse was that they had forgotten about it. After giving them the instructions on how to do that, they could answer 3 questions:

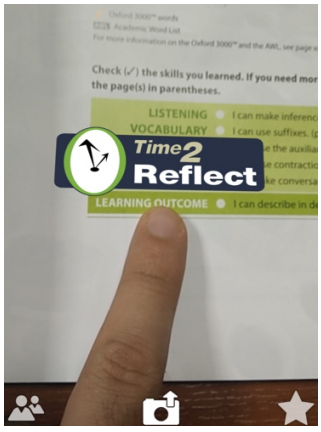


Figure 21. Accessing the AR Learning Journal

Which AR activity did you like most in Unit 1? (You can choose more than one answer.)
What are some things that you liked or find useful while doing the activities above? Please explain briefly.
What are some things that you did not like or find difficult while doing the activities above? Please explain briefly.

It worked out quite fine (Figure 22). Everyone, except for the 4 absent students, could submit their comments. Some posted in Turkish, some did in English. I peeked at their comments briefly and saw that their most favorite activities were “How do first impressions work?” worksheet and “Contractions” video a lot with 9 answers on both. This is almost 50% of the class. However, they did not like the Glossary activity as much since there was only 1 student marking it as his/her favorite.

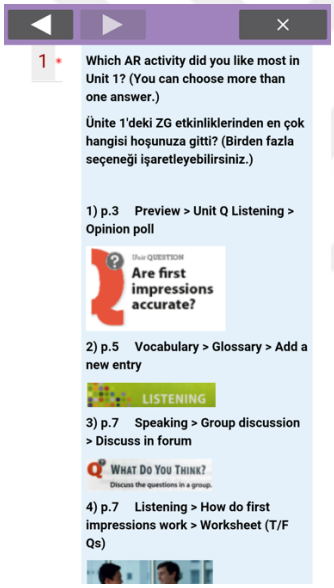


Figure 22. Giving feedback

04/03/2015, Wednesday, 9:30 - 11:20 session (17 present, 2 absent)

The first activity today was a vocabulary activity, and the students were supposed to scan specific words to view the video that provides enough context so that they can predict the meaning of the word. However, there was a technical problem that I had never considered before. When students scanned the trigger image (it was a piece of the text from the book) in order to watch the video on the word "texture", nothing happened as they had already taken some notes and made some annotations on their books because there was also a multiple-choice exercise on the same page (Figure 23). The marks they had made interfered with the predefined image on the server, and the devices could not recognize the scanned area as the patterns did not match. Making a

quick decision without necessarily spending more time on this activity, I told them that we should maybe postpone it to a later time.

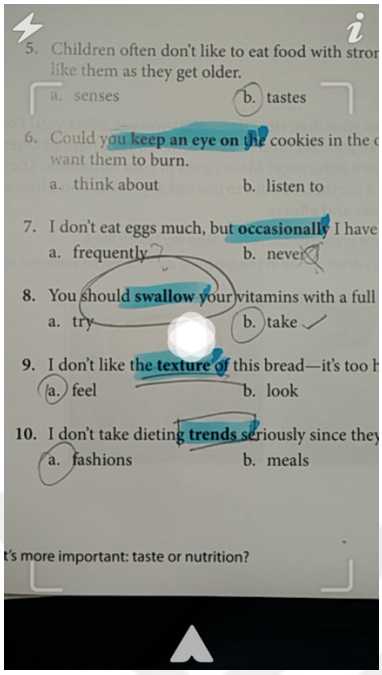


Figure 23. App camera not recognizing the modified trigger image

I moved on to the listening part and started a discussion on "food tasting". The discussion took a bit more than expected; however, I did not want to intervene as they were rarely so productive, so I let them speak more. After a 30-minute discussion, we did the first listening in the book and answered some comprehension questions. There was almost no time left. I thought I could assign the AR activity for home and see what the turnout rate would be. They will do it at home and bring the worksheet to class tomorrow.

05/03/2015, Thursday, 9:30 - 11:20 session (15 present, 4 absent)

Due to some technical problems, we faced the previous day, we could not do the scanning activity as planned, so I thought I could give it another chance by taking all possible problems into consideration. Having learned lessons, this time, they scanned the word "texture". Those who had problems regarding the image scanning because of the marks on their books used a cleaner copy of the book, and they were successful. They watched the video clip about the word "texture". After the video, they were prompted to go to the dictionary entry (Figure 24) and further analyze the word at form and meaning level. While they were busy with that, I introduced new words about the texture of the food on the board, such as: crisp, tender, hard, soft, juicy, creamy, grainy, hearty, crunchy. We briefly discussed in order to exchange ideas on their favorite foods and food textures. All in all, it took about 7 minutes and served very well as a warm-up activity.

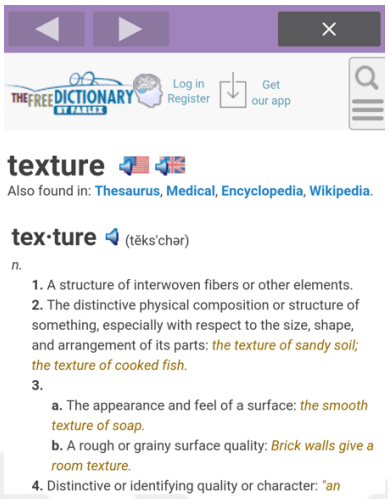


Figure 24. Dictionary entry following the video

Now that the vocabulary activity was over, we had a fresh start with Unit 3. There were some questions about success and failure. While answering these questions, we briefly talked about their university entrance exam experience, and with regards to this, what success means to them and what they learnt from this experience in particular. After this quick overview, I told them to scan the unit preview image and listen to the unit question discussion. They did so, and the content prompted them to participate in an opinion poll. As they started sending their responses, I reflected the poll results on the board via the digital projector so that we could easily see the choices and columns as well as who voted for what (Figure 25).

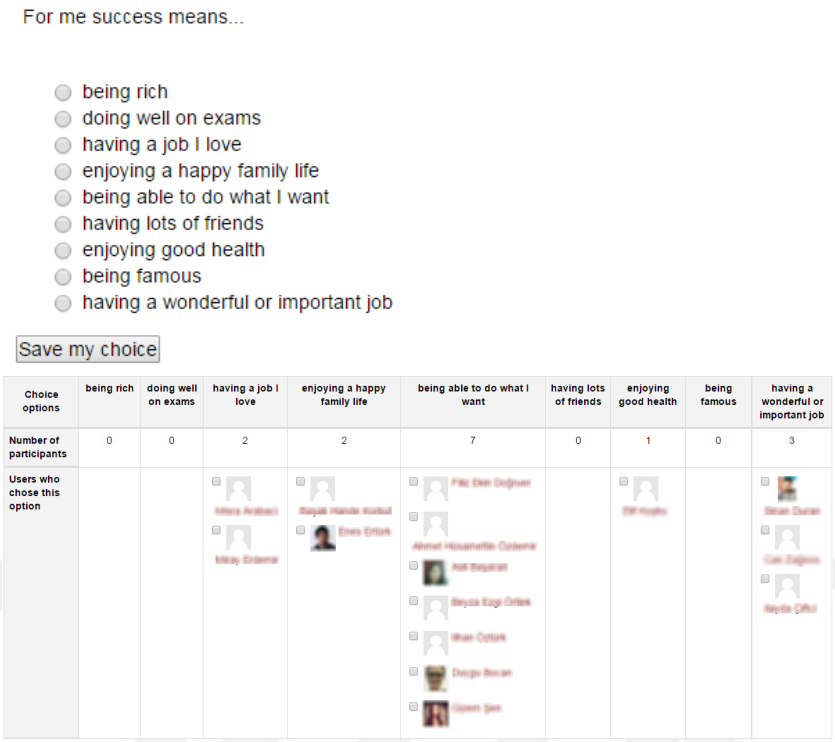


Figure 25. Poll questions and results

One advantage of receiving individual responses in such an activity was that I could easily pose specific questions to those who chose a specific answer. They were also able to give their answers in their groups without having to relocate themselves because the students were already grouped according to their preferences. Even the quietest student in class could express his ideas in a proper way. This was very convenient for me, as a teacher since I didn't have to spend time for that allocation and force them to talk. All in all, we had a nice discussion talking about what success meant to them and a smooth transition to the main listening activity.

09/03/2015, Monday, 9:30 - 11:20 session (17 present, 2 absent)

Before we started with the key vocabulary activity preceding the main listening, we briefly talked about the words. I asked if they knew the meaning of the word "determination". Except for a few students, the majority said "no". I told them the video they are about to watch could be a bit below their level; however, it is very sensational and catchy and will help them learn the word better than anything else. Being curious, they scanned the word. There popped up the video content featuring the song "Determination" from the cartoon Thomas the Train. Some of them even told that they knew the series, and they enjoyed watching on TV when they were younger. They enjoyed the song a lot; some were even singing and nodding their heads as they were getting exposed to the word "determination" repeated again and again (Figure 26). At the end of the song, they were forwarded to the Free Dictionary's entry on "determination". After quickly reading about the word, they made some example

sentences with the word and shared with the other students. At the end of the class, they were asking for more songs as one student admitted “this is a very good way of learning”.

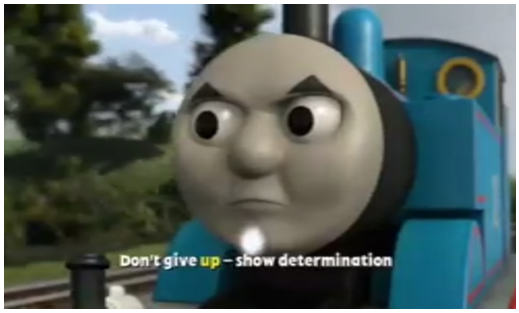


Figure 26. Vocabulary in the context of a song

10/03/2015, Tuesday, 9:30 - 10:20 session (12 present, 7 absent)

Today was a bit quiet in class. All the active students were absent. At first, I was hesitant to do the activity because I thought I may not get enough input, but then I said why not because one of the main arguments of having educational content in a virtual environment is to make it available anytime and anywhere. Therefore, after the unit listening and before the main discussion, I told the students to scan the picture at the bottom of the page. When they scanned, they started watching a short TED talk by Richard St. John on “success”. This was the first time none of the students complained about technical problems, which made me think that AR applications were no longer a special treatment, they were rather part of their learning routine. While I was observing and thinking, they finished watching, and afterwards, tapping on the video, they went to the class forum to reply to the main question I posted earlier. I told them that they could use some of the arguments and opinions they got from the video by giving credit to the speaker. It was great to see how the video scaffolded their learning and supplemented their understanding. Their responses were quite satisfying in terms of their linguistic quality as well as cognitive richness. The average word count for 12 posts was 50 words (lowest 38 words and highest 70 words), which reflected a fair degree of participation. The ones missing the class was going to join the discussion later as the content was available for them, too. Therefore, it didn’t matter so much that 7 students skipped the class, indeed.

11/03/2015, Wednesday, 9:30 - 11:20 session (15 present, 4 absent)

I started the first hour with the activities in the book as some students mentioned concerns in the interviews about our slow pace. Although we are not behind other sections, AR activities somehow created an atmosphere of not spending enough time on the book activities. This was raised as a concern by two students. Therefore, in the first class, I tried to spend more time on the exercises in the book rather than asking them to get their devices ready for an AR activity.

In the second hour, there were more students present, which turned out to be more efficient in terms of participation. After finishing the second listening of the unit, we went on with the pronunciation section which focused on word stress. Because books only show signs and IPA transcriptions, most students are not likely to understand and cannot learn intonation and stress-related topics effectively. Therefore, I thought I could reinforce their learning better with an additional pronunciation video, which would provide audiovisual support and help them practice word level and sentence level stress at the same time (Figure 27). When the video started, they were first commenting on the person and the way she looked. This made me think that they were already distracted. However, as the video played along, they started mimicking her and repeating after her, which was what I was planning to tell them to do. All in all, the video took about 5 minutes. That was enough of exposure I thought as they were still repeating the intonation pattern in the video.

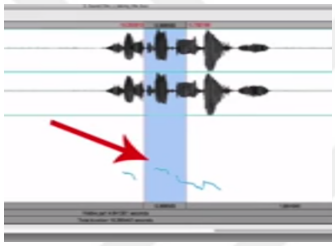


Figure 27. Rising/falling intonation illustrated in the video

There were no major technical problems except for a temporary (50 sec) interruption in the streaming of the video due to the internet connection. Most probably too many connection requests to the same source caused the lag. However, as soon as it was restored, the video went on playing. We, then, practiced example sentences in the book and everyone in the class were actively participating.

After a couple of minutes, we moved on to the speaking section. The topic was “asking for and giving clarification”. They could easily integrate the information from the previous activity and relate it to the expressions and phrases while I was giving some brief information on the topic. I answered their questions and told them to scan the section title and follow the instructions that was going to pop out. The students scanned and started watching another video clip on the intonation of clarification expressions. I told them to integrate the strategies they learned here into their speaking video homework.

At the end of the class, I assigned the while-listening worksheet for home. They were supposed to scan the trackers on top of the worksheet to activate the audio streaming and fill in the missing words and expressions while listening.

12/03/2015, Thursday, 9:30 - 11:20 session (17 present, 2 absent)

We started the first lesson checking the ESLPod homework (Figure 28) and the Academic Word List worksheet for Unit 4. It was simply a typical vocabulary class, in which we mainly discussed the meanings and definitions of words and so on. Although they did not get any technical support at home, they all could easily do the AR worksheet by themselves.

Figure 28. While-listening worksheet trigger image

In the second hour, we started with Unit 5 in the book. We had to skip Unit 4 as this was the decision of all the Pre-Int L&S instructors to be able to incorporate more authentic activities and provide some flexi-time to the instructors.

As each unit starts with a picture and a couple of discussion questions, I thought it would be nice to activate their schemata by talking about the unit picture first while addressing the questions. The picture was about an aid worker who was examining a turtle, and the main question was “Are we responsible for the world we live in?” We had a small in class discussion for about 10 minutes. The participants were, as usual, the most outgoing individuals in the group. Although I did my best to ask everyone about their opinion, they were somewhat reluctant in their responses, so I cannot say that there was production at the desired level. After collecting enough arguments and making the rest of the class familiar with the issues we were going to cover in this unit, I told them to scan the unit preview to view the AR content. They did and after watching a quick introduction, they clicked on the virtual window to proceed to the listening. They listened to the unit discussion and got some more ideas while getting exposed to the discussion language. After the listening, they are forwarded to the opinion poll link at the bottom of the page so that they could answer the discussion question. They all looked very engaged and busy looking up words in their dictionaries or exchanging ideas. Some of them were asking me how to say a specific expression in English, while some others were completely by themselves concentrating on their posts (Figure 29).

Figure 29. Students fully concentrated on their posts

While the entire room was in total silence, one student cried out “Oh no!”. We were all looking at him, and I couldn’t help asking what happened. He said that he hit the “Done” button on the top right corner of the screen to submit his post; however, that was the “Close” button indeed, so he could not submit as his comment was not “saved”. Some students also added that they had also experienced the same thing a couple of times until they learned their lesson not to do that again. In the end, however, he noted that he was going to give it another try soon again.

As we approached the end of the lesson, I assigned the authentic listening video homework for Monday. I printed out the worksheet and set a predefined image on the worksheet for the video by adding a small “Scan here” tag under. This assignment had two purposes. First of all, I wanted them to get involved in AR activities as much as possible outside the class, and second, I knew that they were doing their assignment most of the time; however, in order to force them to work on their assignments individually, I linked the AR content to the assignment area on ELC Online. This was going to help me see how many of them were actually working on the assignment and record their production.

17/03/2015, Tuesday, 9:30 - 10:20 session (16 present, 3 absent)

Tuesday sessions are usually short, not only because it is just one class hour, but also most students come to class with at least a 10-minute delay. Therefore, it is very difficult to have a discussion or any activity that requires preparation. That is why I usually prefer to check their homework or do similar activities on Tuesdays. Today, out of 16, at least 13 of them reported that they did their homework, the while-listening worksheet that featured an AR component. This showed that students could access the multimedia content by using their smart devices without having to compromise the ease and convenience of working on a print document. They were also aware of this and reported that they enjoyed the AR dimension. We discussed the expressions and checked the answers at the end.

As soon as we finished it, I checked my watch and saw that we still had about 15 minutes left. We had been talking about social responsibility until then, and I said it was time to move on to individual responsibility because the next listening was going to be about that. I told them to get their phones ready for an online discussion. Most students had positive feelings about this activity and spoke so highly of the forum. Some were already excited about it because they told me in the interview that they felt more comfortable expressing their opinions and become more productive. Without further explanations, they all started typing on their phones and tablets.

One student told me that she had difficulty in scanning the trigger image because her phone somehow could not work properly. I gave her the extra iPad I had with me, so she could continue without losing much time. Another student, who had been absent

for about 3 weeks, told me that her phone got broken and she could not get a new one yet, so I gave her my iPod Touch (Figure 30). For at least 3 minutes, there was this deep silence of concentration in the room although they were actively engaged, expressing their opinions as individuals in their learning community. This was a great moment for me as an educator. After this silence, some started asking how to use certain expressions in their discussion posts. It was, then, my time to walk around the room, and scaffold their learning while they are practicing, producing language.

Figure 30. Spare iPad and iPod Touch

18/03/2015, Wednesday, 9:30 - 11:20 session (17 present, 2 absent)

In the second hour, just after finishing the second listening, I thought it would be nice to back up the concepts on how personal responsibility leads social responsibility, so I gave them a TED Talk worksheet I had printed out earlier. Without further instructions, they scanned the worksheet and got forwarded to the related YouTube page. The majority of the class could scan and start the activity. There were again some problems with the quality of the internet connection at the very beginning, most probably due to the heavy demand on the network; however, in less than a minute, everyone was on board. Two students asked for the spare devices, as one of them could not receive her new phone yet, and the other one reported that her phone was running out of battery.

The activity was a while listening activity, which required very careful listening and answering some questions in the meantime. On my account, I would say the activity went very well as they all seemed to be enjoying the content. Each and every student could write down their answers as they moved along. I told them that they could get help from their partners, so they started exchanging their answers and filling in the missing parts on their worksheets. In a regular note-taking activity from a video clip projected on the board, they usually share their answers to the questions without necessarily answering all of them. However, the level of individuality while doing the activity contributed a lot to their performance as they felt somehow alone and obliged to answer (Figure 31). Overall, the entire activity took 13 minutes, and when I told them to have a quick answer check together, I was surprised at the unexpectedly high level of participation.

Figure 31. Student concentrating on her worksheet (left) and students exchanging answers (right)

19/03/2015, Thursday, 9:30 - 11:20 session (12/15 present, 7/4 absent)

When I went to the classroom, there were only 6 students, which was something not very usual. I was wondering where the others were and the students told me that they had no idea, either. In the next 10 minutes, 6 more showed up; however, it was still not the 60% of the class, so I decided to do the vocabulary study section in the book, trying to raise their awareness on how to use a dictionary. There was also a follow up activity about the second and third meanings of words.

I initially thought that the video I chose for the word “abuse” did not have the same exact meaning as it was used in the “power abuse” context. However, I realized that instead of re-introducing the context in the book, I could maybe show them the alternative context and elicit other possible meanings by asking them. Having this in mind, I started a brief discussion about the word “abuse” by giving examples from real life situations. After that, I told them to scan the word for the media content. They scanned their books and started watching a PSA about animal, woman, and child abuse. It was about one-and-a-half-minute video and was looping so that they could watch again and again. Once it started playing the second time, they were asking me what they were going to do. I told them to compare the context in the video and the context in the book and then tell me the differences and similarities. They started making connections between the two meanings and report in class with examples similar to the one in the video. This activity somehow raised an awareness among students about the different contexts of words. I think it worked out well.

In the second hour, 3 more students joined, and we went on with tag questions and how they are used in daily conversations. They all gave examples of the most common tag questions they prefer. After a quick revision, we started talking about the correct intonation of tag questions. I had prepared a video on intonation in Yes/No and Wh-questions and attached it to the content there. I told them to check the AR content by using their phones. They started interacting with the video again and repeating after the speaker in the video. This was very powerful as they could hear her voice, follow

her lips and facial expressions along with the phonological annotations and illustrations on the video (Figure 32). They were very engaged again and even the least interested student in class could participate in the activity. Their overall feedback was quite positive about the experience.

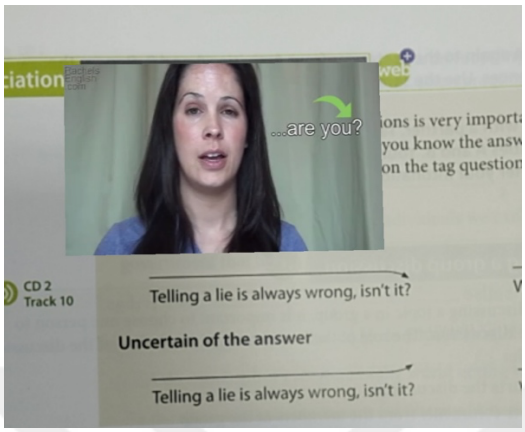


Figure 32. Audiovisual content with virtual annotations

23/03/2015, Monday, 13:30 - 15:20 session (19 present)

Because I was planning to give a quiz in the second hour, I thought I could start with Unit 6 today, at least hold a discussion on the unit discussion question and get as much input as possible from the students in order to get them familiar with the unit theme. After a quick refresher on the assignments and mid-term exams, I told them to go to Unit 6 on their books.

We started a conversation about advertising, how advertisers are changing our behavior, brand loyalty, jingles and so on, and then, answered the questions in the book.

After this conversation, I told them to use their devices to scan the unit question so that they could get more content, that is, opinions and arguments on the topic in an audio file and take notes. They took notes and upon finishing that, they shared the opinions they could catch out of the conversation there. Then, they followed the link to join a public submission area to share their favorite ads and why they like them. They were all looking for something that they wanted to share. Some of them were a bit hesitant as they wanted me to approve that they could use YouTube for that. They quickly typed into the search bar of YouTube, found their favorite ads, and copied the URL to share on the other page. After copying the URL, they also wrote down why they liked this ad (Figure 33). The participation in the activity was very high again. Out of 19 students present, there were 17 submissions. I reflected their submissions on the board and played their favorite ads. After the video clips were over, I asked the students why this ad is convincing or powerful/influential and how smartly it was

designed. They were again very engaged that they did not complain about spending more than half of their break time on this activity.

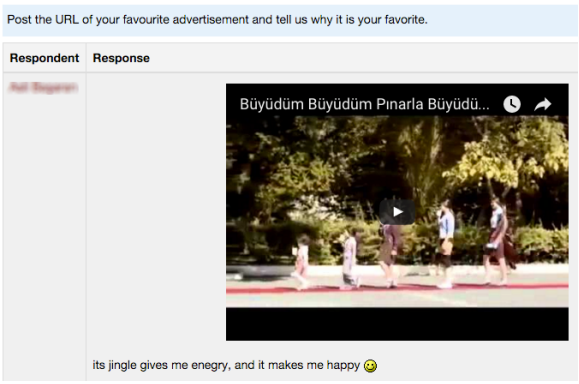


Figure 33. Student submissions of ad links and reasons why they like

Today was very special that we had 19 students present after all those weeks with missing students, so this was good news. Another good news is that one of the students having problems with his phone bought a new phone and told me that he made this investment because he felt like he needed a better phone to improve his learning in this course. This shows how determined and dedicated they could get when it comes to investing in new technologies.

26/03/2015, Thursday, 9:30 - 11:20 session (16 present, 3 absent)

After finishing the first listening on different techniques of advertising, I told them to scan the discussion part in the book and join the virtual discussion. They spent about 5 minutes to post their answers to the question. There were a couple of technical difficulties this time, for instance, the quality of internet connection was a bit low, and some students had to repeat the scanning and viewing process more than a couple of times. Two students, who had never asked for a spare device, requested as they could not use their phones that day. One student reported that her phone's battery died just as she was about to submit her post. However, we could still keep more than 80% participation in the activity. After everyone submitted, we started to check the posts by reflecting the conversation on the board, and each student recapped what they wanted to say by providing extra explanation. This helped them a lot as a scaffold because when they are not given time and a base for preparation, it gets very difficult to receive good quality answers from them. However, once they post there, they can also see what others wrote, so they were not initially influenced by each other's opinions; instead, they were adding into each other's opinions and contributing to the general discussion at an individual level (Figure 34).

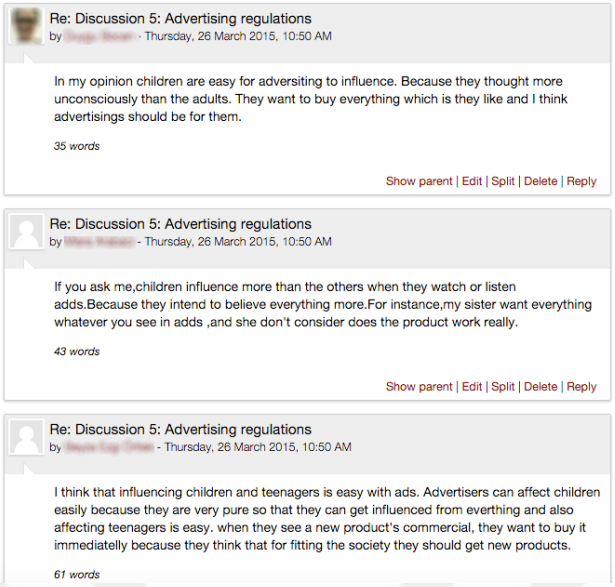


Figure 34. Posts on the discussion board

Another interesting thing was that my favorite silence came up again when they were all concentrating on their own posts. I must admit that it was the quietest moment of the day. It showed how meticulously they were preparing their answers. Of course a language classroom should not be a quiet place; however, if it requires careful thinking and special preparation, I think this is exactly how it should be.

15/04/2015, Wednesday, 9:30 - 11:20 session (16 present, 3 absent)

The second listening of the unit is about advertising ethics and standards. While talking about what it means, I raised the issue of laws that aim protecting consumers. Then, I wrote on the board if there are other words they know associated with “law”. Some said “rules”, but they still did not know the word “regulations”. Now that they were ready and alert, I told them to scan the related part in the book view the AR content. The content was a video, again a song from the cartoon “Thomas the Train”. Similar to the word “determination”, they composed a song on “rules and regulations” (Figure 35). Whenever the video popped up, they were all happy and smiling. They watched it until the end and looked very interested. Then, I asked them what other words could be associated with “law”. This time they added “regulations” and “codes”. On the board, we expanded the expressions and added verbs at the beginning so that they also learned “to make/pass a law/rules and regulations”. We started a whole discussion out of this, and I was asking more questions to elicit answers from them. “Who is the authority to make laws in Turkey?”, “Do you think local governments make some regulations on public issues, such as transportation, traffic etc.?” This provided enough context to internalize the word “regulations” and it was good to hear that some of them were using in the discussion at the end of the day.

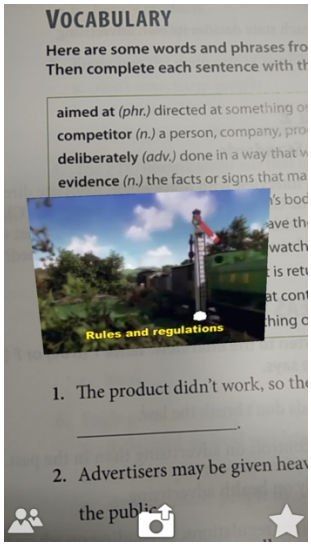


Figure 35. Contextualizing the word "regulations"

16/04/2015, Thursday, 9:30 - 11:20 session (16 present, 3 absent)

Now that we are halfway through the course, I can easily see that AR activities have already become part of their daily routines and we are no longer experiencing user-related problems. They could acquire all the skills needed to utilize this technology and we could successfully incorporate it into regular activities.

As usual, I started teaching the remaining topics for Unit 6 in the book. As soon as we finished those, I thought I could squeeze another worksheet before Unit 7. To promote deeper understanding and back up what they had learned thus far, I gave them an extra practice material on which they could practice while listening skills. This was an ad on a 3D doodling pen. I gave them the worksheets and told them to scan the image on it and start working. I love those moments as all students keep quite and concentrate for a moment to get what they need (Figure 36). Because they knew how to do it, without questioning or making extra comments, they finished their work in about 5 minutes.

Figure 36. Students working on the while-listening worksheet

It was great to see that 2 students bought better devices so that they could make most of this technology. We answered the questions together and started a short discussion criticizing/analyzing the product and the way it was advertised.

20/04/2015, Monday, 13:30 - 15:20 session (17 present, 2 absent)

We started a new unit with a small discussion on the cover photo, which showed the launch of a space shuttle. I was asking them what they knew about being the pilot of such a vehicle and if there are any risks involved with that job. They shared their comments and opinions. Later on, we continued our discussion with the risks that are OK to take. After a brief background check, I asked them to scan the "Unit Question" image to listen to further arguments on the same issue. They were listening to the arguments and taking notes. Once they were done with listening, they were supposed to submit their past risky experiences to the class opinion poll. Because they are somehow bored of reading submissions on the board and talking about them one by one, I offered to turn this into a guessing game, so I was hiding the names of the submissions and randomly choosing a student to read the post and make a guess about who this person could be (Figure 37). I hadn't thought that it would be so engaging as everyone in the class was trying to make their best guesses to find out about the person and ask further questions about this experience. It took for about half an hour but I think it was worth, and especially considering the amount of interaction, students talked a lot.

What is the biggest risk that you have ever taken or will soon take? What makes you think that this was/will be risky?

Respondent	Response
	I will soon take a huge risk that is going and working abroad.I think it will be risk because I may have culture shock.
	Last months my biggest risk is driving without driving licence. It is risky because if some police catch me it will be bad for me.
	I took my biggest risk about my health last year.I took lots of medicines because my life wasn't go well and I wanted to sleep. However the medicines damaged my body and I waited a long time for taking new medicines.
	I am planning to go to Egypt for the AIESEC project in July but if I cannot pass the KUEPE, I have to go to summer school in July. I prefer go to Egypt and maybe I will have to study one more semester because of that.
	I am living relax life and I didn't take any dangerous risk. My big risky experinence is using plane when I going to hometown.
	Rafting is the biggest risk that i have ever taken because when i take rafting ,i was very afraid of wave also i fell down inside of the sea ,i thought that my breath is not adequate to stay inside of sea .after a while i survive huge waves and i will be succesful to get rid of waves

Figure 37. Anonymous answers for the guessing game

In the second lesson, at the key vocabulary part, I told them to scan the word "debt" and watch the related video (Figure 38). While they were watching they were also moving happily with the music. I wrote down a word that took place in the video "GDP - Gross Domestic Product" and asked them to tell me the country which has the most debt in the world. They were quite shocked with the list. Then, I asked them to find out about Turkey's GDP and debt. This time they could relate the new information to their own contexts, which helped them internalize the word better.

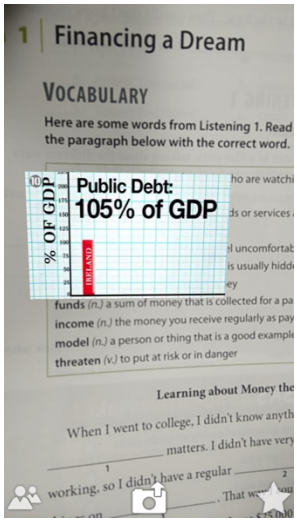


Figure 38. Contextualizing the word "debt"

22/04/2015, Wednesday, 9:30 - 11:20 session (14 present, 5 absent)

I did not plan much for today because students wanted a mock exam to prepare for the Speaking Final exam. Therefore, we spent the first hour on that.

In the second hour, I told them that we were supposed to finish the first listening and then have a discussion. After spending about 20 minutes with the listening activity, I told them to scan their books for the discussion board (Figure 39). The discussion question required for them to think and write down their ideas. For their level, it was a bit complicated to talk about abstract topics easily. Therefore, I thought this would help them to first write down what they think and then talk about it.

Figure 39. Discussion board trigger image in the book

It helped a lot, indeed. After their submissions, they were much eager to talk compared to the traditional way, most probably because they had an outline that they had already worked on.

27/04/2015, Monday, 13:30 - 15:20 session (16 present, 3 absent)

After finishing the listening about the "Loch Ness Monster" and how people believe in paranormal phenomena and risk their reputation, I gave them a note-taking worksheet which featured an AR video from VOA. The video content was about why Americans believed in ghosts and spiritual things. This made them question why people do such things in different parts of the world, and therefore risk certain things. They learned new words and expressions and at the end of the listening, they were supposed to write a paragraph on a question by putting together what they had learned thus far.

While viewing the content, there were some technical difficulties in terms of the quality of the internet connection, yet students were calm, either borrowing devices from me or sharing earphones with their partners again.

28/04/2015, Tuesday, 9:30 - 10:20 session (14 present, 5 absent)

The speaking section of the unit was the first to cover today, so I started talking about the contractions and contracted forms of certain auxiliary verbs as introduced in the book. In addition to that, I told them more about the features of the spoken language and gave examples of contracted forms that are different from the auxiliaries. For further explanation and live examples, I told them to scan the related part in their books and watch an AR video on “wanna” and “gonna” and how they are used. The video was a 3-minute long one, and they watched it with great concentration because they mentioned in their weekly Learning Logs that they had benefited a lot from those just-in-time pronunciation support. After they finished watching, I asked a few questions on how to use these expressions and added some DOs and DON'Ts regarding their use.

04/05/2015, Monday, 13:30 - 15:20 session (14 present, 5 absent)

We had a fresh start with Unit 8 today. The theme of the unit is cities. After talking about the picture of the “Eiffel Tower” and Paris on the front cover of the unit, I asked them which town in Istanbul they identify themselves with, and they were both describing a specific town in Istanbul and explaining how that specific town matches their certain personality traits. Once we were done with this, I wanted them to scan the unit question and listen to the discussion on the unit preview question. They were finally taking notes without me prompting them, which I did not find very interesting. Once they finished listening to the question, they were directed to a poll in which they were asked to tell which city they would like to probably live in and give reasons (Figure 40).

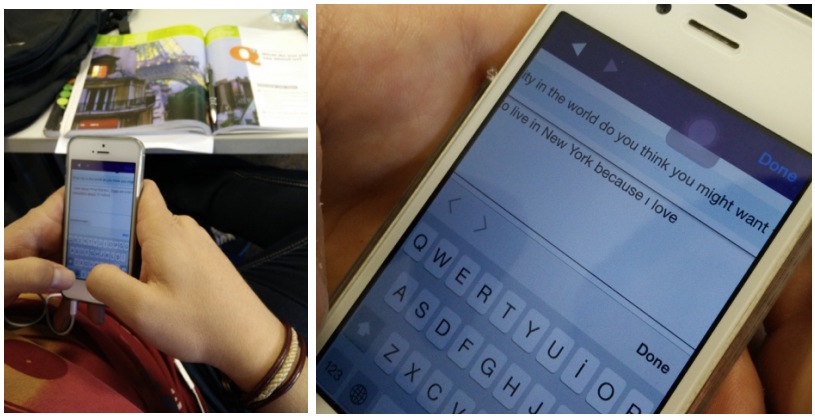


Figure 40. Students doing a poll before a listening activity

It took about 5 minutes for them to listen to the audio file and submit their answers. It was great to see that this time they were using Google to look for specific information about the cities they wanted to live in on a different browser and transfer this information into their posts. When everyone posted, I reflected all the posts in the form of a list and hid the names to see if they could guess the owner of the posts, which made everyone fully engage themselves in the activity as it already did before. Once the activity was over, we went on talking about our personal experiences with those places and exchanged further stories. As a follow-up, we did another quick survey from the book.

05/05/2015, Tuesday, 9:30 - 10:20 session (17 present, 2 absent)

Because this is the week before the last week of classes, I can see how their level of interest in the course material is gradually going down, and instead, they mention that they would like to receive more instruction on the exit exam. Therefore, I did not want to be insisting more as this end of semester psychology may hinder their learning.

After a 15-minute settling down stage, they were finally ready for the first and last AR vocabulary activity of the day. I revised the content from the previous class and told them to do the vocabulary activity in their books first. Once they finished the fill in the blank activity in their books, I told them to scan the word innovation and view the AR content that is associated with it. Because they looked a bit less interested, I told them to listen for specific details and tell me about the "3 steps of innovation" in the video.

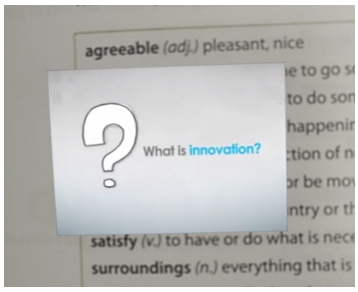


Figure 41. AR content for the word "innovation"

To my surprise, there were not a lot of students this time who were so willing to answer. When I asked them if it had anything to do with the way they did the activity, they said no. I knew that there was not going to be much learning that day, so I started a non-academic conversation about what their short-term goals were and how they thought they would achieve. They seemed more interested in this conversation, so we kept talking about it as a free speaking activity until the end of the class.

07/05/2015, Thursday, 9:30 - 11:20 session (17 present, 2 absent)

We started the class a bit later than usual due to students' tardiness, so I had concerns about not being able to conduct this session as planned. However, it worked out well as this activity served as a warm up. I gave them the instructions clearly and they followed carefully. As soon as they started interacting with the picture on the book by scanning with their devices, there popped up a very short abstract of the talk they were going to watch. They read the abstract, and then, clicked on it to activate the video that would follow in order to fill in the blanks on the worksheet I distributed earlier (Figure 42).

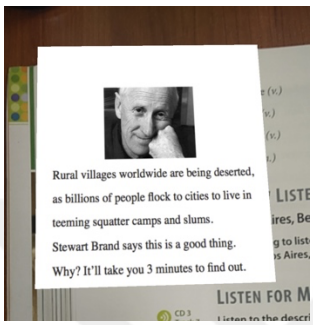


Figure 42. The interactive abstract of the video

I saw some students were pausing and rewinding the video so that they could listen to the missing word. This gave them the chance to get exposed to the language as much as they wanted. After 7 minutes approximately - watching the three-minute video twice, I asked them to look up from their desks so that we could share our answers in class. After making sure that everyone had finished, I called in names, and they answered questions in turns. Then, we discussed and tried to interpret together what the speaker wanted to say. I gave them some examples and asked them to share their own experiences regarding the speaker's experience. Because I had nothing else planned for that day, we went on the discussion until the end of the lesson. Overall, it was a nice experience on everyone's account, and none of the students made complaints about the level and difficulty of the material.

APPENDIX 5: INTERVIEW QUESTIONS

1. Did you like the AR learning experience? Why or why not? What do you think of it?
2. Do you think AR applications influenced your attitude toward language and language learning? If so, how?
3. How do you describe your experience of using the AR technology as a learning tool?
4. Do you think the AR applications are useful in practicing language skills (listening, speaking, reading, and writing) and aspects (grammar and vocabulary)? How?
5. What other skills do you think would be best supported with AR?
6. How do you think the AR applications are useful in collaborating with others?
7. Have you had any technical problems (choice of device, application interface, processing speed, quality of internet connection, battery issues etc.) while performing tasks with the AR apps? What were they?
8. Have you had any instructional problems (not understanding task, intuitive design issues, disorientation, distraction etc.) while performing tasks with the AR apps? What were they?
9. Would you be interested in attending another AR aided language course if there is one? What suggestions do you have for another student who will take an AR aided class?
10. How do you like the idea of having similar AR applications as an educational tool in other courses?
11. What was one AR activity that you liked and benefited most?
12. What was one AR activity that you think was not very effective?

FIRST PAGE OF THE PLAGIARISM REPORT

Ozan Varlı-Doktora Tezi

ORİJİNALLİK RAPORU

%9	%7	%4	%2
BENZERLİK ENDEKSİ	İNTERNET KAYNAKLARI	YAYINLAR	ÖĞRENCİ ÖDEVLERİ

BİRİNCİL KAYNAKLAR

1	link.springer.com İnternet Kaynağı	%1
2	etheses.whiterose.ac.uk İnternet Kaynağı	<%1
3	Submitted to University of Adelaide Öğrenci Ödevi	<%1
4	www.psychopen.eu İnternet Kaynağı	<%1
5	hdl.handle.net İnternet Kaynağı	<%1
6	dokumen.pub İnternet Kaynağı	<%1
7	mjltm.org İnternet Kaynağı	<%1
8	docksci.com İnternet Kaynağı	<%1
9	etd.lib.metu.edu.tr İnternet Kaynağı	<%1

ETHICS COMMITTEE PERMISSION

WARNING: It is mandatory to obtain an Ethics Committee Permission for all research topics related to living subjects.

☒ **Ethics Committee permission is required.**

☐ **Ethics Committee permission is not required.**

Ozan VARLI

(Signature)

ETHICS COMMITTEE FOR CLINICAL STUDIES DECISION

Meeting Date:	11.02.2015
Protocol No:	2015.027.IRB3.010
Principal Investigator	Ozan Varlı
Title:	An Evaluation of the Impact of Augmented Reality Technology on Language Learning
Start Date:	05.02.2015
Duration of The Approval:	1 year (with a possible extension)

The research proposal with the title and protocol number given above and the supporting material have been thoroughly examined by the Committee with regards to its aims, purpose, approach and methods.

The Committee reviewed the research proposal and approved the study protocol. You may begin your research on the start date listed above.

Best Regards.

Chairman

INSTITUTIONAL PERMISSIONS

WARNING: It is mandatory to obtain Institutional Permission for all research topics related to living and dead subjects. In cases involving confidentiality and privacy, the name of the institution should be closed.

☒ **Institutional permission is required.**

☐ **Institutional permission is not required.**

Ozan VARLI

(Signature)