

AUGMENTED AND VIRTUAL REALITY IN THE LANGUAGE CLASSROOM: PRACTICAL IDEAS

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Abstract

This article aims to provide teachers with a practical introduction to the capabilities of augmented and virtual reality (AR/VR) in foreign language education. We first provide an overview of recent developments in this field and review some of the affordances of the technologies. This is followed by detailed outlines of a number of activities that teachers can use in any ESL classroom with access to smartphones or AR/VR capable devices. The article concludes with consideration of privacy concerns, and practical issues of classroom implementation.

Keywords: augmented reality; virtual reality; AR; VR

1. Introduction

Augmented and Virtual Reality (AR and VR) are increasingly common technologies. AR will be familiar to most readers in the form of digital games such as the popular *Pokemon Go* or travel apps such as *Lonely Planet Compass City Guides*. VR is most commonly associated with headsets like *Playstation VR* or *HTC Vive* that display immersive, virtual environments mostly used for gaming. Both technologies are constantly improving and reducing in price – seemingly with new products becoming available every day.

Besides their entertainment value, there is considerable benefit for their application in educational settings, some of it dating back many years (such as simulations for pilots and the training of surgeons). A number of studies have uncovered their potential in language learning as well, including the effect of AR on increasing motivation among college students learning English (Li and Chen, 2014; Lu, Lou, Papa & Chung, 2011), encouraging out-of-class Spanish language use (Holden & Sykes, 2011), to helping elementary school students more

deeply connect with classroom topics (Gadelha, 2018) through virtual reality. However, so far their use in language classrooms has been limited.

In this practical article we will give a brief overview of recent developments in this area, review some of the technology's affordances and give specific examples of how teachers without specialised technical skills can implement AR and VR in the classroom – and support learning beyond the classroom. We will conclude with a number of considerations around privacy, security, socio-economic concerns and practical issues of implementation.

2. An explanation of the technology

AR, VR, and the blending of the two, called mixed or extended reality, are umbrella terms for a range of location, motion and information technologies that enable enhancing reality with digital resources (in the case of AR) or the creation of entirely digital environments (in the case of VR), in which users interact with information and other users. Apps on smartphones that can display information about nearby buildings or trigger location-sensitive media are common examples of AR in use, while immersive 3D virtual worlds that encompass a user's entire field of vision using a dedicated headset are the most common type of VR experience.

VR has been used for decades in the form of flight simulators, so the technology is certainly not new. What has changed is that what was previously expensive, highly specialised and fixed to one location has now become cheap, available for general use and portable. This has led to a wider adoption in a range of settings, all the way from hospitality training to remote support of workers in dangerous environments such as in nuclear reactors and on the battlefield.

An everyday application of AR that is becoming increasingly popular is the use of AR apps that can add virtual objects into real-world physical spaces. Technicians can now provide remote assistance using *Vuforia Chalk* (<https://chalk.vuforia.com/>) by seeing a live-view of another user's environment and drawing on objects in the other user's physical space (see Figure 1). The *Ikea Place* app (<https://www.ikea.com/gb/en/customer-service/ikea-apps/>) is another example where for the purposes of interior design users can add virtual furniture to a real-world living room to see how it looks before purchase (see Figure 2).



Figure 1. One user drawing into another user's physical space.



Figure 2. Placing location-anchored virtual objects into a real room.

Wearable AR devices are rapidly becoming more affordable and more widely available. Companies such as *Aryzon* (<https://www.aryzon.com/>) and *Myra* (<https://www.mirareality.com/>) focus on creating smartphone-powered devices for less than \$100USD, compared with more advanced headsets such as *Microsoft HoloLens* (<https://www.microsoft.com/en-us/hololens>), which currently (early 2018) retail for around \$3,000USD. As these devices become more widely adopted, the blending of physical and digital realities will become common. The same can be said for VR, as companies move from expensive dedicated headsets requiring powerful PCs or smartphones to smaller dedicated headsets that do not require any additional hardware such as the *Oculus Go* (<https://www.oculus.com/go/>) and *Lenovo Mirage Solo* (<https://www3.lenovo.com/us/en/arvr/>). It is also important to mention the contributions to accessible VR that *Google* has made with *Google Cardboard*, the simple VR device that supports most smartphones.

These dramatic reductions in price and increases in availability have opened up many more opportunities for education for both VR and AR. Examples include engineering education, where students have been tasked with manipulating virtual objects in real-world spaces via AR, with measurable and positive impacts on their spatial ability as a result (Martín-Gutiérrez, Saorín, Contero, Alcañiz, Pérez-López, & Ortega, 2010). AR has also provided educational support in history education, where learners can walk through an environment (such as a city), see artifacts from earlier times and observe how buildings and areas have changed over the years. *YouTube's* official 360-degree video channel, via the aforementioned cheap and widely available *Google Cardboard* headsets, have enabled teachers to take their students on virtual field trips using 360-degree videos to immerse them in diverse and informative environments. Another increasingly common use is in science classes, where learners can carry out experiments that would otherwise be dangerous or costly to organise. For example, students can 'mix' two substances to observe the effect in safe virtual environments.

In language education, AR has been used to get students to create campus tours (Reinders, Lakarnchua & Pegrum, 2015) or to get engaged in location-based games by walking around a town to find clues relating to a story (Holden & Sykes, 2011). Despite these and other interesting experimentations, it is safe to say that AR and VR have not yet in any way been widely taken up in primary, secondary or even university level language education. The purpose of this article is to demonstrate how AR and VR can be integrated into everyday language classrooms, without specialised technical skills. We will start by looking at some of the potential pedagogical benefits of AR and VR in education before introducing some practical ideas for teachers to try out.

3. The affordances of AR and VR for language education

Some of the most advantageous features of VR in classroom settings is its ability to reduce distractions. Gadelha (2018) states that "by blocking out visual and auditory distractions in the classroom, VR has the potential to help students deeply connect with the material" (p.40). There are no distracting classroom windows to stare out of when students are directly immersed into the topic they are investigating. This level of immersion also has the benefit of helping students make real world connections between the subject matter and their own lives. VR video content can help students make connections between the concepts they are studying and their effects on the world (Meyer, 2016).

One of the principal features of AR is that it comprises a set of *mobile* technologies, the affordances (potential benefits) of which for learning have long been acknowledged. Reinders and Pegrum (2017) draw on Klopfer et al.'s (2002) list of affordances for mobile learning and apply these to the field of language education. They discuss the benefits of *portability* to support learning that is not tied to one place and that can move between formal and informal settings (Lai, 2017). Secondly, they review the benefits of mobile technologies for facilitating *social interactivity*, enabling interaction and collaborative learning, the benefits of which for second language acquisition have long been recognised (see Chapelle 2001 and Warschauer 1997 for discussions within the realm of technology-enhanced language learning). Thirdly, they offer *context sensitivity* (they adapt to their location, for example by displaying content in a different language), which potentially makes it easier to provide opportunities for situated learning (Gee, 2004). Next, they offer *connectivity* and *access* to such resources as information, teachers and other learners, which has been shown to provide scaffolding and support experiential learning (Schwienhorst, 2012). Finally, they emphasise *individuality* (devices and mobile environments can be adapted to suit an individual's needs, interests and so on), which can help facilitate personalised learning (Benson, 2011).

One way in which AR and VR extend mobile technologies as they are mostly used at present is by involving the physical self in the interaction between virtuality and reality. Rather than engaging with resources at a cognitive level only, AR and VR support “embodied” and “extended” cognition, both of which emphasise the inextricable connection between the mind and the environment and “cognitive activity as grounded in bodily states and activities” (Atkinson 2010, p. 599). What these conceptions of cognition have in common is the role of the physical world in our thinking, and, by extension, our learning. For example, spontaneous gestures have been shown to support thinking and learning, and there is evidence that designed gestures, as well as manipulation of objects (e.g. on a screen or in a VR environment) can have an impact on learning (Segal, 2011). Beyond some experimental studies (e.g. Hwang & Cho, 2012, who investigated the use of portable vibrating bracelets to teach English intonation), there is limited research and application in the English language classroom (for possible ideas see Reinders, 2014).

In addition, AR can encourage learners to participate actively in (co-)constructing their learning environment, for example by posting comments or questions relating to a particular location, uploading photos of their experiences, and so on. Because the technology assists in-the-moment, it can support ‘just-in-time’ learning. In these ways, AR allows teachers to open up the classroom, provide remote assistance, and design activities that bridge formal and

informal learning contexts. Recent studies have shown that learners appreciate the addition of a physical element to their learning and not having to be tied to one location (Lindgen & Johnson-Grenber, 2016).

Research into the use of AR and VR in language education is still in its infancy, with most reports being of exploratory studies designed to investigate possibilities and student perceptions. Some early evidence of its potential comes from Holden & Sykes (2011), who describe the development and deployment of *Mentira*, a Spanish-language place-based game in which learners are required to go out into the local (Spanish-speaking) community to obtain information, find cues and solve quests. The authors found that engaging in out-of-class, authentic interaction, supported by technology and scaffolded through the game-like environment of *Mentira*, proved motivating to the students and showed considerable promise for further implementation. However, they conclude by saying that the design of innovative and meaningful learning opportunities requires more than new tools or artifacts.

In an example of a collaborative activity using AR, Reinders & Wattana (2014) describe students at a university in Thailand developing an augmented reality campus tour for future visitors. The real-world outcome and the physical aspect of the activity resulted in high student motivation and interaction and the authors argue that especially in a foreign language context this outweighed some of the additional time investment required to teach students how to use the technology.

We encourage language teachers to engage in their own exploratory practice and research and for this reason include a number of activities that draw on the affordances for language learning highlighted above. The activities below are all designed to be able to be used with minimal technical skill, and include practical activities that use AR and VR both within and outside the language classroom.

4. Practical examples for the language classroom

To give an idea of how an AR or VR activity might work in the classroom, a sample activity is first provided with worked-out steps for implementation. This details some of the decisions to be made and procedures to be followed, including which tools and apps to use. This also allows us to introduce some of the technical terms readers may not be familiar with. Following this, we offer short explanations for a number of further, practical activities; some supporting classroom-based study, others encouraging out-of-class learning. Each of these activities has been developed with high-school or university age students in mind and most are based on currently available, free and easy-to-use resources. A brief overview of the aims,

class time necessary and the resources that will be needed is provided and then followed by a brief overview of how the activity can be implemented.

4.1. Creating a Campus Tour

Aims: *Using English for Specific Purposes and practicing descriptive language*

Class time needed: *60-80 min*

Resources: *Wikitude, HP Reveal, Layar or Blippar, smart devices with cameras*

A relatively easy and fun way to introduce students to the affordances of AR is by having them create and share tours of their school/institution. This could be a tour for parents, for visitors, or for new students. This type of activity was successfully deployed by one of the authors of this paper at a university in Thailand, where students created a tour of academic services available to visiting professors (see above). Not only did the students enjoy the activity a lot, the resulting product (the tour) has been useful for the university in helping people new to the campus find their way.

First things first

The technology is not being used for its own sake, so the first step is to decide what the activity is trying to achieve. Is it to create opportunities for students to collaborate, discuss and negotiate? To learn to write instructional text types? Something else? Once the aim is chosen, it is time to make sure the technology and the activities created with them achieve it.

The technology

In essence, a tour activity involves the creation of information that visitors can see by looking at real-world objects through their cameras¹. For example, they might point their camera at an office in a building and learn that this is where IT support is offered from 08:00-17:00 six days per week, along with links to contact details. The object that results in the display of information is called a 'target' or 'trigger'. So, in the previous example, the IT building is what 'triggers' information to be displayed. The information can be anything, from text (opening times), pictures (of the staff who work there), links (to IT help files), to videos and so on. The act of pointing a camera at a trigger is called 'scanning'.

¹ At present this will involve mostly the use of smartphones, but with the advent of other devices, such as glasses and other wearables, additional tools may be available in the near future.

Targets or triggers do not have to be physical objects, though. They could, for instance, be pictures of objects. As an example, students could take photos of key buildings and put them on a poster. Visitors can then scan the pictures (the triggers) to learn what the buildings are. To develop such materials, use an AR creation tool, such as *Wikitude* (www.wikitude.com/) for location-based triggers, *HPReveal* (www.hpreveal.com/), *Blippar* (www.blippar.com/) or *Layar* (www.layar.com/) for image-based triggers. They all provide step-by-step tutorials on how to create content and share it with others online.

Step-by-step

Once the appropriate app has been chosen, it is time to prepare the class. Please remember that the procedures below are an example only. How the teacher introduces the activity will depend on the size of the class, how much pre-teaching students may need of new vocabulary, and so on – in other words, these are general guidelines only.

1. Divide the class into an even number of small groups. Each group creates either an academic themed (describing all academic services on campus) or a social themed tour (describing facilities such as canteens and sports).
2. Students brainstorm interesting and informative things to say about each of the locations.
3. Students then visit the locations and create their tour videos. They could also interview people at the locations to get more information to talk about.
4. While at the locations, students create triggers with their AR creation tools to display the video content. Some location-based AR services only provide services in certain countries or areas, so in this case create image-based triggers using of any flat object there, such as a sign or map (see Figure 3).
5. Show students how to create an account on one of the AR creation tools and how to upload their target images and attach their tour videos to the targets.
6. Students create a video that introduces the tour locations and where to find the targets that will start the tour videos.
7. Ask the groups to create a quiz with one question about each of the locations that can be answered by watching the tour videos.
8. For the final part of the activity, ask the groups to find another group with a different theme and take their tour, answering the quiz questions as they go.



Figure 3. A photo of a university map (left) used as a trigger to activate an introduction video (right) in *HP Reveal*

4.2. Giving and following directions

Aims: Practicing vocabulary such as location prepositions, and giving and receiving instructions.

Class time needed: 45-60 min

Resources: Wikitude, *HP Reveal*, *Layar* or *Blippar*, smart devices with cameras

Students can also use the *campus tour* procedure above to create activities focused on giving and receiving directions. Rather than creating videos related to the locations themselves, students can create videos explaining how to go from one place to another. Groups of students work their way to a common point, possibly in the form of a competition with the first team to arrive winning. Teachers can create the directions themselves or students can work together as a class to create a set of directions that another class would use.

4.3. More realistic presentation practice through 360-degree videos and VR

Aims: Practicing shadowing and improving presentation skill confidence

Class time needed: 20-30 min

Resources: Dedicated VR headset such as *HTC Vive*, mobile VR headset such as *Oculus GO* or *Google Cardboard* with VR capable smartphone, *YouTube*, headphones

Virtual Reality cameras (that take photos or film video in all directions simultaneously) and headsets can provide users with much more immersive experiences than watching a regular video. Online services such as *YouTube's* 360-degree video library, called *YouTube VR*, can take students to many different locations, providing them with a better understanding and spatial awareness of a location before a school trip, let them experience far-away locations and many more classroom activities.

One affordance of 360-degree videos and cheap VR headsets like *Google Cardboard* is being better able to practice improving presentation skills. Until now, the most common way students have often practiced for a presentation before a large audience has been to speak in front of a mirror or find some quiet space to recite their speeches while imagining an audience before them. With 360-degree videos and VR though, students can take advantage of the large quantity of 360-degree online presentation videos to practice giving presentations in front of actual audiences.

1. Using headphones, some mobile VR headsets, and the students' own smartphones, assign students a 360-degree presentation video to watch (either a suitable one found online or one made by the teacher).
2. Encourage the students to focus their attention on the speaker and listen to what they are saying and the gestures they use.
3. On the second viewing, students should attempt to shadow the speech given by the speaker and, if possible, try to copy their gestures.
4. For the third viewing, ask students to face the audience while shadowing and attempt to make eye contact with as many audience members as possible while doing so.
5. Finally, if students are preparing to give their own presentations, after the students have practiced trying to remember as much of their own speeches as they can, have them watch the video again, but this time mute the audio and ask them to recite their speeches to their virtual audience.

4.4. Creating community content maps for the local area

Aims: *Writing and reading reviews using target language in authentic contexts*

Class time needed: *45-60 min*

Resources: *Google Maps, any smart device or PC*

Online maps such as *Google Maps* (www.google.com/maps) provide opportunities to create community content layers that appear on top of their regular maps and are shareable with

other people. These layers provide additional information to, for example, special locations, user reviews, images and even directions to follow. For projects, students can design their own layers individually or as a class. At the end of the academic year, first year students can create map overlays that provide information to next year's students. These overlays can include tips on the best places to go, such as the best coffee shops in town or places to study quietly on campus, and the fastest ways to get there, along with images and information about each location.

A similar activity would involve prefacing this activity with field trips where students have to go and collect information about a particular building, person or topic. This could include going to a local museum, finding historical buildings around town, or locating (and perhaps interviewing) a particular person.

More directly related to what is covered in class, students can be asked to tag examples of certain vocabulary items located nearby, or even examples of the use of a particular grammatical feature (e.g. tagging locations with reviews to practice giving opinions). Students putting target language into use in authentic contexts such as their own local areas has been suggested to have significant learning benefits (Kukulka-Hulme & Bull, 2009). Teachers can also create this information themselves, and provide pictures, links, tips and even specific vocabulary items for students to study (Bo-Kristensen et al., 2009).

4.5. Location-based puzzle treasure hunts

Aims: *Understanding context clues, practicing listening comprehension and procedural language*

Class time needed: *45-60 min*

Resources: *HP Reveal, Google Maps, any smart device or PC*

Treasure hunts are a useful activity that can be enhanced with AR. While traditional language-focused treasure hunts often incorporate written clues hidden at each location, AR-enhanced treasure hunts can take advantage of the ability to also embed audio and video into the environment. This can provide the addition of speaking and listening practice to an activity that is traditionally focused on reading and writing.

In this activity, two teams are paired and given different instructions which they need to share to retrieve information from around the town (this could be limited to just one campus, for example) in order to find a hidden treasure. In order to get to the treasure,

students leave notes for the other team by tagging items with a recorded video that explains where to find the next video.

A treasure hunt can also involve location sharing. *Google Maps* now features the ability to let users track friends and choose whom to share their own location with². A variation of the treasure hunt is for one group of students to head out and for another to stay in class, tracking the first group's location (see Figure 4), and perhaps sending out instructions with tasks for the group to complete over *Skype* (<https://www.skype.com/>) or *Google Hangouts* (<https://hangouts.google.com/>).

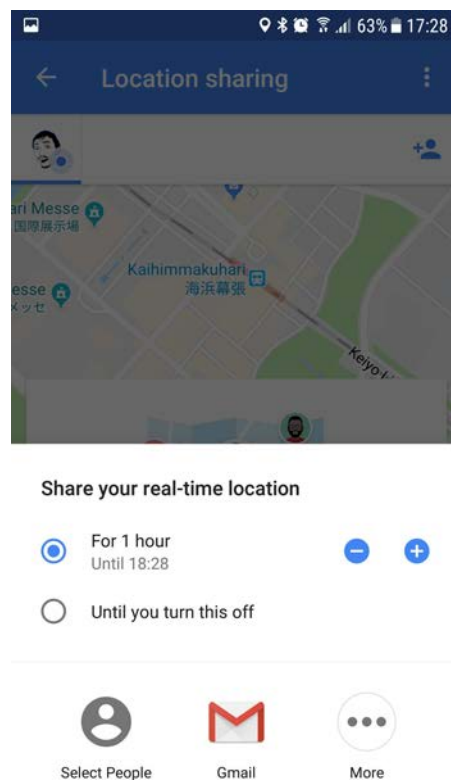


Figure 4. Users can limit who they share their location with and for how long

4.6. Providing instant-access supplementary materials for readings

Aims: *Providing faster students with additional activities and slower students with additional assistance without physically modifying materials*

Class time needed: *10-20 min*

Resources: *HP Reveal or Layar, a scanner, smart devices with cameras*

² <https://blog.google/products/maps/share-your-trips-and-real-time-location-google-maps/>

It is a common occurrence that some students finish an activity early while others are struggling to keep up. One way of dealing with this is to provide learners with the option of accessing additional information, based on their needs and/or preferences. AR services can make it easy for teachers to provide further explanations or additional exercises. By scanning the activity in the textbook, learners can access further resources online via links and videos embedded into the text itself. These resources could enable students for whom the content may be too easy to access additional tasks or more challenging questions (see Figure 5), while simultaneously assisting struggling students with translations of key vocabulary, a summary of a reading text, charts or diagrams to help explain difficult concepts.

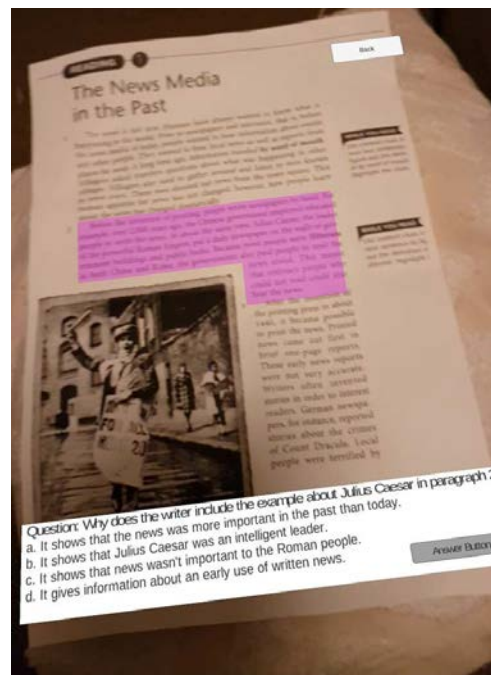


Figure 5. Questions added to the bottom of a text with the relevant paragraph highlighted

To achieve this, physically scan the desired page from the textbook (using a scanner or photocopier), convert it to a digital image and upload it to an AR service such as *HP Reveal* or *Layar*. Once uploaded, use the website tools to place the additional information on top of the page so that students can access it when they point their AR app cameras at the textbook activities.

4.7. Automatically assigning roles in information gap activities

Aims: *Using targeted language in a communicative environment with a focus on all members speaking equally*

Class time needed: *15-30 min*

Resources: *Layar or HP Reveal, smart devices with cameras*

Information gap activities (where learners are missing information they need to complete a task and need to talk to their team members to discover it) are a popular classroom activity. With AR, teachers have the opportunity to enhance these activities by exposing students to a wider variety of media to discuss. AR apps such as *HP Reveal* and *Layar* can provide teachers with the tools they need to quickly embed content such as videos, text, audio, websites and more into any image. After finding a few images related to the topic of the information gap activity, teachers can upload them to an AR creation tool and embed the desired content into each one. Once the images have been printed out on paper, they can be distributed to students who can then use their cameras to access the content and start explaining it to their group. Some examples of information gap activities include:

- **Vocabulary:** Presented with a paragraph of text missing key vocabulary, students have to collect sets of nouns, action verbs and adjectives from the AR targets and work together to place them correctly into the text.
- **Grammar:** Each AR target displays a set of key information related to a narrative, such as the tense, perspective, events etc. that students have to put together to understand the full context of the story.
- **Pragmatics:** when given a particular text type, such as a request or an apology, students collect the key components needed to word the letter correctly, by finding and sharing such information as the intended audience, the severity of the issue, the topic at hand and the level of politeness needed.
- **Communication:** each student can see some information about an object, such as a related image, a video, an audio recording or a 3D model. By sharing what they can see, they try and identify, for example, the purpose of the object they are looking at, or some information about it, such as who it belongs to, or what should be done with it.

4.8. Virtual reality video creation

Aims: *Providing students with new environments to express their creativity in language production focused role-playing activities*

Class time needed: *60-90 min*

Resources: *High-end VR Headset such as Oculus Rift and VR capable PC, projector, free copy of Mindshow*

For teachers with access to a high-end VR headset, asynchronous film creation programs such as *Mindshow* (www.mindshow.com/) can be useful in helping students express creativity in their language production in new and exciting ways. Students can create environments and then film themselves in it one after the other, layering each student's movement and dialogue onto the scene until a fully filmed, multi-actor scene is created. Students can custom-design scenarios that are enhanced by 3D virtual realia and props and create engaging videos to demonstrate language usage scenarios to their classmates. Airports, hotels, presentations, news reports, job interview scenarios and more can all be made and shown in class (see Figure 6).



Figure 6. A Mindshow news program scenario

4.9. Backchanneling with the teacher during classwork or homework

Aims: *Providing ways for teachers to measure understanding and gather feedback*

Class time needed: *5-15 min*

Resources: *Layar, HP Reveal, Google Forms, smart devices with cameras*

One common challenge faced by teachers is knowing how much of the class content is being understood. One method of monitoring student performance is backchanneling, where teachers request responses and feedback from students at key points during the lesson to gauge comprehension. AR opens up the ability to quickly distribute access to online questionnaires and feedback opportunities without having to add QR codes or web links to printed handouts. Digital image copies of handouts can be uploaded to any AR service and

have links to online forms embedded in them. Teachers can take entire units worth of material and embed backchanneling opportunities into the worksheets without needing to reprint the material with weblinks. Students simply use an AR app to point their phone cameras at the handout and access the backchanneling material.

Some of the many backchanneling opportunities that online questionnaires enable include presenting students with a few sentences after teaching them a new grammar point or vocabulary item and asking them to indicate which ones are correct or incorrect. For reading activities, comprehension questions can be administered or students can select from a list of keywords after skimming a short article. For writing, students can choose which thesis statement is most appropriate for a topic or place a number of essay paragraphs in order (see Reinders, 2014 for more on backchanneling).

To create these backchanneling opportunities in the classroom, scan or take a photo of the activities and use them as AR targets to take students to online forms where they can answer questions and provide responses. In *Layar*, *HP Reveal* or any online AR service that permits creating URL links from AR targets, simply create a link to a *Google Form* (<http://docs.google.com/forms/>) and change the settings as desired.

Students can also provide anonymous feedback on specific activities without teachers needing to create multiple forms. *Google Forms* supports pre-filling sections of the form automatically based on the URL used to access the form, allowing for teachers to auto-fill the name of the activity whenever a student scans an activity with *Layar* or *HP Reveal*.

To do this in *Google Forms*, after creating questions for students to answer, create a question with a short answer field such as “Which activity do you wish to talk about?” Then go to the “More” icon (three vertical dots) in the top right and select “Get pre-filled link.” Answer the above question in the form with the name of the activity that is going to be augmented and then click “Submit.” Now there will be a link that can be pasted into an online AR service, using the activity sheet/textbook page itself as a target and any time a student points their smartphone at that target, they will be automatically sent to that *Google Form* with the activity title pre-filled.

4.10. Orienting students to a reading topic through 360-degree videos

Aims: Familiarising students with a topic and providing them with vocabulary in context

Class time needed: 20-30 min

Resources: Cheap VR headsets such as Google Cardboard, student smartphones

Many textbooks are not particularly topical and the subjects can sometimes be discussed in very generic, impersonal terms. As a form of pre-reading or familiarizing students with a topic before classroom discussion, use 360-degree videos in *Google Cardboard* or other VR systems to fully immerse students in the subject at hand, using current resources. Check sites such as *YouTube* for “360-degree (topic)” and look for content that would be suitable for students. For example, on the topic of ‘separation’ there are some truly touching videos of the plight of refugees (see Figure 7) that are likely to spark a reaction from students.

Once students have watched these videos, ask them to write and discuss a few questions (Teeter, 2018):

- What aspects of the video affected you the most?
- What can be done to solve this problem/improve this situation?
- Share your ideas with a partner.



Figure 7. The short 360-degree video “Refugees” on the refugee situation in Syria

<http://scopic.nl/projects/refugees/>

5. Implementing VR and AR in teaching: Some considerations

Before deciding to use VR or AR, there are a number of important considerations. As with any technical innovation there is likely to be an investment on the teacher’s as well as the students’ part. How much time is likely needed for learning the technology and assisting students? In addition, do students have access to capable devices? If not, could they share between them?

In addition to these considerations, AR and VR raise important questions about privacy and security. Along with many of the usual privacy and security issues online, VR presents a few new issues that should not be overlooked. While online harassment is a known

problem in social spaces such as chat rooms or online games, VR poses new dangers. Harassers can enter another person's personal space and depending on the VR environment make it difficult or even impossible for that person to retaliate by pushing the harasser away or escaping without quitting the space altogether. In creative spaces, harassers can also physically destroy creations and generally make use of the space impossible. As a result it is important to make sure that students use password-protected social spaces and that the teacher monitors the students' interactions to avoid this becoming an issue.

One of the first concerns before asking students to use their own smartphones for these activities is to remember that the socio-economic situations for each student are different. Some students may not be able to afford a smartphone, or may have one with a cracked screen that can prevent them from using VR devices such as *Google Cardboard*. To mitigate this issue, it is recommended, specifically for VR, that students have a non-VR alternative available to them. This can be accomplished by the teacher casting their own VR experience via projector or television.

Due to AR's ability to be used by any user with a modern smartphone, teachers should be aware of the possible permissions that an AR app is granted when being installed on student phones. AR Social apps may access and keep an updated history of the users frequented locations for ad purposes, while more nefarious apps may request access to the phone's microphone or camera, or scan a user's browser history or access other sensitive content. It is important to do a background check online for each new app students are asked to install.

Another consideration is who has access to the data that these apps produce. Students need to be made aware of who has access to their personal information or location data when using the apps so they can be fully aware when choosing to use them. It should also be made clear who has access to any chat logs, questions, feedback or test data, where this data is stored, and if possible, how to remove it.

A student should feel safe taking part in any discussion activity, expressing an opinion, or admitting that they do not understand something, without fear of this information being used against them in class by either their peers or teachers, or it being shared with others outside the class.

Instructors need to be aware of pricing too when creating VR or AR activities for classes. While some services may be free when first used, they may have limitations that can prevent their use in the classroom. VR social spaces may require a per-user subscription fee after the first month of use or may ask for a fee to allow a larger number of users into the

same space at the same time. These kinds of limitations may not become apparent or come into effect until students are already using them in the classroom, so it is necessary to make sure to know the parameters of the free-to-use model that the service is providing.

For AR, one needs to learn the usage limitations of free online services and whether or not they have educator licenses available. These limitations may be there to encourage creators to sign up for paying accounts and as such may not come into effect until a certain number of users have viewed an AR target, or a number of free access days have passed. *HP Reveal* allows publishing the target online without payment but requests a monthly fee in exchange for additional content options and removing the need to subscribe to a creator's channel to activate the AR target. Services such as *Blippar*, *Augment* (<https://www.augment.com/>), and *Layar* all provide free educational licensing opportunities for teachers.

Finally, it is still early days for VR and AR with many companies trying to establish themselves as the best content creation service. While initially many of these companies may provide excellent free content, eventually their start-up investments may begin to evaporate and it can be expected that many of them will introduce more expensive price structures or reduce their free services. This is particularly a risk if a service offers a free education service and then finds education becoming a larger and larger part of their core user base.

Despite these challenges, it is clear that many exciting developments are taking place in the AR and VR space. As educators, it is important to learn about these developments, their risks, and – most importantly – their potential benefits for learning. As a way of linking formal with informal learning spaces, there is a lot to be gained from teachers experimenting with the many possibilities of these new technologies.

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