

Language and AI in Asia

Augmented Reality, an experiential language learning encounter

Corine PHILIPPART*

* University of Luxembourg, Luxembourg

corine.philippart@uni.lu

Abstract

The democratisation and ubiquity of the smartphone has made it possible to integrate immersive technologies, including Augmented Reality (AR), into the language classroom. The effectiveness of AR has been extensively researched, but not always from a psychological point of view. This paper therefore aims to discuss the effectiveness of AR according to the user's degree of perception in a heterogeneous, multilingual teaching context that explicitly favours digital educational practices. To this end, quantitative and qualitative data collected through anonymous questionnaires from two case studies were analysed. This analysis points to the fact that the pedagogical role of the user of our case studies, i.e., as a learner or a (future) teacher, may influence the degree of perception of AR. In addition, the novelty and particularities of AR do not make it common and easily accessible, even for users familiar with other educational technologies. Hence the integration of AR requires progressive and proactive planning, including purely technical hands-on workshops for both sides of the classroom, to achieve the most satisfactory learning experience possible.

Keywords

Augmented Reality (AR), perception, adult language teaching, (perceived) effectiveness, foreign language

Introduction

The effort of addressing equally different and varied needs in education continues to retain the attention of teachers, as human flows constantly reshape learner diversity in the classroom. At times challenges or opportunities, globalisation has greatly impacted the educational sphere, redefining pedagogical expectations as well as the teacher's role in the process (e.g., Günther-Van Der Meij & Duarte, 2022; Wu, 2022). For language teachers in particular, globalisation has a special significance: whether for educational or economic purposes, learning the language of the new community is key for integration (Punar Özçelik et al., 2022: 134).

In this context of a globalized classroom, an inclusive approach is advocated to manage diversity and accommodate the learners' differing needs (Arneton et al., 2022: 69). Among other strategies, technology-enhanced learning is regarded as a compelling response to this inclusive expectation (Sandberg et al., 2022), while yielding multiple additional benefits for language learners (e.g., Mallahi, 2022; Milanovic, 2010).

Over the past years, following the changes brought by globalisation and digitalisation, teachers have thus continued to rely on technical and technological advances to stimulate, support and differentiate language learning (Marín-Díaz, 2017: 126). Moving away from the computer and the internet, the notable technological milestones of the 1980s (Karsenti, 2004), the rise of portable devices, such as smartphones, has enabled a new range of technologies to access the classroom. This new range includes emerging technologies, of which immersive technologies and in particular, Augmented Reality (AR) are representative examples.

The use of a new technology should nonetheless not take precedence over the added value it is supposed to bring to learning. In this context, the integration of a new form of technology must be subordinated to one of the following two objectives: it must either guarantee greater efficiency when used to implement pedagogical activities, or it must facilitate educational activities that would not otherwise have been possible (Noben, 2022: 46-47). To this end, the "pedagogical added value"¹ (Noben, 2022: 4-48) of AR, particularly in terms of its effectiveness on learning, has been researched and documented (Punar Özçelik et al., 2022). Nevertheless, a need to "demonstrate the effectiveness of the inclusion of AR systems in teaching-learning processes" is still identified as insufficiently explored (Garzón, Pavón & Baldiris, 2019: 457).

This article will therefore consider AR, i.e., a type of immersive technology, from a psychological perspective. We will focus on the effectiveness of AR as perceived by the user in the context of language learning and teaching taking place in Luxembourg's higher education. This specific context of the University of Luxembourg, which actively promotes digitalized educational practices and has a proven past track record of language learning diverging needs (e.g., Lejot, 2015; Weber & Horner, 2012), provides an appropriate framework to explore how the students perceive AR in the classroom. To this end, our research hypotheses can be formulated as follows:

- (1) Students perceive Augmented Reality as an uncommon but effective learning tool.
- (2) Students' familiarity with other educational technologies is a key factor in their acceptance of AR.

To examine these hypotheses, we will begin by contextualising this research in the context of the Grand Duchy of Luxembourg. This contextualisation will then be extended by providing a theoretical framework, thus explaining the terms "immersive technology", "Augmented Reality" and "user perception". In the next section, we will describe the two case studies for which qualitative and quantitative data were collected primarily in the form of anonymous questionnaires. Finally, we will explore the most salient perceptions reported by the participants and contrast them in more detail, before concluding with a discussion on the challenges and opportunities offered by such new technologies for language learning and teaching in Luxembourg and elsewhere.

Literature review

In this literature review section, we will recontextualise this study in the context of Luxembourg and its University. We will then set out the theoretical framework by discussing what is meant by "immersive technologies", "Augmented Reality" and "user perception". Finally, we will reposition this study in relation to the existing

¹ Translated from French : "la plus-value pédagogique" (Noben, 2022).

literature on the subject and, more specifically, in relation to the literature gap that this study seeks to address.

Language learning and digitalisation – perspectives from Luxembourg

In 2022, Luxembourg was home to more than 170 nationalities, making 47% of the population foreign (Laurent & Doré, 2022: 3). Besides this diversity of languages and cultures stemming from these foreign populations living in the country, Luxembourg is peculiar in that its communities are *de facto* plurilingual (Garcia, 2014). This is due not only to its social history, but also to the implementation of a trilingual system. Luxembourg's three official languages, which comprise two administrative languages (French and German) and one national language (Luxembourgish), are not used on a geographical basis, but according to the topics under discussion (Garcia, 2014). A better command of French, German and Luxembourgish is therefore directly needed to move towards greater economic, social and educational integration in this plurilingual context.

In Luxembourg, the traditional education system has been built around this culture of multilingualism and hospitality (Lejot & Philippart, 2023: 96). In practice, this education system begins by instructing pupils in Luxembourgish, then in German and, finally, in French (Laurent & Doré, 2019: 31). The University of Luxembourg further develops this long-established culture, by making multilingualism an integral part of its internal regulations. Since the University's creation in 2003, French, English, German and, to a lesser extent, Luxembourgish were officially recognized as the academic teaching languages (Lejot, 2015: 50). As a result, programs offered at the university commonly require language skills in two (or more) languages (Lejot, 2015). This academic multilingualism brings with it multiple linguistic challenges and opportunities, especially since, like the country in which it is established, the University of Luxembourg welcomes a large foreign population, i.e., 54% of international students and 80% of international staff (University of Luxembourg, 2022: 3).

At all levels of the education system, these successive changes and more broadly, the different teaching languages represent a challenge for learners, who must have a sufficient proficiency in the teaching language to be able to learn, as well as for teachers, who are faced with speakers of often distinctive dominant languages. In 2022, for example, about 6 out of 10 pupils in secondary school did not speak Luxembourgish as their first language at home (MENJE, 2022: 2). In response to these classes with heterogeneous language levels, Luxembourg has, especially since the 2010s, steadily developed its “digital education policies to encourage schools and teachers to develop educational practices for a digital age (...) by providing namely new curricular objectives and new teaching tools and materials (hardware, software, and digital learning materials)” (Reuter, 2022).

It might be argued that, although increasingly widespread, IT equipment's availability is still far from perfect, highlighting the social and digital divide that may question technologies' usefulness in the classroom. In Luxembourg, however, considerable efforts have been devoted to make digital equipment widely accessible, thus empowering schools and teachers to further pursue these digital education policies (e.g., “L'équipement numérique”, 2022; Le Gouvernement Luxembourgeois, 2020; Reuter, 2022). Some examples of national initiatives and projects that are part of these policies are “EduSphere”, i.e., a “portal designed for teachers to support teaching and learning”², “Office 365 for Education” which aims to give free access to the tool to “12,000 primary and secondary school teachers, 45,000 secondary school pupils and 5,000 administrative staff”³ or “Innovative Schools”, i.e., “a project to develop the use of digital tablets in the classroom and promote the new learning strategies they enable”⁴ (MENJE, 2015).

These efforts and policies build together a global trend towards digitalisation that the sole public university of the country also abides by, as it too brings together heterogeneous plurilingual communities (Garcia, 2014; Laurent & Doré, 2022; MENJE, 2022) and seeks to “explore how we can take advantage of digital technology while

² Translated from French : « un portail pour enseignants destiné à soutenir l'enseignement et l'apprentissage » (MENJE, 2015).

³ Translated from French : « à 12.000 enseignants du fondamental et du secondaire, 45.000 élèves du secondaire et 5.000 agents administratifs » (*Ibid.*).

⁴ Translated from French : « un projet portant sur l'utilisation de tablettes numériques en classe et la promotion des nouvelles stratégies d'apprentissage qu'elles permettent » (*Ibid.*).

maintaining a critical eye, and how we can meet the needs of today's students”⁵ (Kambala, 2023). This reflection on the pedagogical value added by technologies (Noben, 2022) implies providing a definitional framework of the tools in question to explore the best ways of using them more fully.

Immersive technology and Augmented Reality

Immersive technology can be generically approached as a “technology that blurs the boundary between the physical and virtual worlds” (Suh & Prophet, 2018: 77).

This difference between perceived worlds highlights how immersive technology relies on delivered *sensory and tracking information* to bring about an immediate and interactive user *experience* (Ali, 2022: 18; Hein et al., 2021: 119; Suh & Prophet, 2018: 77). This explains why immersive technology creates, as its name suggests, a sense of *immersion*ⁱ (e.g., Ali, 2022: 13; Suh & Prophet, 201: 78-79).

If defined by objective technological factors, immersive technology can be classified by the degree of immersion it holds (Hein et al., 2021: 123). From this point of view, there is not just one immersive technology, but rather several technologies that are subsumed under the term *immersive technology* (Hein et al., 2021: 118; Suh & Prophet, 2018: 78). As a result, immersive technologyⁱⁱ can be sorted out on a reality-virtuality continuum, comprising technologies such as *Virtual Reality* (VR) or *Augmented Reality* (AR) (Suh & Prophet, 2018: 78-79).

VR and AR do not provide identical sensory and tracking information to the user. VR “creates a complete, artificial virtual environment and thus offers complete virtualization” (Hein et al., 2021: 118). On the contrary, AR punctually “allows for the superimposing of computer-generated virtual 3D objects on top of a real environment in real time” (Iqbal et al., 2022: 1).

A consequence of this fixed virtual overlay is that AR “typically [requires] something in the real world [to trigger] the virtual simulation” (Gonzalez et al., 2021: 2). These *triggers* (or *markers*) can be activated either by image recognition or by the location of the user (GPS). These types of AR are respectively categorized as *vision-based* and *location-based*. Vision-based AR can be further subdivided according to the type of image recognition technique. On the one hand, if a specific trigger like a QR code or an image is needed, AR is said to be *marker-based*. If on the other hand, the immediate environment surrounding the user triggers AR, it is referred to as *markerless* (Punar Özçelik et al., 2022: 132).

Perceived effectiveness of immersive technology

The “effectiveness of immersive learning with the use of technology” (Ali, 2022: 14), esp. of AR in education, has been widely documented (Punar Özçelik et al., 2022: 131). However, certain aspects are still reported to be left underexplored. The fact that Taiwan was the most researched environment in the studies published on AR represents a context-related gap (Punar Özçelik et al., 2022: 149), which this study, conducted in the European context of Luxembourg, could contribute to addressing. Another aspect that could benefit from wider research includes, among others, AR’s “usefulness (...) from a psychological perspective” (Chen & Wang, 2018: 705). To this end, this paper’s discussion on AR’s effectiveness will focus on the perception of the user who relies on this medium to learn.

Literature defines *learner perception* “of an AR-mediated environment (...) as the experience of learning through AR and interacting with such an environment” (Chen & Wang, 2018: 696). The degree of perception, including information transferability to real life, is influenced by four factors: “accuracy of the virtual environment, immersion, presence, and user acceptance” (Ali, 2022: 14).

In this framework, high *accuracy of the virtual environment*, i.e., the ability to imitate the real world, will positively impact both the experience and the interaction of the learner (Marcassi et al., 2002: 311; Research Center Rennes-Bretagne-Atlantique, 2012: 2).

⁵ Translated from French : « Observer comment nous pouvons tirer avantage du digital tout en gardant un regard critique, et comment répondre aux besoins des étudiants d’aujourd’hui » (Kambala, 2023).

A satisfactory learner perception induces in turn a major psychological effect, i.e., an increased learner presenceⁱⁱⁱ (Chen & Wang, 2018: 695-697). By *learner presence* is meant the “human reaction to a system of a certain level of *immersion*^{iv} and thus describes a subjective state” (Hein et al., 2021: 119).

An increased learning presence, for which the interaction experience is a good predictor, can finally be correlated with more successful learning outcomes (Chen & Wang, 2018: 705-706). Nevertheless, if the learner does not perceive any potential usefulness and ease of use with the technology (following Technology Acceptance Model), s/he will most likely have little to no intentions to use the technology, which equates to poor *user acceptance* (Cabero-Almenara et al., 2019: 2-3; Suh & Prophet, 2018: 81) of the learning experience and in turn, unsatisfactory learner perception. This attitude and intention to use a technology is moreover further influenced by external variables, such as age, experience in the use of technologies, professional level, and personal tendency towards innovation, to name but a few (Cabero-Almenara et al., 2019: 2).

Methodology

In this section, we will focus on the research design as well as the participant characteristics, data collection procedures and data analysis techniques used in this study. More particularly, we will describe two case studies that were conducted regarding AR. Their results were compiled and compared in a multiple case study to discuss the research hypotheses.

Case Study 1: Pre-service teachers as AR users and developers

The first case study was integrated in a face-to-face mandatory master programme. This lecture on language and media didactics involved 17 aspiring high school teachers of French. These 13 female and 4 male participants, 88% of whom were between 20 and 30 years old, experimented with AR, first as users and then, as developers. This AR sequence was not foreseen as an in-depth technical training, but rather as an introduction to the topic of AR in education. A lecture presenting what immersive technologies and AR are, as well as a session focusing on trial uses of vision-based marker-based and markerless AR activities were scheduled. The first case study collected aspiring teachers' perceptions via an anonymous questionnaire. Given the place assigned to digital didactics in the curriculum of these aspiring teachers (University of Luxembourg, Programme du master en éducation, langues et littératures françaises), this first case study involved a two-stage data collection process. A first anonymous online questionnaire collected the pre-service teachers' perceptions prior to any lectures or uses of the technology. The main aim of this first questionnaire was to assess whether AR had already been taught in another course. The second anonymous online questionnaire assessed the aspiring teachers' perceptions following the autonomous design of a 10min. AR activity that could be used in a real class setting.

Case study 2: Incoming and outgoing students as AR users

The second case study was carried out as part of an online multilingual (French/ German) preparatory course for international mobility (Lejot & Philippart, 2023). It involved 5 female and 2 male students aged between 20 and 30 and with an average B1/B2 level in the target language. Thematically, the AR sequence developed for this course focused on language registers, on which the students worked in small groups per target language (2 students for French and 5 for German). For this AR sequence, the language learners were presented with a problem-based assignment requiring them to use a commercial (vision-based markerless) AR application to choose furniture. After their selection, the students would advocate for the purchase of the furniture of their choice in two written productions. The argumentation was supported by a visual (i.e., a printscreen of the device used during the AR sequence) showing the full-sized furniture in AR in the accommodation of one of the students of the workgroup. Unlike the first case study, the perceptions of the participants of case study 2 were collected via a single anonymous online questionnaire at the end of the AR activity.

Tool used, question format and data analysis

All questionnaires collected data using Microsoft Forms. Questions were structured using close-ended questions and four-point Likert scales. Open-ended questions, for the most part mandatory, were systematically paired with the previously mentioned question types to gather qualitative inputs from the participants. A short follow-up discussion was then carried out in class. Quantitative data was analysed via Microsoft Excel, while qualitative data was approached thematically in the light of the research hypotheses.

Results

In this section, we will present the findings by addressing each research hypothesis independently.

Research hypothesis (1): Students perceive AR as an uncommon but effective learning tool.

The first research hypothesis we formulated questioned whether students would perceive AR as an uncommon but effective learning tool. To this end, we explored whether our participants had prior knowledge or experiences about AR. In both cases, aspiring teachers (case study 1) and language learners (case study 2) predominantly reported little to no knowledge about AR (see tables 1 and 2 below). In the second questionnaire, i.e., after the introductory session on AR in education, this rate increased from 52.94% to 87.50% for aspiring teachers to reach a percentage similar to that of language learners (85.71%).

Table 1

Case study 1: Knowledge about Augmented Reality

Answers to the close-ended question « I am familiar with AR » ⁶	Number of respondents: case study 1/ before	%	Number of respondents: case study 1/ after	%
Disagree	5	29.41	6	37.50
Somewhat disagree	4	23.53	8	50.00
Somewhat agree	7	42.18	2	12.50
Totally agree	1	5.88	0	00.00
Total	17	100.00	16	100.00

Table 2

Case study 2: Knowledge about Augmented Reality

Answers to the close-ended question « I am familiar with AR » ⁷	Number of respondents: case study 2/ before	%	Number of respondents: case study 2/ after	%
Disagree	/	/	3	42.86
Somewhat disagree	/	/	3	42.86
Somewhat agree	/	/	0	00.00
Totally agree	/	/	1	14.29
Total	/	/	7	100.00

However, this general lack of prior knowledge or experience did not work as a good predictor of the degree of perception, as both case studies resulted in very different overall degree of perception.

As shown in table 3 below, 71.43% of the language learners' group (case study 2) found AR to be beneficial or

⁶ Translated from French « Je connais bien la réalité augmentée ».

⁷ Translated from French « Je connais bien la réalité augmentée ».

somewhat beneficial for language learning. Language learners justified their degree of perception essentially from the point of view of user acceptance and presence. They reported a good degree of perceived enjoyability, given that they could interact with the AR content and directly observe the results of their actions in their own home. In addition to this personal and contextualized learning setting triggered by AR, the students also highlighted the dynamism of the exchanges with their work partners. According to them, the social presence with the workgroup led to a greater sense of collaboration between them and resulted in a more intensive use of the target language.

While the presence of team members was mentioned as a driving force, it also contributed to 57.14% of the learners in case study 2 putting more of their language repertoires into action (see table 4 below). Around a quarter of the learners in case study 2 (table 5: 28.57%) directly related this change to the integration of AR in the classroom.

Table 3

Case study 2: Perception of AR in the classroom

Answers to the close-ended question «AR is a waste of time in the classroom »⁸	Number of respondents: case study 2/ before	%	Number of respondents: case study 2/ after	%
Disagree	/	/	3	42.86
Somewhat disagree	/	/	2	28.57
Somewhat agree	/	/	2	28.57
Totally agree	/	/	0	00.00
Total	/	/	7	100.00

Table 4

Case study 2: Language repertoires used

Answers to the close-ended question « Did you only use the target language of the course during the AR activity? »⁹	Number of respondents: case study 2	%
Yes	3	42.86
No	4	57.14
Total	7	100.00

Table 5

Case study 2: AR as a multilingual tool

Answers to the close-ended question « Do you think you would have made less use of your different language skills in an activity without AR? »¹⁰	Number of respondents: case study 2	%
<i>Respondents who used only the target language of the course (see table 4)</i>	3	42.86
Yes	2	28.57
No	2	28.57
Total	7	100.00

⁸ Translated from French « L'intégration de la réalité augmentée est une perte de temps en classe ».

⁹ Translated from French « Avez-vous utilisé uniquement la langue cible du cours pendant l'activité de réalité augmentée ? ».

¹⁰ Translated from French « Pensez-vous que vous auriez moins utilisé vos différentes compétences linguistiques dans une activité sans réalité augmentée ? ».

The main difficulty that mitigated the overall degree of perception of the participants of case study 2 related to immersion. Learners with unsatisfactory perceptions generally explained their rating with technical issues. For instance, the phone battery would not last a whole session, some smartphones did not have the AR option and a slow internet connection impeded interactivity and presence in some other cases.

Despite their overall satisfactory degree of perception, it should be noted, nonetheless, that the participants in case study 2 do not yet expect language teachers to systematically integrate AR as a teaching medium.

Whereas language learners had the most positive perception of AR (71.43%), table 6 shows that only about a third of pre-service teachers (case study 1) were satisfied or somewhat satisfied with AR in the classroom at the end of the introductory session. It is also noteworthy that the ratings of aspiring teachers were about halved between the first and second questionnaires (from 58.82 % to 31.25%). The arguments raised by the participants of case study 1 to justify their degree of perception essentially related to their role as teachers.

A large majority of aspiring teachers had a poor user acceptance of AR, regardless of the fact that they have been placed in the position of user or developer. Even if they were offered a ready-to-use AR activity to carry out in the classroom, more than 9 out of 10 aspiring teachers claimed they would not feel confident in implementing the activity successfully. A similar proportion expressed the same concerns if they had to create an activity from A to Z. In comparison to other tools, they have come to master, the participants of case study 1 also correlated AR with unreliability due to the dependence on the learner's device and an off-balance ratio between preparation time and use in the classroom.

More marginally, AR has been assimilated to a game and its use as a serious teaching medium has been ruled out.

Table 6

Case study 1: Perception of AR in the classroom

Answers to the close-ended question « AR is a waste of time in the classroom »¹¹	Number of respondents: case study 1/ before	%	Number of respondents: case study 1/ after	%
Disagree	2	11.76	0	00.00
Somewhat disagree	8	47.06	5	31.25
Somewhat agree	5	29.41	9	56.25
Totally agree	2	11.76	2	12.50
Total	17	100.00	16	100.00

Research hypothesis (2): Students' familiarity with other educational technologies is a key factor in their acceptance of AR.

The second research hypothesis put forward that the students' familiarity with other educational technologies represents a facilitating factor in their acceptance of AR.

Even if AR was overall perceived as innovative and/or enjoyable, participants of both case studies found it difficult to skilfully familiarize themselves with AR. From this point of view, the educational technologies traditionally used in the Luxembourgish classroom (e.g., Moodle) did not seem to be a sufficient resource for the participants in the two case studies.

Users experienced technical difficulties in various forms. One of them related to the use of the personal smartphone. Several users expressed concerns regarding their data protection rights, which could be resolved by lending another device or using an app without registration. Other users required targeted technical help with their smartphones, as they did not know their way around the device. This issue was particularly documented among the pre-service teachers (case study 1), who repeatedly asserted that their digital skills were limited.

¹¹ Translated from French « L'intégration de la réalité augmentée est une perte de temps en classe ».

Because of the technology's novelty, the same participants also expressed doubts about the added value for language learning and teaching. Given the perceived difficulty of programming and tailoring even code-free apps and platforms for a specific teaching context, participants of case study 1 explicitly expressed their reluctance to engage with AR.

Discussion

Interpretation of results

AR's versatility has led to its early adoption and high regard, notably, in STEM education (Iqbal et al., 2022: 5-6; Lampropoulos et al., 2022: 3). As pointed out in Marín-Díaz' study (2017) however, the use of AR in education, whether STEM or else, appears uncommon, even in an educational setting in favour of digitalization like Luxembourg.

The infrequent use of AR should not be interpreted as a lack of effectiveness. From the strict point of view of the learners (case study 2), AR's use in the language classroom is widely seen favourably. This finding is consistent with previous research^v, describing AR as portable and adaptable, enjoyable, and problem-based, realistic and situated, risk-free and experiential^{vi}, autonomous and collaborative, interactive and innovative (e.g., Arneton et al., 2022: 74; Elmeziene & Lecorre, 2021: 2-3; Hein et al., 2021: 118-131; Iqbal et al., 2022: 2-23; Lampropoulos et al., 2022: 3; Punar Özçelik et al., 2022: 131-144). These features induce a result-oriented approach, which reinforces the learner's role as an actor (Iqbal et al., 2022: 22-23; Punar Özçelik et al., 2022: 133).

Yet, regardless of these advantages, the digital uses developed from other educational technologies do not seem to be transferable to the new digital uses required by AR. Among pre-service teachers (case study 1), the extra effort required to master AR is reflected in the perception that AR is an inappropriate, i.e., ineffective, teaching medium. This result can be understood in the context of a broader need for training in digital pedagogy focussing on AR, as already emphasised by Belda-Medina & Calvo-Ferrer (2022).

AR being an educational technology "that is still in its infancy", users/learners and developers/teachers could only seize limited opportunities to test and to train to set up AR activities (Belda-Medina & Calvo-Ferrer, 2022: 12124). The newness of AR consequently potentially entails a lack of digital literacy from both AR users and developers on one hand (Hein et al., 2021: 128; Punar Özçelik et al., 2022: 146) and a sensitivity to the novelty effect on the other hand (Elmeziene & Lecorre, 2021: 16; Hein et al., 2021: 128). This novelty effect may distract the learners from the task at hand, hence impairing the effectiveness usually associated with immersive technologies (e.g., Ali, 2022; Chen & Wang, 2018).

Implications

Even if the overreliance of AR on the smartphone, with consequences in terms of immersion and user experience, cannot be addressed easily (Iqbal et al., 2022: 23; Punar Özçelik et al., 2022: 134; Wu, 2022: 165), the maturation of immersive technologies should lead to the development of new, more flexible, and interactive apps and platforms, with a greater focus towards the education sector (Belda-Medina & Calvo-Ferrer, 2022: 12138; Wang, 2017 : 165).

In the meantime, as far as teaching practices are concerned, the initial approach to an educational activity involving AR should be further marked out. Prior to the in-class activity, teachers engaging with AR could find out about the hardware of the equipment available to the students in their class. As not all apps and platforms are necessarily compatible with both iOS and Android, this step would be useful to help choose the app or platform on which the AR activity could be used, if it relies on existing apps, or developed, if it is designed independently. In a second stage, during class, an introduction to AR as a technology could be provided before the actual teaching activity begins. These steps would make it possible to mitigate at least some technical difficulties, which are the main sources of dissatisfaction observed among the participants of our case studies.

Limitations of the study

The main limitation of this study resides in the small number of participants considered (total number of participants: 23/24). This limited number of participants and therefore the limited amount of data produced could call into question the generalisation of the results reported and discussed. Although the alignment with the existing literature tends to support this paper's findings, the continuation and repetition of studies evaluating the perceived effectiveness of AR in different contexts should make it possible to address this main limitation in the future.

Conclusion

Summary of key findings

The new socio-political transformations brought by globalisation are intricately intertwined with technological and informational mutations (Wu, 2022: 163). Hence, alongside globalisation, there is a global trend towards the digitalisation of society, initiating a new age known as the digital era.

This digital era is pervasive and has been affecting a growing number of sectors. Because of this digital era, the education sector has opened to the use of technologies, some of which have since become obsolete, while new ones have taken their place (Karsenti, 2004). Augmented Reality (AR) fall into the latter category. Following the rise of the smartphone, AR, which were previously the privilege of equipped laboratories, has made its way into the classroom.

Augmented Reality is deemed to be “one of the fastest-growing sectors with an impact on Education” (Belda-Medina & Calvo-Ferrer, 2022: 12124). Meanwhile, it is only “timidly (...) introduced in the educational sphere as shown by the view of the students” in certain studies (Marín-Díaz, 2017: 138). In practice, the novelty of AR is more of a disadvantage than an advantage. This novelty means that language learners and their teachers are confronted with a technology that bears very little resemblance^{vii} to those they are accustomed to using or have already mastered. Especially from the point of view of the aspiring teachers of case study 1, this lack of familiarity and the effort it takes to learn how to use the technology itself, lead to poor user acceptance with AR and therefore to a rather negative overall perception of the tool.

Although the integration of AR is therefore not always seen as straightforward, it has been widely described as an innovation that should be promoted and supported for its pedagogical advantages and its ability to "facilitate the creation of inclusive learning experiences", an obvious asset in a globalized heterogeneous classroom (Lampropoulos et al., 2022: 30).

This more positive perception of AR is most prominent among the language learners of case study 2. Unconcerned with questions of preparation and pedagogical planning, these users perceive the experimental side of AR more clearly, discover a tool “which can be claimed as magic” (Punar Özçelik et al., 2022: 131), and thus enjoy to a greater extent (even though through trial and error) the learning experience and interactivity offered by this new technology.

Recommendations for future research and final thoughts

Although the main limitation of this multiple case study is the small number of participants, it provides results that are consistent with existing research. Future work should therefore expand the sample size and share new insights regarding the perception of AR in an educational setting where digital technology is largely promoted. Determining whether AR can effectively be a key enabler of multilingual didactics is yet another axis of research.

User acceptance is a crucial challenge for future technologies, like AR (Iqbal et al., 2022: 23). Due to its influence on the degree of perception, poor user acceptance, esp. negative “psychological responses of learners to AR environments”, could successively impede the degree of presence and affect the learning outcomes (Chen & Wang, 2018: 706). Such inefficiency is surely the last scenario teachers would wish to see, as they experiment “to modify their strategies and diversify their teaching tools” in an increasingly globalized classroom (Ali, 2022: 17).

References

- Ali, S. (2022). The effectiveness of immersive technologies for future professional education. *Futurity Education*, 2(2), 13-21.
- Arneton, M., Muratet, M., Vanbrugghe, A., Geffroy, V. & Ferrand, M.-H. (2022). Proposer un jeu sérieux pour former à l'inclusion : retour d'expérience en France. *Revue internationale des technologies en pédagogie universitaire*, 19(1), 68-75.
- Béchar, J.-P. (2012). Mieux comprendre l'apprentissage expérientiel. Journée de la pédagogie 19 Avril 2012. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.hec.ca/daip/compte_rendu_evenements/journees_pedagogie/PresentationJPB.pdf. Last consulted 30.08.2023.
- Belda-Medina, J. & Calvo-Ferrer, J. R. (2022). Integrating augmented reality in language learning: pre-service teachers' digital competence and attitudes through the TPACK framework. *Education and Information Technologies*, 27(9), 12123–12146.
- Cabero-Almenara, J., Fernández-Batanero, J. M. & Barroso-Osuna, J. (2019). Adoption of Augmented Reality Technology by University Students. *Heliyon*, 5.
- Chen, Y.-H. & Wang, C.-H. (2018). Learner presence, perception, and learning achievements in augmented-reality-mediated learning environments. *Interactive Learning Environments*, 26(5), 695–708.
- Elmeziiane, A. & Lecorre, T. (2021). Micro-étude de l'impact de l'utilisation de la réalité augmentée sur la performance et les attitudes des apprenants dans le cadre d'un cours sur les techniques boursières. *Revue internationale des technologies en pédagogie universitaire*, 18(2), 1-23.
- Garcia, N. (2014). Monolinguisme politique dans une société plurilingue ? Le cas du Luxembourg. *Revue internationale de politique comparée*, 21, 17-36.
- Garzón, J., Pavón, J., & Baldiris, S. (2019). Systematic review and meta-analysis of augmented reality in educational settings. *Virtual Reality: The Journal of the Virtual Reality Society*, 23(4), 447–459. <https://doi.org/10.1007/s10055-019-00379-9>.
- Gonzalez, D. A. Z., Richards, D. & Bilgin, A. A. (2021). Making it real: A study of augmented virtuality on presence and enhanced benefits of study stress reduction sessions. *International Journal of Human-Computer Studies*, 147.
- Günther-Van Der Meij, M. & Duarte, J. (2022). There Are Many Ways to Integrate Multilingualism': All-inclusive Foreign Language Education in the Netherlands. In: Krulatz, A., Neokleous, G. & Dahl, A. (Ed.) (2022). *Theoretical and Applied Perspectives on Teaching Foreign Languages in Multilingual Settings: Pedagogical Implications*. Multilingual Matters, 82-100.
- Hein, R. M., Wienrich, C., & Latoschik, M. E. (2021). A systematic review of foreign language learning with immersive technologies (2001-2020). *AIMS Electronics and Electrical Engineering*, 5(2), 117–145.
- Iqbal, M. Z., Mangina, E., & Campbell, A. G. (2022). Current Challenges and Future Research Directions in Augmented Reality for Education. *Multimodal Technologies and Interaction*, 6(9), 75–.
- Kambala, M. (2023). *Nous devons répondre aux grandes questions actuelles*. Virgule.lu, <https://www.virgule.lu/luxembourg/nous-devons-repondre-aux-grandes-questions-actuelles/28722.html> Last consulted 30.08.2023.
- Karsenti, T. (2004). Pourquoi une revue scientifique internationale portant sur l'intégration des TIC en pédagogie universitaire? *Revue internationale des technologies en pédagogie universitaire*, 1(1), 7–8.
- Le Gouvernement Luxembourgeois (2020), https://gouvernement.lu/fr/actualites/toutes_actualites/articles/2020/02-fevrier/06-meisch-einfach-digital.html. Last consulted on 29.04.2023.
- Lampropoulos, G.; Keramopoulos, E.; Diamantaras, K. & Evangelidis, G. (2022). Augmented Reality and Gamification in Education: A Systematic Literature Review of Research, Applications, and Empirical Studies. *Applied Sciences*, 12, 6809.
- Laurent, A. & Doré, L. 2022. Nouveaux arrivants au Luxembourg : guide pratique. Mediaweb.

<https://www.guidedesimpots.lu/wp-content/uploads/2022/05/GUIDE-PRATIQUE-2022.pdf> . Last consulted on 04.09.2023

Lejot, E. (2015). Les pratiques multilingues au cœur des programmes de Master et de Bachelor à l'Université du Luxembourg. *Synergies Pays Germanophones*, (8), 49-64.

Lejot, E. & Philippart, C. (2023). La place de la culture dans les cours de préparation à la mobilité. *Synergies Pays Germanophones*, (16), 95- 118.

Lin, V., Liu, G.-Z., & Chen, N.-S. (2022). The effects of an augmented-reality ubiquitous writing application: a comparative pilot project for enhancing EFL writing instruction. *Computer Assisted Language Learning*, 35(5-6), 989–1030.

L'équipement numérique des professeurs continue en 2022 (2022). Virgule.lu. <https://www.virgule.lu/luxembourg/l-equipement-numerique-des-professeurs-continue-en-2022/42931.html>. Last consulted on 29.04.2023.

Mallahi, O. (2022). Review of Research on the Use of Information and Communication Technologies (ICTs) in ELT-related Academic Writing Classrooms. *Journal of Language and Education*, 8(2), 165–178.

Marín-Díaz, V. (2017). The Relationships Between Augmented Reality and Inclusive Education in Higher Education. *Bordón. Revista de Pedagogía*, 69 (3), 125-142.

Marcassi, M. ; La Palombara P. F. ; Nofrini, L. & Malvisit, A. (2002). Computer-aided surgery in Orthopaedics. In: Caramella, D. & Bartolozzi, C. (Eds) (2002). *3D Image Processing: Techniques and Clinical Applications*, 311-320.

Milanovic, M. (2010) L'intégration des TIC en classe de langue étrangère – pourquoi et comment ?. *Studii si Cercetari Filologice: Seria Limbi Straine Aplicata*, 9, 104–107.

Ministère de l'Education nationale, de l'Enfance et de la Jeunesse (MENJE) (2022). L'enseignement au Luxembourg en chiffres 2021-2022. <https://men.public.lu/fr/publications/statistiques-etudes/themes-transversaux/21-22-enseignement-chiffres.html> . Last consulted on 21.06.2024.

Ministère de l'Education nationale, de l'Enfance et de la Jeunesse (MENJE) (2015). Développer les compétences du 21^e siècle: Claude Meisch présente la stratégie Digital (4) Education. https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2015/05-mai/20-meisch-digital.html. Last consulted on 21.06.2024.

Noben, N. (2022). Les plus-values pédagogiques liées à l'intégration du numérique : les représentations d'étudiants du master en sciences de l'éducation de l'Université de Liège. *Revue internationale des technologies en pédagogie universitaire*, 19(3), 44-59. <https://doi.org/10.18162/ritpu-2022-v19n3-03>.

Punar Özçelik, N., Eksi, G. & Baturay, M. H. (2022). Augmented Reality (AR) in Language Learning: A Principled Review of 2017-2021. *Participatory Educational Research*, 9(4), 131-152.

Research Center Rennes-Bretagne-Atlantique (2012). Team Vr4i Virtual Reality for Improved Innovative Immersive Interaction in Collaboration With: Institut De Recherche En Informatique Et Systèmes Aléatoires (irisa). <chrome-extension://efaidnbmnnnibpcajpcgiclfefindmkaj/https://radar.inria.fr/rapportsactivite/RA2012/vr4i/vr4i.pdf>. Last consulted on 31.08.2023.

Reuter, R. (2021). Teaching in the digital and social media age. In: Research Luxembourg, <https://www.researchluxembourg.org/en/teaching-in-the-digital-and-social-media-age/>. Last consulted on 21.06.2024.

Reuter, R. (2022). Preparing future teachers to strategically integrate digital media and technologies into their teaching practices: An insight into higher education practices at the University of Luxembourg. *Education Technology Insights Europe*, <http://hdl.handle.net/10993/53936>.

Sandberg, G. (2022). The use of digital technology for differentiation of teaching in early school years. *Nordic Journal of Literacy Research*, 8(1), 172-188.

Suh, A. & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in Human Behavior*, 86, 77-90.

University of Luxembourg (2022). Welcome new PhDs.

University of Luxembourg. Programme du master en éducation, langues et littératures françaises.

<https://www.uni.lu/fhse-en/study-programs/master-en-enseignement-secondaire-langue-et-litterature-francaise/programme/> Last consulted on 01.09.2023.

Kambala, M. (2023). « Nous devons répondre aux grandes questions actuelles ». *Virgule* : <https://www.virgule.lu/luxembourg/nous-devons-repondre-aux-grandes-questions-actuelles/28722.html>.

Last consulted on 21.06.2024.

Wang, Y.-H. (2017). Exploring the effectiveness of integrating augmented reality-based materials to support writing activities. *Computers and Education*, 113, 162–176.

Weber, J. J. & Horner, K. (2012). *Introducing multilingualism: a social approach*. Routledge.

Wu, J. G. (2022). Emerging Technologies and Research Designs in Technology-Enhanced Language Learning: An Interview with Mark Pegrum. *International Journal of TESOL Studies*, 4(3), 162–.

Endnotes

ⁱ Please note that “while in the field of [Human-Computer Interaction], clear definitions of immersion and presence exist, including theories, measures, and a large corpus of empirical results. In the field of education, immersive technologies are used without such a clear definition and theoretical base.” (Hein et al., 2021: 125).

ⁱⁱ Immersive technologies are also referred to as *eXtended Reality* (XR) (Hein et al., 2021: 118).

ⁱⁱⁱ In AR, by contrast to VR, just being connected to the activity does not guarantee learner presence. Chen & Wang (2018: 698) identify three types of presence: physical, social, and temporal.

^{iv} Immersion and presence are described as “so-called hygiene factors” (e.g., Hein et al., 2021: 119).

^v Although it is debated (Marín-Díaz, 2017), AR technology is also characterized as inclusive (Lampropoulos et al., 2022: 3).

^{vi} An experiential mode of learning is defined as a “a learning model that advocates participating in activities in contexts that are as close as possible to the knowledge to be acquired, the skills to be developed and the attitudes to be formed or changed (Legendre, 2007).” (Béchar, 2012) (Translated from French: “L’apprentissage expérientiel est un modèle d’apprentissage préconisant la participation à des activités se situant dans des contextes les plus rapprochés possibles des connaissances à acquérir, des habiletés à développer et des attitudes à former ou à changer (Legendre, 2007). »)

^{vii} Most users generally already know how to scan QR codes (in the case of a vision-based marker-based AR activity).