

2 **Mobile Augmented Reality**  
 3 **(MAR) in Technology-**  
 4 **Enhanced Language Learning:**  
 5 **Theoretical Underpinnings,**  
 6 **Affordances, and Future**  
 7 **Directions**

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12 **Abstract**

13 This entry provides a systematic review of  
 14 Mobile Augmented Reality (MAR) in lan-  
 15 guage education. It begins by conceptualising  
 16 MAR and outlining its key features: authentic-  
 17 ity, interactivity, immersion, engagement, and  
 18 convenience. The entry then establishes the  
 19 theoretical alignment of MAR with construc-  
 20 tivism, sociocultural theory, and connectivism,  
 21 explaining how it facilitates situated, social,  
 22 and networked language learning. Subse-  
 23 quently, the entry synthesises empirical evi-  
 24 dence on MAR’s affordances, including  
 25 personalised and inclusive learning, enhanced  
 26 motivation, improved language proficiency,  
 27 and teacher professional development. Finally,  
 28 it highlights challenges and proposes future  
 29 directions for stakeholders, emphasising the  
 30 need for updated teacher education, collabora-  
 31 tive content creation, accessible technological

tools, and the cultivation of MAR literacy to 32  
 ensure the ethical and effective integration 33  
 of MAR. 34

**Keywords**

Mobile Augmented Reality (MAR) · 35  
 Conceptualisation · Features · Theories · 36  
 Affordances · Future directions 37  
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**Conceptualisation and Key Features of 39**  
**MAR 40**

Augmented Reality (AR), which seamlessly sup- 41  
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60 configurations, thereby enabling them to access  
61 relevant information, address queries, and collab-  
62 orate with others. MAR transforms the world into  
63 a user interface (Höllner & Feiner, 2004), mean-  
64 ing that everyday objects and locations can  
65 become interactive points for accessing  
66 language-related information, media, or commu-  
67 nication tools.

68 As with any educational tool, the effectiveness  
69 of MAR in language learning depends on its strate-  
70 gic implementation in a comprehensive learning  
71 program. However, their unique features offer  
72 promising opportunities to enhance language  
73 acquisition and foster an immersive, engaging  
74 learning environment. The key features of MAR  
75 are as follows:

- 76 • **Authenticity:** MAR empowers language  
77 learners to “experience” the language in their  
78 real-world context through digital overlays on  
79 real-world objects (Godwin-Jones, 2016).
- 80 • **Interactivity:** MAR creates interactive envi-  
81 ronments where learners can engage with vir-  
82 tual characters who speak the target language,  
83 providing a safe space to practice without fear  
84 of public mistakes. MAR can also facilitate  
85 social interactions with other learners or native  
86 speakers through virtual meetups, language-  
87 exchange sessions, and collaborative tasks.
- 88 • **Immersion:** MAR can transport learners to  
89 diverse global settings, allowing them to expe-  
90 rience cultural contexts relevant to the lan-  
91 guage in which they are learning (Verhulst  
92 et al., 2021).
- 93 • **Engagement:** MAR can enhance learners’  
94 cognitive, behavioural, and affective engage-  
95 ment in language learning, thereby boosting  
96 motivation and making the learning process  
97 enjoyable (Parmaxi & Demetriou, 2020).
- 98 • **Convenience:** MAR mobility on devices  
99 enables learners to access language-learning  
100 experiences seamlessly, anywhere, and at any  
101 time. This flexibility enables impromptu learn-  
102 ing opportunities that extend the limited class-  
103 room learning time and reinforce language  
104 competencies (Liu & Tsai, 2013).

## 105 **Theories and Frameworks Related to** 106 **MAR in Language Education**

### 107 **Constructivism**

108 Constructivism posits that learners actively con-  
109 struct their understanding based on prior knowl-  
110 edge and experience (Piaget, 1973). This  
111 approach recognises each learner’s unique back-  
112 ground and promotes deep engagement in mean-  
113 ingful educational activities (Dewey, 1916).  
114 Many well-recognised teaching principles, such  
115 as discovery, hands-on experience, and problem-  
116 solving, are based on constructivist perspectives  
117 (Zhang et al., 2020).

118 MAR exemplifies a technology aligned with  
119 constructivist principles, as it enables learners to  
120 actively construct knowledge through immersive  
121 and interactive experiences (Liu & Tsai, 2013;  
122 Zhang et al., 2020). Specifically, MAR facilitates  
123 situated learning by overlaying digital informa-  
124 tion onto the physical environment, thereby  
125 anchoring vocabulary, grammar, and communica-  
126 tive practices to authentic contexts (Lave &  
127 Wenger, 1991). In these situated scenarios,  
128 learners apply prior knowledge to complete mean-  
129 ingful tasks, demonstrating understanding and  
130 reinforcing contextually grounded language  
131 acquisition.

### 132 **Sociocultural Theory**

133 Sociocultural Theory (SCT) posits that learning is  
134 fundamentally a social and culturally mediated  
135 process (Vygotsky, 1978). It emphasises that cog-  
136 nitive development occurs through interaction  
137 with more knowledgeable others and is facilitated  
138 by cultural tools, which is a concept known as  
139 mediation (Lantolf et al., 2015). A key related  
140 construct is the Zone of Proximal Development  
141 (ZPD), which refers to the gap between what a  
142 learner can do independently and what they can  
143 achieve with guidance or collaboration, often  
144 through scaffolding (Vygotsky, 1978).

145 MAR aligns closely with SCT principles by  
146 functioning as a dynamic mediating tool. It  
147 extends learning beyond the classroom, enabling  
148 collaborative and contextually rich interactions  
149 (Zhang et al., 2020). For instance, place-based

150 AR activities often require teamwork, directly  
151 fostering the social interaction central to SCT.

152 More specifically, MAR can provide  
153 scaffolded support within a learner's ZPD.  
154 Through features such as contextual AR annota-  
155 tions or virtual conversational prompts, MAR  
156 offers just-in-time assistance during real-world  
157 language tasks. This allows learners to engage in  
158 complex interactions that would be beyond their  
159 independent ability, thereby mediating their pro-  
160 gress through the ZPD. In this way, MAR  
161 operationalises SCT by embedding social and  
162 tool-mediated support into the fabric of the lan-  
163 guage learning environment.

### 164 **Connectivism**

165 In the digital era, connectivism has been proposed  
166 as a constructivist approach. Connectivism  
167 emphasises the role of technology in creating  
168 new learning opportunities, allowing learners to  
169 access, acquire, and apply knowledge, which pro-  
170 motes interactive and collaborative learning  
171 within networked contexts (Siemens, 2005). The  
172 emphasis lies on navigating networks and making  
173 connections, which is considered more important  
174 than the mere possession of information  
175 (Siemens, 2005). MAR, underpinned by  
176 connectivism theory, extends learning beyond tra-  
177 ditional limitations by offering instant access to  
178 educational resources and immersing learners in  
179 both physical and virtual environments (Zhang  
180 et al., 2020). Specifically, MAR fosters networked  
181 learning by connecting learners not only to digital  
182 content but also to peers, native speakers, and  
183 online communities through shared AR experi-  
184 ences. For instance, location-based MAR activi-  
185 ties can link learners studying the same language  
186 in different parts of the world, enabling cross-  
187 cultural exchanges and collaborative problem-  
188 solving. This constant connectivity supports life-  
189 long and lifewide language learning, aligning  
190 with connectivism's vision of learning as a con-  
191 tinuous, networked process.

### **Affordances of MAR in Language Education**

MAR has been increasingly applied in language 194  
education, with research highlighting its potential 195  
across several key themes. Empirical studies dem- 196  
onstrate that MAR supports personalised learning, 197  
enhances learner motivation, improves language 198  
proficiency, and shapes teacher perceptions, while 199  
also revealing practical challenges. Below is a 200  
synthesised overview of these themes, illustrated 201  
with representative studies. 202

### **Personalised and Inclusive Learning**

MAR allows for adaptable learning experiences 204  
that cater to diverse learner needs. For instance, El 205  
Shemy (2022) demonstrated that MAR can pro- 206  
vide tailored, interactive experiences for learners 207  
with autism spectrum disorder (ASD), thereby 208  
facilitating engagement through multimodal con- 209  
tent. Similarly, Wei et al. (2020) designed an 210  
MAR environment with virtual avatars that pro- 211  
vide real-time feedback and adaptive guidance, 212  
underscoring the role of interface design in 213  
personalisation. Beyond special education, MAR 214  
supports differentiated instruction by allowing 215  
teachers to customise content based on profi- 216  
ciency levels, learning styles, or interests. For 217  
example, MAR apps can adjust task difficulty, 218  
provide multimodal glosses (text, audio, and 219  
visual), or offer choice-based learning pathways, 220  
thereby addressing individual learner variability 221  
more effectively than one-size-fits-all materials 222  
(Yeh & Tseng, 2020). 223

### **Motivation and Engagement**

Research consistently indicates that MAR 224  
enhances learner motivation through immersive, 225  
context-rich experiences. Liao et al. (2023) com- 226  
pared elementary school learners in urban and 227  
rural Taiwan using a marker-based MAR app for 228  
vocabulary practice. Both groups showed signifi- 229  
cant gains in motivation and language outcomes, 230  
with notably more substantial benefits for rural 231  
learners, highlighting MAR's potential to mitigate 232  
educational disparities. MAR enhances engage- 233  
ment through gamification elements such as 234  
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236 points, badges, and interactive storytelling (Tan &  
237 Ng, 2024). These elements tap into intrinsic moti-  
238 vation by making language learning playful and  
239 goal-oriented. Furthermore, the novelty effect of  
240 MAR can sustain curiosity and reduce language  
241 anxiety, particularly among younger or less confi-  
242 dent learners (Cai et al., 2022).

### 243 **Language Proficiency and Skill Development**

244 MAR supports various language skills, including  
245 vocabulary, reading, and speaking. Bursali and  
246 Yilmaz (2019) found that fifth graders using  
247 MAR for reading comprehension outperformed  
248 peers in traditional settings. MAR also fosters  
249 pragmatic and intercultural competence by simu-  
250 lating real-world communicative contexts  
251 (Morady Moghaddam, 2025). For instance,  
252 MAR role-play scenarios can prepare learners  
253 for specific situations like ordering food, attend-  
254 ing interviews, or participating in cultural rituals,  
255 thereby bridging the gap between classroom  
256 instruction and real-life language use. Addition-  
257 ally, MAR supports multimodal literacy by com-  
258 bining text, image, sound, and movement,  
259 encouraging learners to interpret and produce  
260 meaning across different semiotic systems (Yeh  
261 & Tseng, 2020).

### 262 **Teacher Perceptions and Professional 263 Readiness**

264 The successful integration of MAR depends  
265 largely on teacher preparedness. Belda-Medina  
266 and Calvo-Ferrer (2022) examined preservice  
267 teachers in Spain and found that structured MAR  
268 training enhanced their confidence, engagement,  
269 and pedagogical innovation. However, without  
270 adequate training, teachers may resist adoption,  
271 underscoring the need for holistic professional  
272 development that integrates technological, peda-  
273 gogical, and content knowledge. Training pro-  
274 grams should not only focus on technical skills  
275 but also on developing teachers' capacity to  
276 design MAR-enhanced tasks aligned with curricu-  
277 lar goals. Communities of practice and peer  
278 mentoring can further support teachers in sharing  
279 successful MAR implementations and collabora-  
280 tively trouble-shooting challenges (Dille &  
281 Røkenes, 2021).

In summary, MAR offers meaningful 282  
affordances for language education but requires 283  
thoughtful implementation, ongoing teacher sup- 284  
port, and equitable access to realise its full 285  
potential. 286

### 287 **Future Directions**

This section concludes by outlining four future 288  
directions for different stakeholders. 289

#### 290 **Teacher Educators: Update of Teacher 291 Education**

292 Teacher education is a prerequisite for effective  
293 and large-scale application of MAR in language  
294 education (Lee & Wu, 2024). Without knowledge  
295 or experience of utilising MAR for educational  
296 purposes, teachers tend to harbour negative, resis-  
297 tant attitudes, thereby limiting their use of MAR  
298 within and beyond the classroom. Consequently,  
299 there is a growing recognition of the need to  
300 update teacher training programs for both pre-  
301 service and in-service teachers (Belda-Medina &  
302 Calvo-Ferrer, 2022). When instructing teachers,  
303 the integration of awareness, knowledge, and ped-  
304 agogical strategies for MAR is encouraged to  
305 enhance teachers' expertise and agency in design-  
306 ing new technologies by selecting, creating, and  
307 evaluating appropriate learning activities for their  
308 students (Lee & Wu, 2024).

#### 309 **Teachers and Learners: Collaborative Creation 310 of MAR Content for Educational Purposes**

311 A persistent barrier encountered by teachers and  
312 learners when applying MAR to teaching and  
313 learning is the need for suitable learning materials  
314 that are compatible with commercial MAR soft-  
315 ware (Marshall, 2023). This deficiency stems  
316 from the lack of communication between educa-  
317 tional users and technology companies.  
318 Addressing this issue can be approached in two  
319 ways: (1) Teachers can use MAR platforms to  
320 self-develop learning content and activities with  
321 learners through specialised applications. How-  
322 ever, platforms such as Unity typically require a  
323 certain level of programming knowledge, posing  
324 significant challenges for language instructors;

325 (2) actively fostering dialogue among learners,  
 326 teachers, and technology companies is essential.  
 327 This entails negotiating learning content among  
 328 the three parties and involving students and  
 329 teachers in developing MAR resources for lan-  
 330 guage education (Zhang et al., 2020).

331 **Technology Professionals: Readiness for the**  
 332 **Emerging MAR Landscape**

333 The continued evolution of MAR in language  
 334 education depends significantly on advancements  
 335 in the underlying technology. Future development  
 336 efforts should focus on enhancing the sustainabil-  
 337 ity, accessibility, and pedagogical intelligence of  
 338 MAR tools to ensure their long-term viability in  
 339 diverse educational contexts. A key area for pro-  
 340 gress is the integration of virtual reality (VR),  
 341 mixed reality (MR), and artificial intelligence  
 342 (AI) with MAR to create more adaptive and  
 343 responsive learning environments (Mystakidis,  
 344 2022; Wu et al., 2024).

345 Nevertheless, there is a need to make MAR  
 346 development tools more accessible to educators.  
 347 While powerful platforms exist, they often require  
 348 significant programming expertise, which  
 349 remains a barrier for most language teachers  
 350 (Marshall, 2023). The creation of more intuitive,  
 351 low-code, or no-code authoring tools specifically  
 352 designed for educational content is a crucial step  
 353 towards empowering teachers to become  
 354 co-creators.

355 Finally, technological development must be  
 356 guided by a strong ethical and pedagogical frame-  
 357 work. This involves ensuring data privacy,  
 358 designing for digital well-being to prevent cogni-  
 359 tive overload, and prioritising cost-effective,  
 360 energy-efficient solutions to promote equitable  
 361 access across socio-economic and geographical  
 362 settings (Reinders et al., 2015; Yang et al., 2024).

363 **All Stakeholders: Addressing Practical**  
 364 **Challenges and Fostering MAR Literacy**

365 As noted earlier, MAR implementation faces sig-  
 366 nificant obstacles, including limited technological  
 367 access, potential distractions, digital divides,  
 368 device compatibility issues, and time demands  
 369 on teachers (Reinders et al., 2015; Annamalai  
 370 et al., 2023). Moving forward, it is crucial for all

stakeholders, including educators, learners, devel- 371  
 372 opers, and policymakers, to address these practi-  
 373 cal challenges collaboratively. This includes  
 374 designing MAR activities that are pedagogically  
 375 sound to avoid cognitive overload, ensuring equi-  
 376 table access to devices and connectivity, and inte-  
 377 grating MAR seamlessly into existing curricula.

378 Moreover, as MAR technologies become more  
 379 widespread, there is a growing need to cultivate  
 380 MAR literacy among both teachers and learners.  
 381 MAR literacy encompasses not only the technical  
 382 skills to interact with AR interfaces but also the  
 383 critical ability to interpret digital information  
 384 embedded in physical contexts, as well as an  
 385 awareness of ethical issues such as data privacy  
 386 and digital well-being. Future efforts should  
 387 therefore incorporate MAR literacy training into  
 388 teacher education programs and student learning  
 389 objectives, ensuring that users are equipped to  
 390 navigate and co-create responsibly and effectively  
 391 within augmented environments.

392 **Cross-References**

- ▶ [Extended Reality](#) 393
- ▶ [Immersive Literacy](#) 394
- ▶ [MALL in the Age of AI](#) 395
- ▶ [Mobile Augmented Reality \(AR\) for Language Learning](#) 396
- ▶ [Mobile-Assisted Language Learning \(MALL\)](#) 398
- ▶ [Virtual Reality-Assisted Language Learning \(VRALL\)](#) 399

401 **Competing Interest Declaration** The author(s) has no  
 402 competing interests to declare that are relevant to the con-  
 403 tent of this manuscript.

404 **References**

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Uncorrected Proof