Interaction Design in Mobile Augmented Reality for Education: Insights from a Systematic Review

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Motivation

01 Growth of Mobile Augmented Reality (MAR) in education

02 Need to understand interaction design for diverse learners

03 Few studies link input modalities and learning contexts

Research Questions

RQ1: Tracking mechanisms & input modalities

RQ2: Relation of input modalities to spatial scope & coupling

RQ3: Common user tasks & content delivery strategies

RQ4: Variations across age groups & subjects

RQ5: Correlations between age groups & input modalities

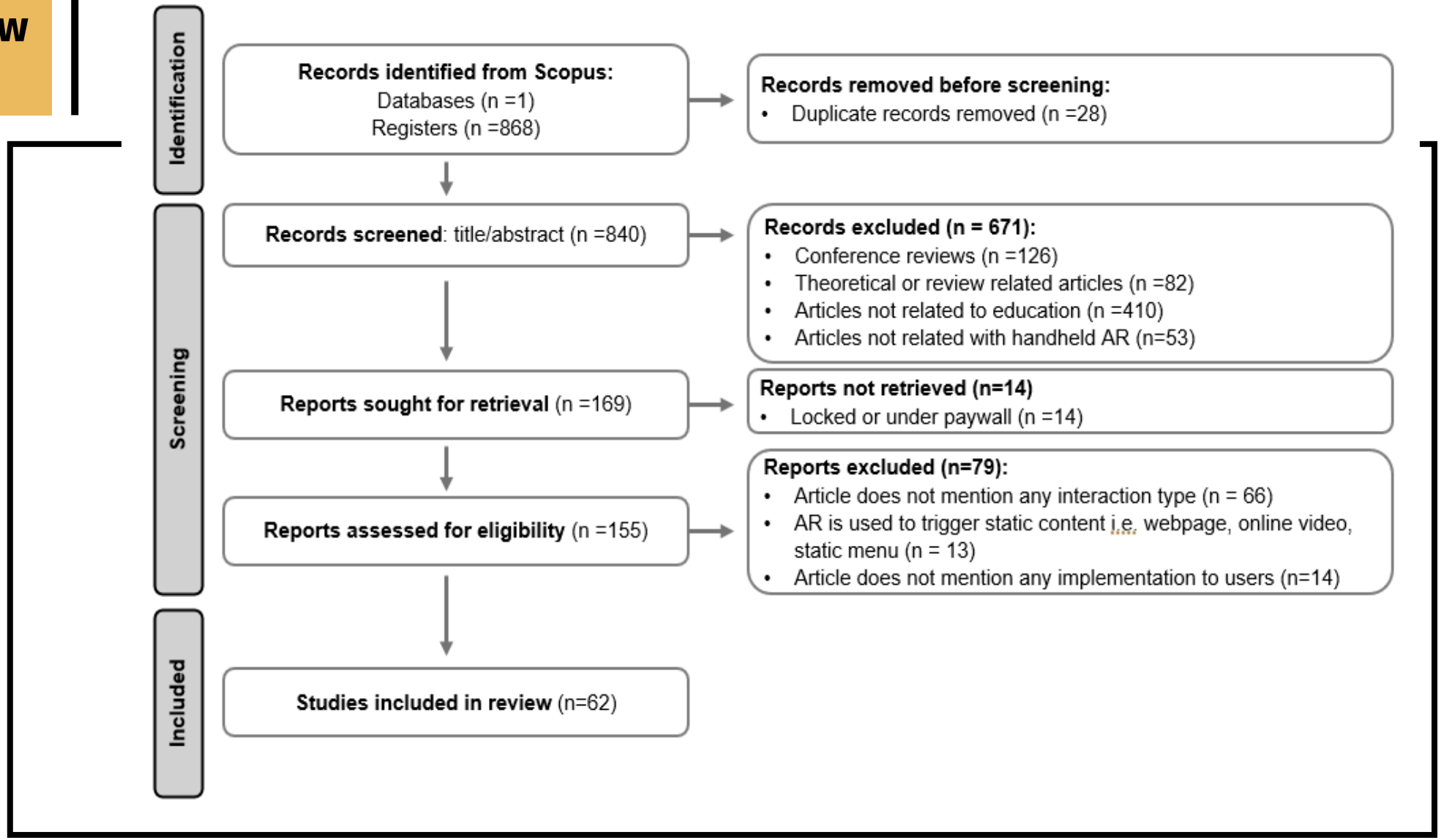
Methodology

PRISMA framework

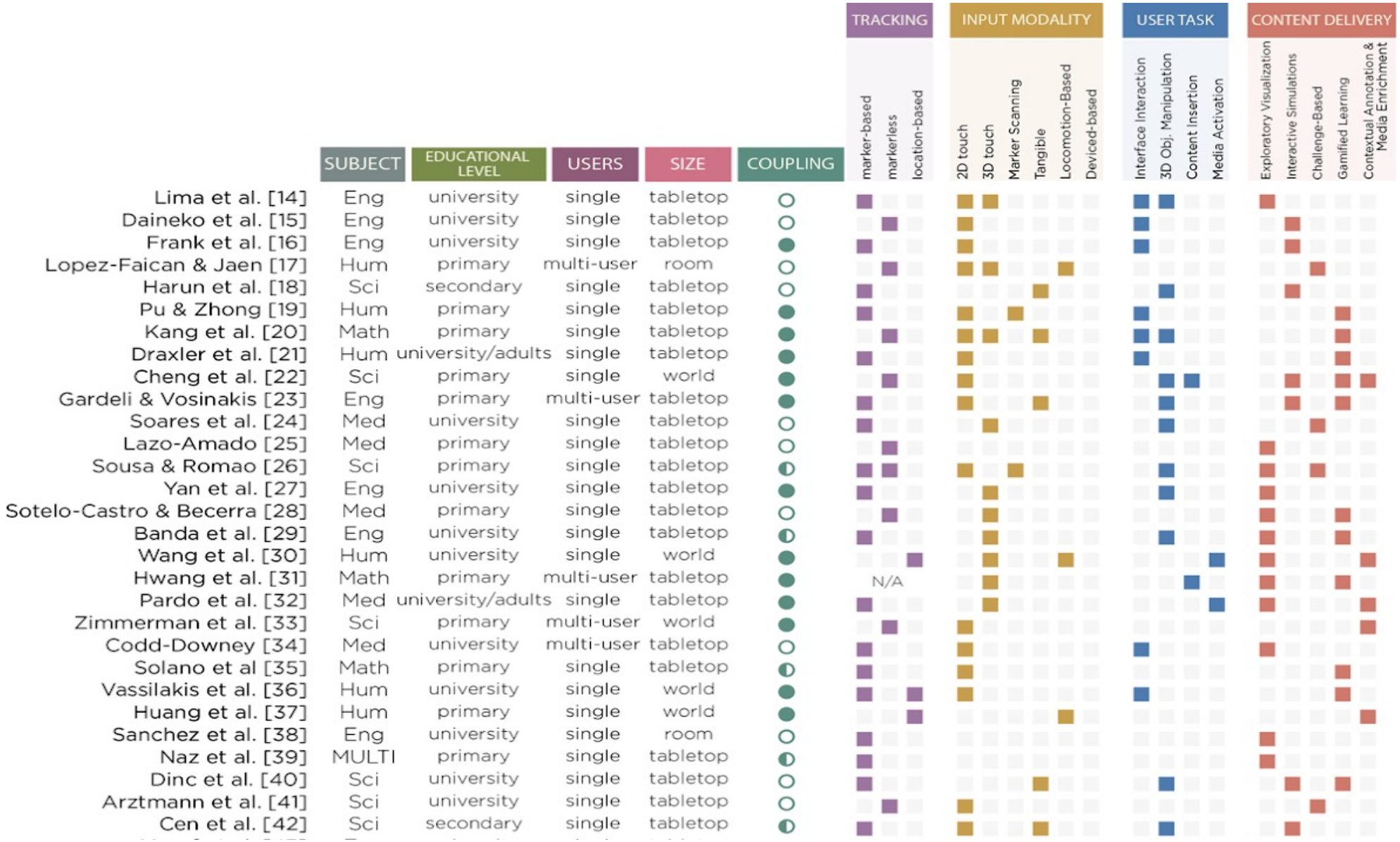
Search: Scopus with Boolean query
Inclusion/exclusion criteria, inter-coder agreement κ=0.98

Final sample: 62 studies

Systematic literature review flow chart

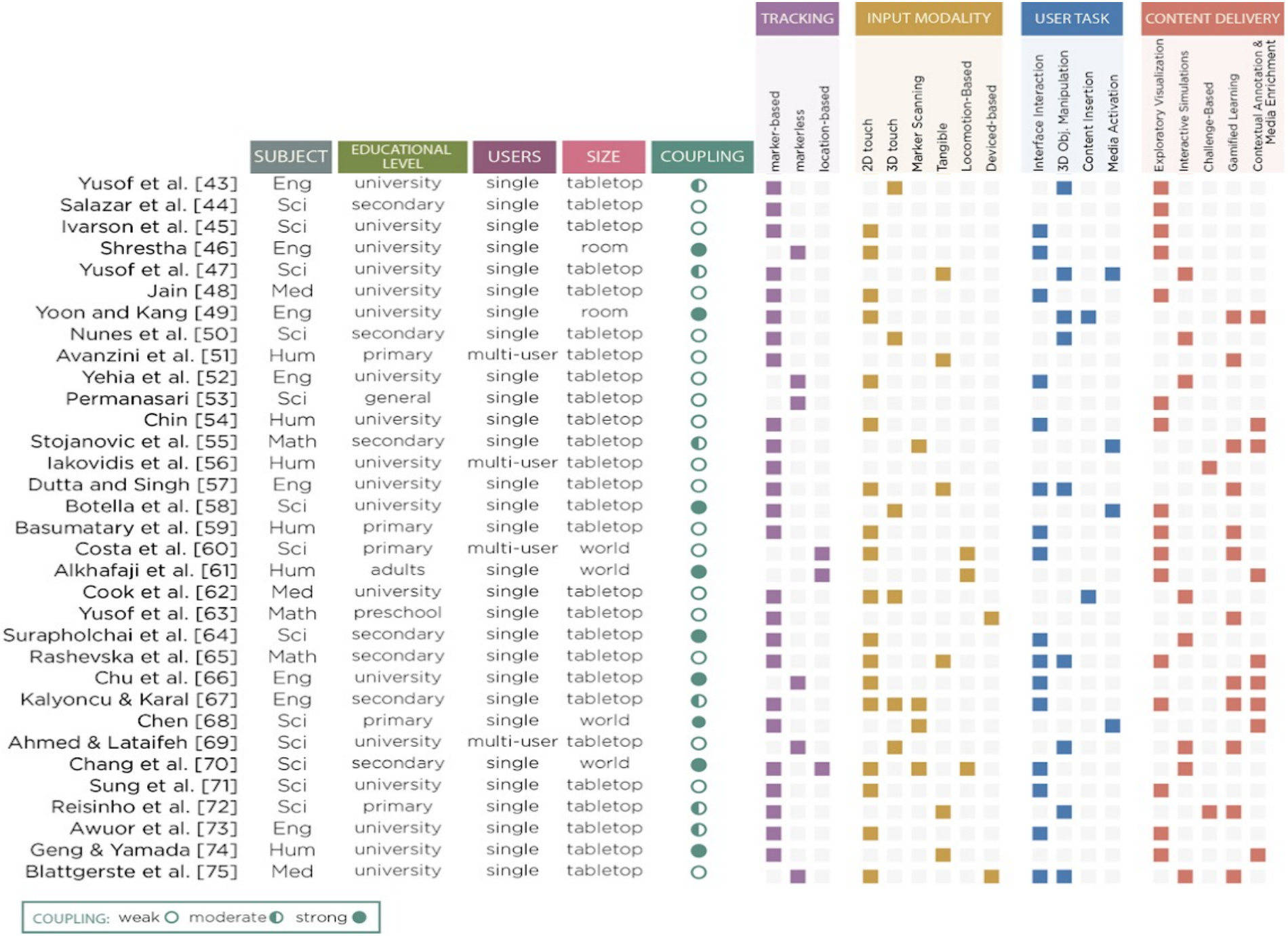


Papers & Dimensions



	SUBJECT	EDUCATIONAL LEVEL	USERS	SIZE	COUPLING
Lima et al. [14]	Eng	university	single	tabletop	○
Daineko et al. [15]	Eng	university	single	tabletop	○
Frank et al. [16]	Eng	university	single	tabletop	●
Lopez-Faican & Jaen [17]	Hum	primary	multi-user	room	○
Harun et al. [18]	Sci	secondary	single	tabletop	○
Pu & Zhong [19]	Hum	primary	single	tabletop	●
Kang et al. [20]	Math	primary	single	tabletop	●
Draxler et al. [21]	Hum	university/adults	single	tabletop	●
Cheng et al. [22]	Sci	primary	single	world	●
Gardeli & Vosinakis [23]	Eng	primary	multi-user	tabletop	●
Soares et al. [24]	Med	university	single	tabletop	○
Lazo-Amado [25]	Med	primary	single	tabletop	○
Sousa & Romao [26]	Sci	primary	single	tabletop	◐
Yan et al. [27]	Eng	university	single	tabletop	●
Sotelo-Castro & Becerra [28]	Med	primary	single	tabletop	○
Banda et al. [29]	Eng	university	single	tabletop	◐
Wang et al. [30]	Hum	university	single	world	●
Hwang et al. [31]	Math	primary	multi-user	tabletop	●
Pardo et al. [32]	Med	university/adults	single	tabletop	●
Zimmerman et al. [33]	Sci	primary	multi-user	world	●
Codd-Downey [34]	Med	university	multi-user	tabletop	○
Solano et al [35]	Math	primary	single	tabletop	◐
Vassilakis et al. [36]	Hum	university	single	world	●
Huang et al. [37]	Hum	primary	single	world	●
Sanchez et al. [38]	Eng	university	single	room	○
Naz et al. [39]	MULTI	primary	single	tabletop	◐
Dinc et al. [40]	Sci	university	single	tabletop	○
Arztmann et al. [41]	Sci	university	single	tabletop	○
Cen et al. [42]	Sci	secondary	single	tabletop	◐

Papers & Dimensions

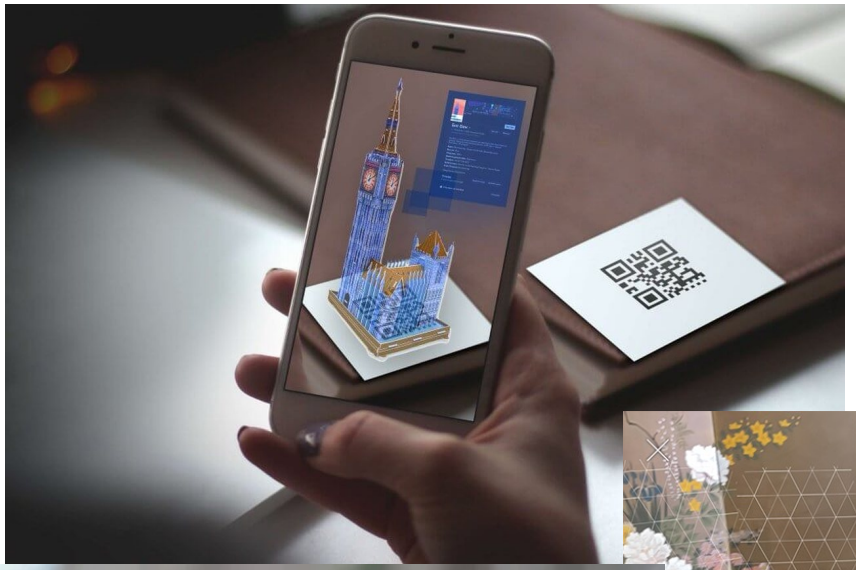


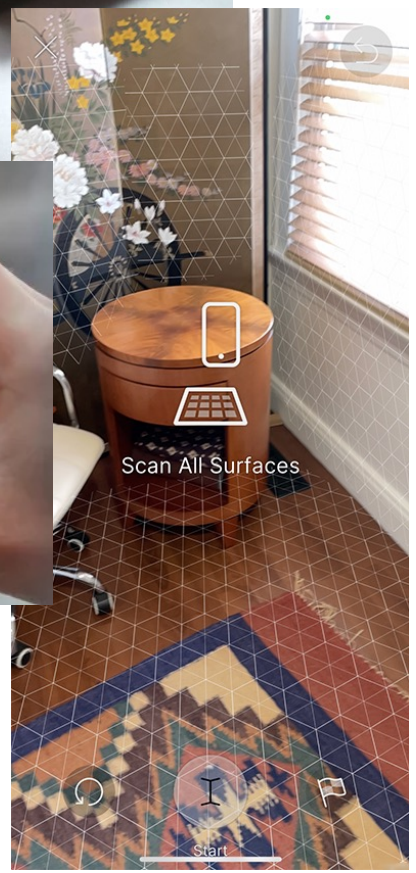
	SUBJECT	EDUCATIONAL LEVEL	USERS	SIZE	COUPLING
Yusof et al. [43]	Eng	university	single	tabletop	moderate
Salazar et al. [44]	Sci	secondary	single	tabletop	weak
Ivarson et al. [45]	Sci	university	single	tabletop	weak
Shrestha [46]	Eng	university	single	room	strong
Yusof et al. [47]	Sci	university	single	tabletop	moderate
Jain [48]	Med	university	single	tabletop	weak
Yoon and Kang [49]	Eng	university	single	room	strong
Nunes et al. [50]	Sci	secondary	single	tabletop	weak
Avanzini et al. [51]	Hum	primary	multi-user	tabletop	weak
Yehia et al. [52]	Eng	university	single	tabletop	weak
Permanasari [53]	Sci	general	single	tabletop	weak
Chin [54]	Hum	university	single	tabletop	weak
Stojanovic et al. [55]	Math	secondary	single	tabletop	moderate
Iakovidis et al. [56]	Hum	university	multi-user	tabletop	weak
Dutta and Singh [57]	Eng	university	single	tabletop	weak
Botella et al. [58]	Sci	university	single	tabletop	strong
Basumatary et al. [59]	Hum	primary	single	tabletop	weak
Costa et al. [60]	Sci	primary	multi-user	world	weak
Alkhafaji et al. [61]	Hum	adults	single	world	strong
Cook et al. [62]	Med	university	single	tabletop	weak
Yusof et al. [63]	Math	preschool	single	tabletop	weak
Surapholchai et al. [64]	Sci	secondary	single	tabletop	strong
Rashevska et al. [65]	Math	secondary	single	tabletop	weak
Chu et al. [66]	Eng	university	single	tabletop	strong
Kalyoncu & Karal [67]	Eng	secondary	single	tabletop	moderate
Chen [68]	Sci	primary	single	world	strong
Ahmed & Lataifeh [69]	Sci	university	multi-user	tabletop	weak
Chang et al. [70]	Sci	secondary	single	world	strong
Sung et al. [71]	Sci	university	single	tabletop	weak
Reisinho et al. [72]	Sci	primary	single	tabletop	moderate
Awuor et al. [73]	Eng	university	single	tabletop	moderate
Geng & Yamada [74]	Hum	university	single	tabletop	strong
Blattgerste et al. [75]	Med	university	single	tabletop	weak

RQ1

Tracking Mechanisms

- Marker-based (43 apps)
- Plane-based (9)
- Feature-based (5)
- Location-based (6)
- 1 app no tracking info

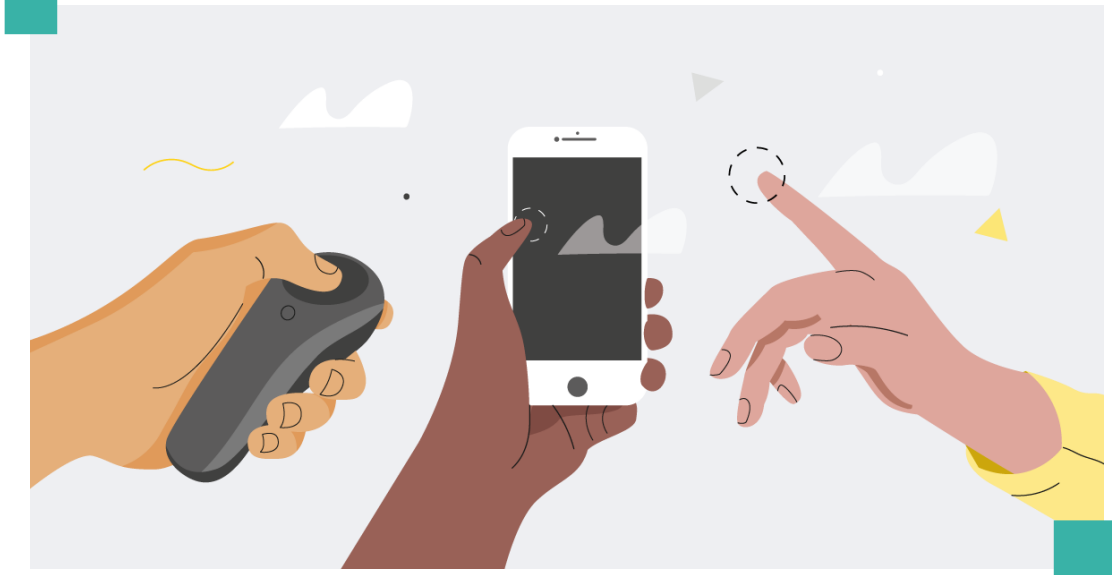




RQ1

Input Modalities

- 2D touch (32)
- 3D spatial (16)
- Tangible input (11)
- Marker scanning (6)
- Locomotion-based (6)
- Device-based (2)



RQ2

Spatial Scope & Coupling

- Tabletop (49)
- Room-sized (4)
- World-sized (9)

- Weak coupling (29)
- Moderate (11)
- Strong (22)

Patterns: Touch in tabletop, locomotion in world-sized, tangible in room/strong coupling

RQ3

User Tasks & Delivery

Interface interaction (24)
3D object manipulation (20)
Content insertion (4)
Media activation (6)

Delivery approaches: Exploratory Visualization, Challenge-based, Interactive Simulation, Gamified, Contextual Annotation

RQ4 Variation Across Age & Subjects

Target: preschool (1), primary (19), secondary (10), university (31), adults/public (4)

Subjects: Science (20), Engineering (15), Humanities (12), Medicine (8), Math (6) Tangible/spatial in STEM & medical; Touch in primary; Location/contextual in heritage/environment

RQ5

Correlations Between Age & Input

Younger learners: simple UI, low cognitive load

Secondary: UI + annotation/contextual

University: 3D manipulation, multimodal, tangible

Special education: minimal-touch

Key Insights

01 Marker-based tracking dominates but limits mobility

02 Tangible input intuitive but can cause fatigue

03 Tabletop setups common but underuse AR’s full potential

04 Strong coupling demands embodied interaction
Age, subject, and context shape interface design

Recommendations

Align input modality with learners' abilities & spatial context

Address cognitive load and usability systematically

Explore fixed-device or hands-free configurations

Integrate learning theory and measure outcomes longitudinally

Limitations

Few long-term studies

Limited cross-cultural and accessibility analyses

Cognitive load rarely assessed

Conclusions

MAR offers interactive visualization & context-based learning

Interaction design must be age- and context-sensitive

Future research: inclusivity, usability, and learning impact

Thank you

Q&A