

AR Coding Manual

INFORMATION CODES	EXPLANATION
-Title	Record the full title of the study
-Authors	Record the authors' names
-Year	Record the year the study is published
-Source	Record the source of the study
-Research Type	
<i>T: Theoretical</i>	T: Focuses on theoretical perspectives and construction of theory
<i>E: Empirical</i>	E: Empirical study including types specified in the next code, including DBR
<i>S: Synthesis</i>	S: Synthesizing literature on AR
<i>D: Design case</i>	D: Design case (design and development of systems or apps in education without conducting empirical research)
-Empirical Type	Specify the types of the empirical study
<i>X: Experimental</i>	X: Experimental and quasi-experimental research design
<i>N: Quantitative</i>	N: Quantitative study that is non-experimental
<i>A: Qualitative</i>	A: Qualitative study including case study, ethnography, etc
<i>M: Mixed method</i>	M: Mixed study research, combined with quantitative and qualitative method
<i>S: Survey Research</i>	S: Use questionnaires for simple descriptive statistics
<i>D: Design-based research</i>	D: Design and iterate on specific teaching mode.
-Groups/Independent variables	How many sub-studies are there and identify them numerically as 3-1, 3-2, 3-3, etc.
-Sample Size	Record the total number of total participants of this relevant (sub)study.
<i>[Total size]</i>	
<i>[Treatment size]</i>	Record the number of students that are in the treatment group or that you collect data with.
-Experimental Research Design	
<i>C1: Control with post only</i>	C1: Control with post only
<i>C2: Control with pre/post</i>	C2: Control with pre and post measures
<i>T: Treatment only</i>	T: Treatment group only (repeated measures)
-Data Collection	
<i>T: Content Tests</i>	T: Results from paper-based or electronic tests or quizzes
<i>S: Surveys</i>	S: Student responses to the questionnaire
<i>I: Interviews</i>	I: Interview transcripts
<i>Ob: Videos/Fieldnotes</i>	Ob: Video recordings/observations/behavior captures
<i>O: Other</i>	O: Other (e.g., projects, artifacts, bio-measurement...)

TECHNOLOGY CODES EXPLANATION

-Cost	Record the cost of AR equipment when mentioned in the paper. NM: not mentioned
-Input	The types of user input during interaction with AR object
● <i>N: Natural</i>	N: User input was based on natural interaction
<i>N_V: Voice command</i>	N_V: User input enabled by voice command
<i>N_MA: Magnetic</i>	N_M: User input enabled by magnetic field sensors
<i>N_MO: Motion</i>	N_MO: User input (e.g., gestures, gait analysis, motions) enabled by motion sensors (e.g., Kinect)
<i>N_H: Haptic</i>	N_H: User input enabled by synthetic haptic stimuli (e.g., touching, pressing) using force feedback or tactile devices
<i>N_L: Location-based</i>	N_L: Position coordinates acquired from GPS is the main input.
● <i>A: Artificial</i>	A: User input was based on unnatural interaction with interface.
<i>A_MK: Mouse & Keyboard</i>	A_MK: clicking and typing being the main forms of input.
<i>A_SC: Scan</i>	A_SC: Image/QR code recognition is the main input.
<i>A_ST: Stylus</i>	A_ST: input enabled by Stylus (触控笔)
<i>A_C: Controller</i>	A_C: button-pressing controller being the main tool of input.
<i>O: Other</i>	O: Other novel forms of input, e.g., biodata (brainwave, heartrate), eye-tracking...
-Computing Devices	
<i>D: Desktop/laptop</i>	D: Data is processed by desktop or laptop.
<i>T: Tablet</i>	T: Data is processed by tablet.
<i>M: Mobile phone</i>	M: Data is processed by mobile phone.
<i>O: Other hand-held</i>	O: Data is processed by other hand-held devices.
<i>W: Wearable device</i>	W: Data is processed by wearable devices, e.g., suit.
<i>C: Cloud</i>	C: Data is uploaded and processed in cloud.
-Output	
<i>M: Monitor-based</i>	M: The image in real world is captured by the camera, input to the computer, combined with the virtual scene generated by the computer graphics system, and output to the screen display, e.g., computer screen.
<i>V: Video see through</i>	V: The image in real world is captured by the camera, input to the computer, combined with the virtual scene generated by the computer graphics system, and output to the devices, e. g. HMD, mobile / handheld, glasses
<i>O: Optical see through</i>	O: The image in the real world enters the human eye directly after a certain dimming process, and the information of the virtual channel enters the human eye after being reflected by the projection. (裸眼,类似于 zspace)
-Media Representation	
<i>S& I: symbol/indicator</i>	S & I: The information carrier received by the user is symbol/indicator. (箭头, 标记等)
<i>T: text</i>	T: The information carrier received by the user is text.
<i>D: data</i>	D: The information carrier received by the user is data.
<i>2D: 2D image</i>	2D: The information carrier received by the user is 2D image.
<i>3D: 3D object</i>	3D: The information carrier received by the user is 3D object.
<i>V: Video</i>	V: The information carrier received by the user is video.
<i>A: Animation</i>	A: The information carrier received by the user is animation.
<i>F: Fantasy</i>	F: Game play based on GPS. e.g. environmental detective

O: voice	O: The information carrier received by the user is voice in AR.
-Interactivity	Level of interactivity between learner and AR object
0: no interaction	0: Students are not allowed to manipulate (Video, physical model of a human heart) or the tool doesn't provide feedback (paper/pencil).
1: low level	1: Students are allowed to manipulate only few things (e.g. play, pause, fast/forward of a simulation with low level of interaction)
2: High level	2: Students are allowed to manipulate several variables in AR (e.g. programmable, constructive, simulation with much interaction).
-Internet	0: Not require the Internet access.
	1: Require the Internet access.
-Brand	HTC, DELL, etc. Indicate the brand if referred.
Development tools	Indicate the tools if referred. e.g. AR-media, ARToolKit, Junaio, Layar, Aumentaty, Metaio Creator, String, etc.

DESIGN CODES	EXPLANATION
- Instructional Function	
A: Attention grabber	A: AR is used as an import tool to grab students' attention
C: Content deliver	C: AR is just used for delivering instructional content
P: Practice	P: Use AR for practice
S: Assessment	S: Use AR as an assessment tool to examine students' learning results
E: Engagement	E: Use AR as a tool to engage students engaged cognitively, behaviorally, emotionally.
O: Other	O: AR is used for other purposes
NM	
- Pedagogy	
I: Inquiry-based	I: Inquiry-based instruction including problem-based learning, case-based learning, and project-based learning
G: Gamed-based learning	G: Game-based learning allows students to acquire knowledge and skills in a new learning scenario that is fascinating, personalized, interactive and entertaining
C: Collaborative	C: Collaborative learning focuses on group work and peer dialogue
T: Trial-and err	T: Trial-and-err based on behaviorist view of learning
D: Direct instruction	D: Lecture-based or Content-delivery focused.
E: Experiential learning	E: experiential learning: Specific experience, observation and reflection, conceptualization. Emphasize embodied cognition, situational learning and the acquisition of specific experiences.
- Level of Inquiry	
0: Lecture-based	0: Lecture-based with minimum inquiry activities.
1: Intermediate	1: A balance of lecture and inquiry activities, mostly intermediate-level cognition such as analysis, application.
2: Inquiry oriented	2: AR integrated relevant elements of the real world that allows for free exploration, unguided inquiry, and creative activities.
NM	
- Scaffolding	
0: No scaffolding	0: No support for teaching.
M: Manuals	M: paper based guidance.
C: Computer	C: Guidance in computer, like arrows, pictures.
T: Teacher	T: Guidance from teacher.
B: Both	B: Guidance from manual or computer and teacher.
NA: Not applicable	NA: Not applicable
NM: Not mentioned	
- Assessment Mode	How the assessment is delivered.
0: No assessment	0: No assessment
A: AR	A: Questions or quizzes delivered in the AR environment, or the assessment is based on the interaction with AR. The feedback is given in AR.
T: Traditional	T: Assessment is delivered and the feedback is given in traditional classroom settings.
M: Mixed	M: Both in AR and traditional setting.
NA: Not applicable	NA: Not applicable
NM	

IMPLEMENTATION CODES	EXPLANATION
- Country	Name of country, country where the experiment was conducted [do not infer from the author's country]
- Grade Level U: Undergraduate G: graduate A: associate	[If available, indicate specific grade]
- Disciplines B: Basic Science S: Social Science E: Engineering L: Language H&M: Health & Medicine M: Mathematics O: Other	B: Physics, Chemistry S: Interpersonal communication O: Maker, Steam, robot, etc.
- Participant Gender M: Male only F: Female only MM: Most Male MF: Most Female C: Co-Ed	M: Male only F: Female only MA: Most male FA: Most female C: Co-Ed
- Research Contexts	Record school and student population background as the paper described: e.g., underrepresented, private/public school, urban/suburban/rural,
- Teacher Training 0. No 1. Yes	0. Teacher training of AR is not reported. 1. Teacher training of AR is reported.
- Students Training 0.No 1.Yes	0. Students training is not required. 1. Students training is required.
- Implementation Duration 0: Not reported 1: 0-3 hours 2: 3-10 hours 3: More than 10 hours	Total hours of AR implemented. Here, 1 hour is considered any period that ranging from 45min to 60min.
- Rounds of Practice 1: One single round 2: Two rounds 3: Three rounds M: More than 3 rounds.	M: If possible, specify the cycle rounds.
- Implementation Setting F: formal settings I: informal settings U: Unrestricted Settings (both)	F: AR is implemented in formal settings, like laboratory or classroom. I: AR is implemented in informal settings, like field trips, museums, outdoor activities, etc.

RESEARCH CODES	EXPLANATION
-Learning outcomes	
<i>K: Knowledge</i>	K: Measure acquisition of content/conceptual knowledge
<i>B: Behaviors/ skills</i>	B: Measure changes in behaviors and skills (e.g. motor skill)
<i>A: Affective</i>	A: Measure students' affective outcomes such as interest, attitude, motivation etc.
<i>C: capacity</i>	C: Measure students' cognitive capability such as spatial skills, computational thinking, etc.
<i>O: Other</i>	O: Other measurements (e.g., teamwork, professionalism)
-Measurement Format	How to make an assessment
<i>T: Test</i>	T: Objective testing such as multiple-choice or True/False, subjective testing such as essay, reflection.
<i>Psy: Psychometric</i>	Psy: use questionnaires measuring creativity, teamwork
<i>Pr: Product</i>	Pr: Evaluation on students' hands-on work.
<i>C: Conversation</i>	C: Conversation with students such as interview, debriefing, etc.
<i>Pe: Performance</i>	Pe: Assessing learning performance (e.g., complete a hands-on experiment or a project. If the performance is simply involved in another form of test but the performance itself is not evaluated, it should not be counted.)
<i>O: Other</i>	O: Other
-Statistical Results	Results: means and means differences Report whatever statistics/tests they use (Cohen's d, t, F, etc.) even if the statistical results are non-significant; We need to calculate effective sizes -- see the list below for needed information to calculate effective sizes.

ADVANTAGES AND	CHALLENGES
-Advantages	A general summary of the advantages and challenges mentioned in the literature. ● Cognitive: learning outcome, content understanding, physical performance, cognitive engagement ● Emotional: Learning motivation, learning engagement, learning experience, emotional engagement ● Behavioral: Learning behavior, participation, etc. behavioral engagement
-Challenges	● Tech issues ● Cost ● Pedagogical issues ● Resistance from school or teachers