

Augmented Reality for Raising Students' Behavior Management and Self-regulation Skills Within SWPBS

Sui Lin Goei¹, Lara Engelsman¹, Rochelle Hurenkamp¹, Bernard De Roosz¹
Crispino Tosto², Giuseppe Chiazzese², Luciano Seta², Antonella Chifari², Marco Arrigo², Mariella Farella²
Eleni Mangina³

¹*Vrije Universiteit*, Amsterdam, North Holland, Netherlands

²*Istituto per le tecnologie Didattiche*, Consiglio Nazionale delle Ricerche, Palermo, Italy

³*University College*, Dublin, Ireland



The Augmented Reality Interactive Educational System (ARETE) Project¹

- ❖ Horizon 2020 Project
- ❖ 10 European partners
- ❖ AIM:
to develop and evaluate the effectiveness of an interactive Augmented Reality ecosystem with educational purposes

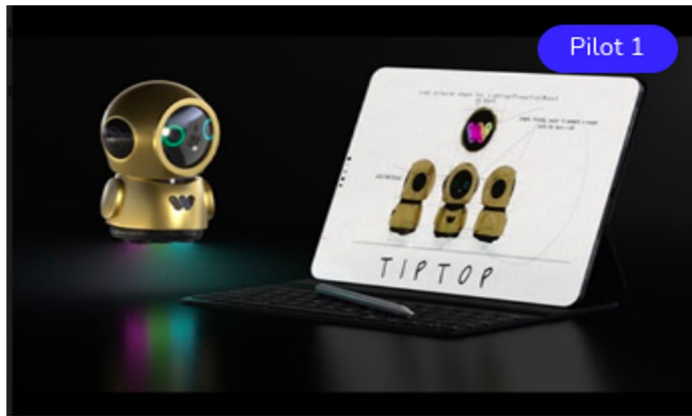


¹ <https://www.aretoproject.eu/>

The Augmented Reality Interactive Educational System (ARETE) Project

impact of Augmented Reality on primary school students' learning of:

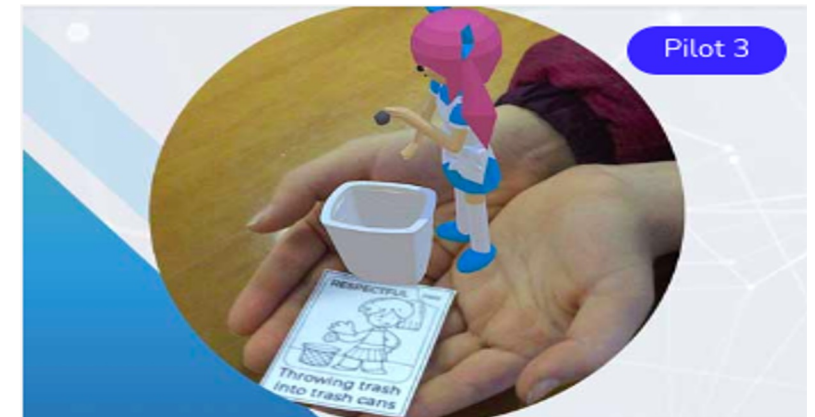
- english literacy
- STEM knowledge
- **behavioural and social skills**



Using Augmented Reality to Facilitate Teaching English Literacy Skills



Augmented Reality as Efficient Tool for STEM Information Retention



Augmented Reality for promoting Positive Behaviour Intervention and Support (PBIS)

ARETE Project Pilot 3

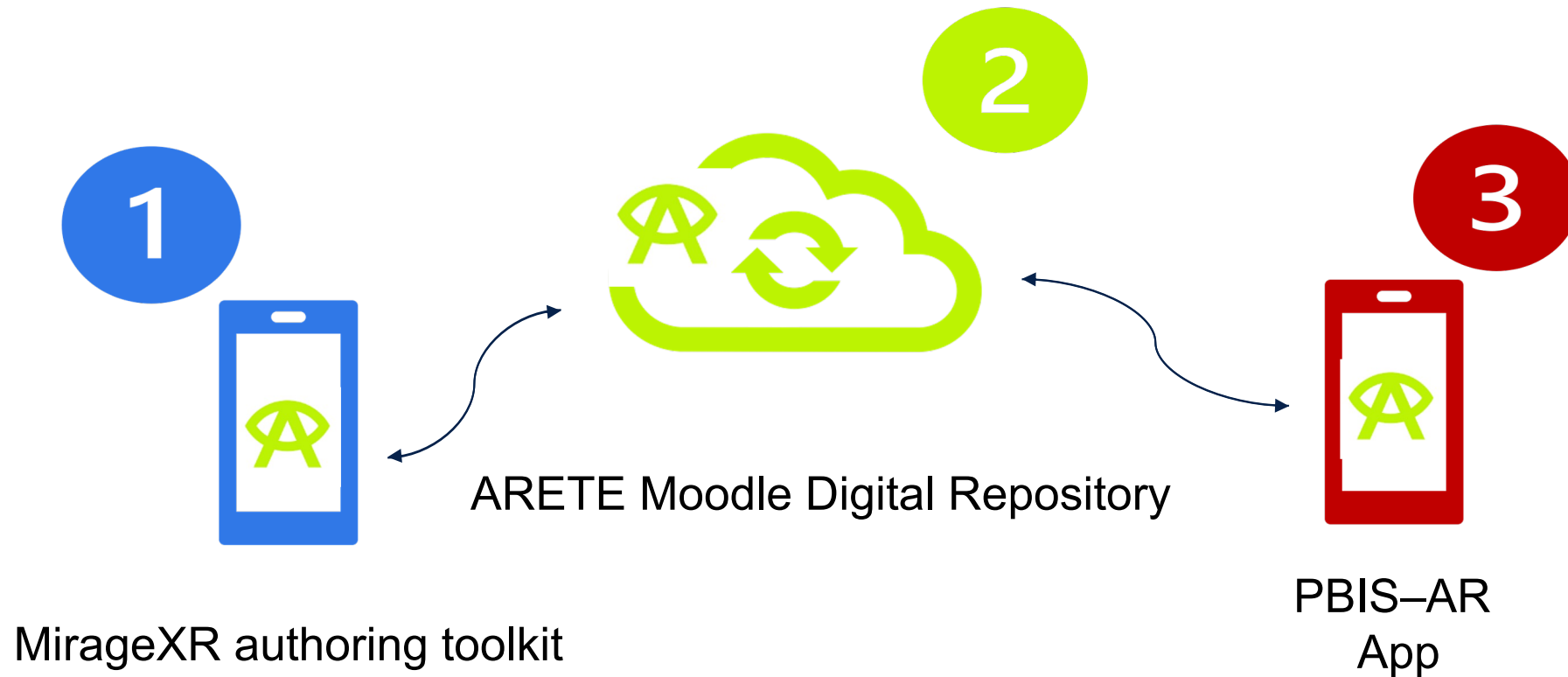


**Augmented Reality for
promoting Positive Behaviour
Intervention and Support (PBIS)**

- ❖ WP 5 “Interactive Augmented Reality for PBIS”
- ❖ AIM
design, develop, and evaluate Augmented Reality support to
teaching of socio-emotional self-regulation skills to primary school
students

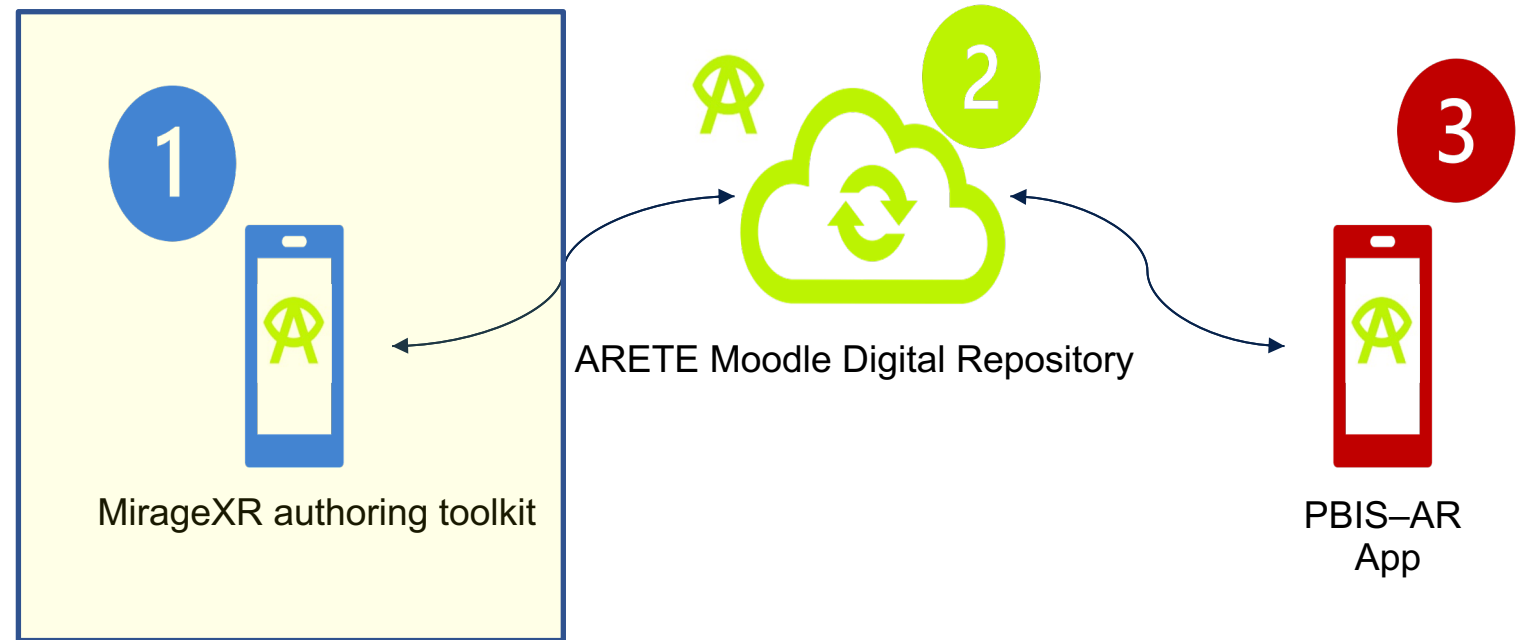
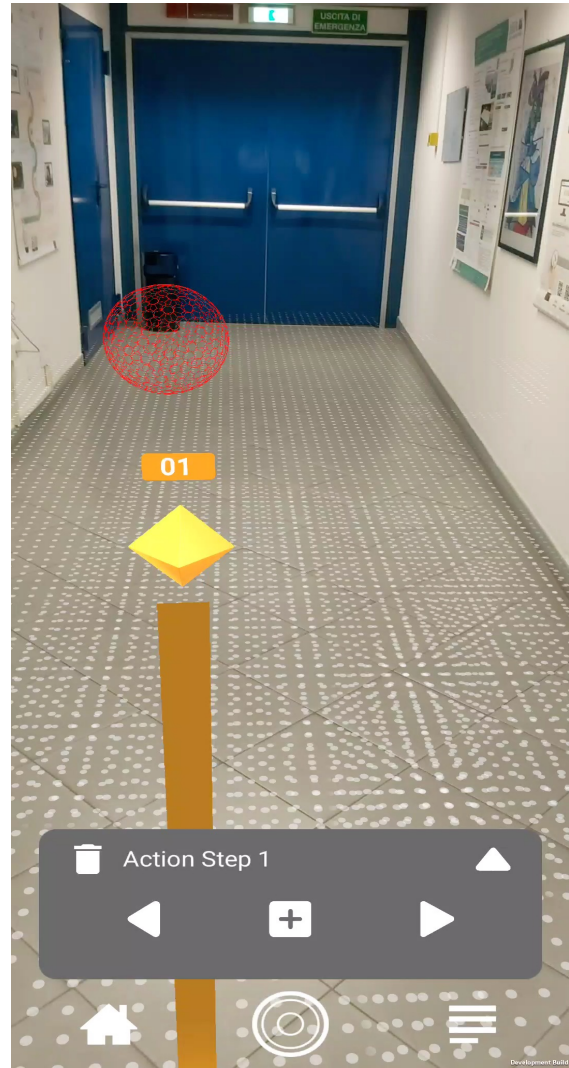
ARETE Ecosystem

WP5 - Pilot 3



The authoring Tool MirageXR

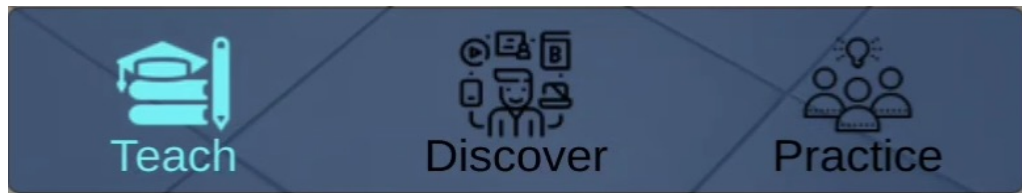
Example of creation of a behavioural routine with Augmented Reality



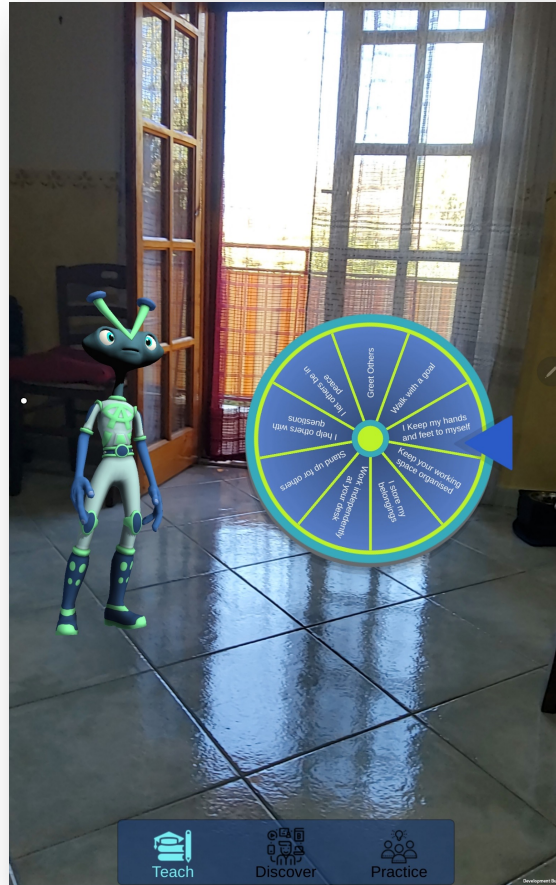
PBIS-AR App

The **PBIS-AR** consists of three main areas:

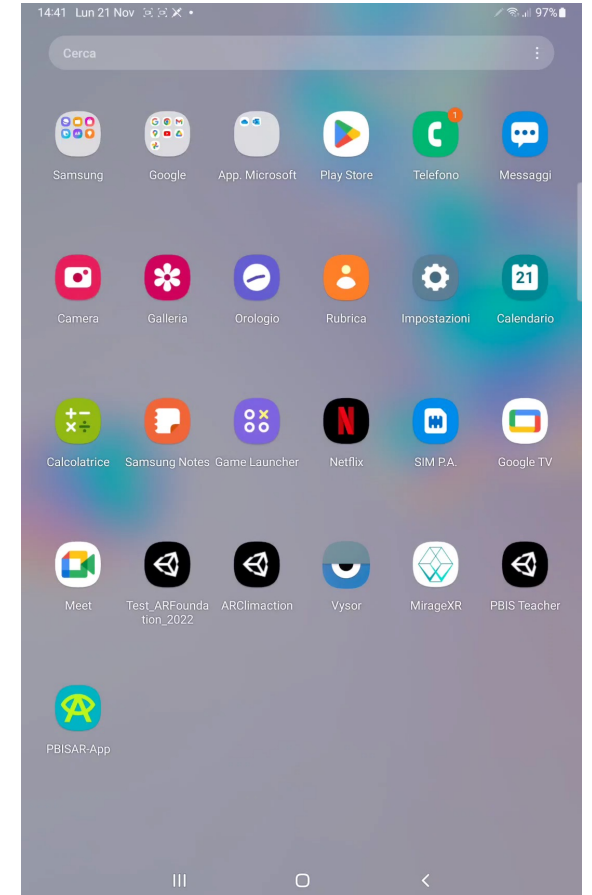
1. Teach: to play a behaviour to learn
2. Discover: to test what student learnt
3. Practice: To role playing together with others



PBIS-AR App: Teach

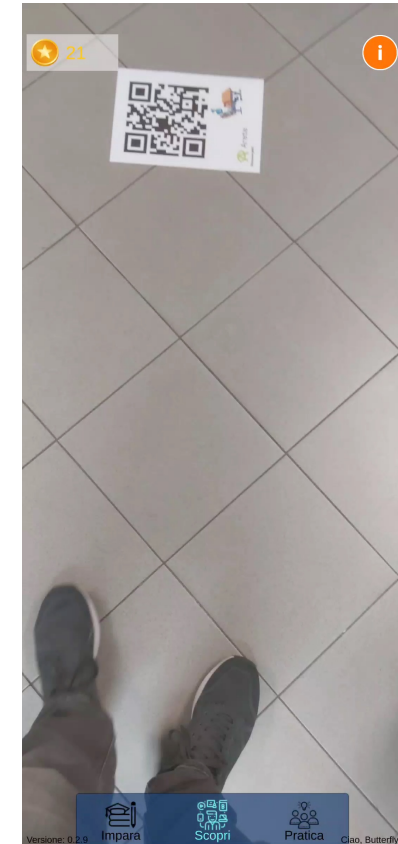


The student plays the behavioural routine created by the teacher in the specific setting with MirageXR app and stored in the ARETE moodle repository.



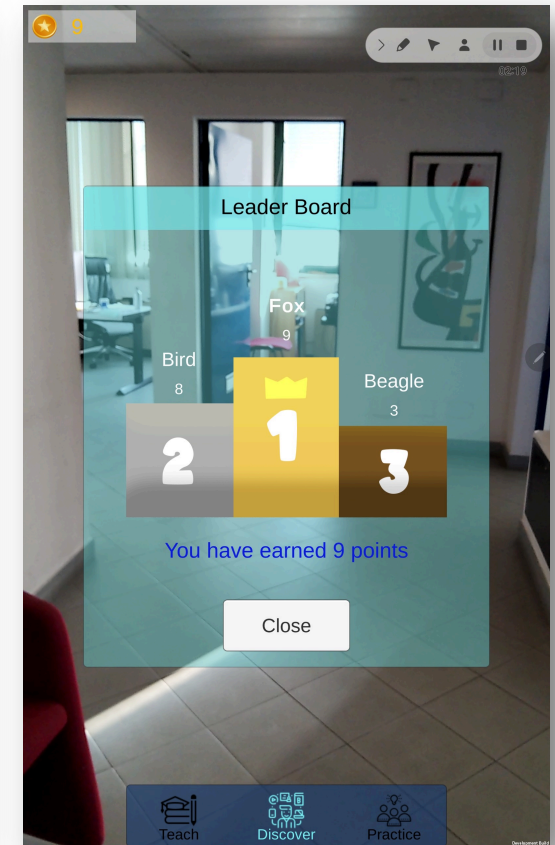
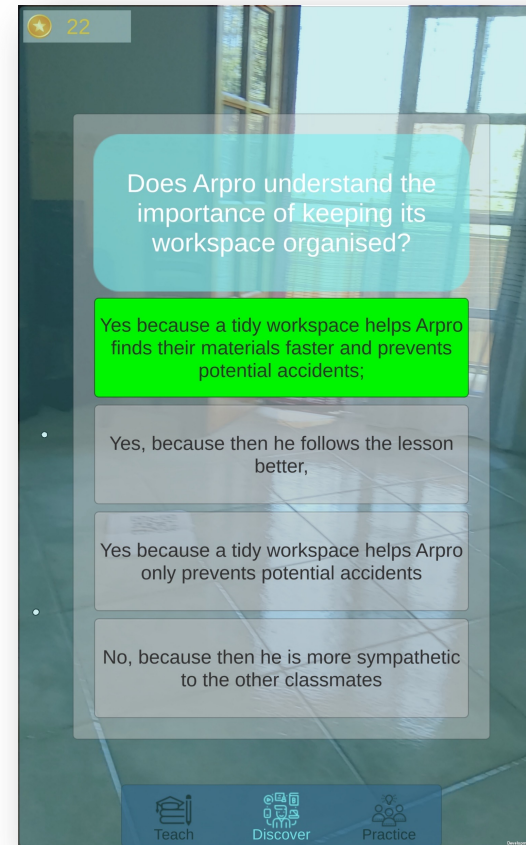
PBIS-AR App: Discovery

The student participates in a behavioural reflection game in AR. Through a series of image markers located in the various settings, expected and unexpected behaviour are displayed.



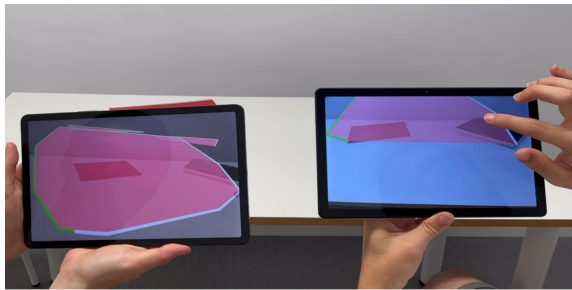
PBIS-AR App: Discovery

At the end the student is invited to reflect through quizzes whose positive answer determines the assignment of a score and the updating of an overall ranking (leaderboard).

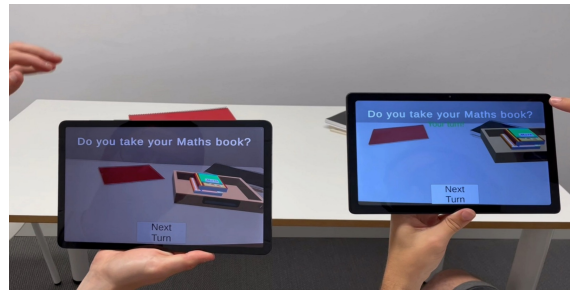


PBIS-AR App: Practice

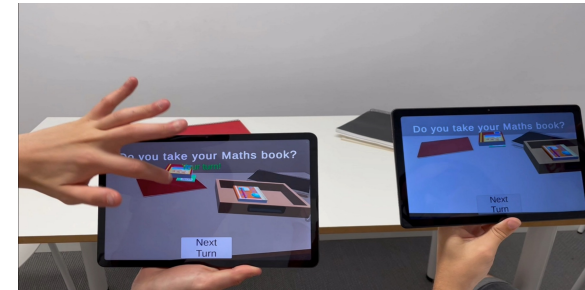
The student is involved in a multi-user interactive behavioural activity designed to allow students work in pairs.



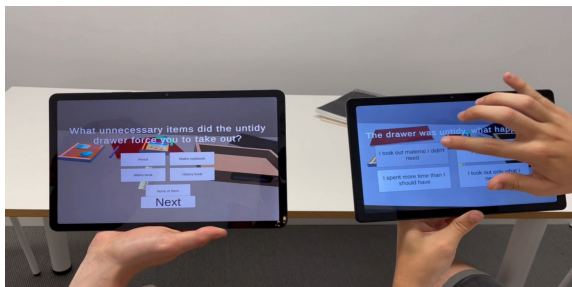
A) Surface recognition



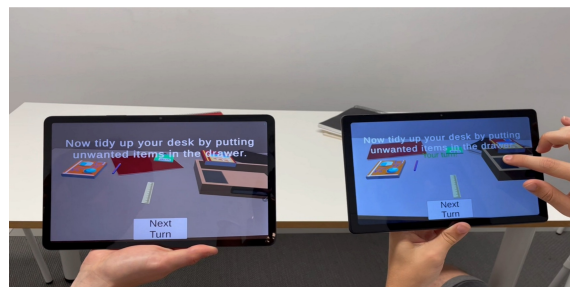
B) Placement of the drawer



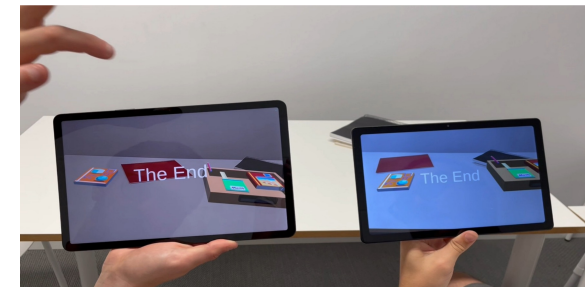
C) Dragging objects



D) Quiz



E) Tidy up



F) Ready for the lesson



**Keep your
workspace
organised**

(Tidy version)



ARETE

Pilot 3 - Research question

Does integrating AR contents exert an incremental effect compared to PBIS intervention as usual on:

- 1) students' social, emotional, and cognitive behavioural management and development (e.g., prosocial behaviour, well-being, and executive functioning), and
- 1) students' learning of expected positive behaviours in line with established school values

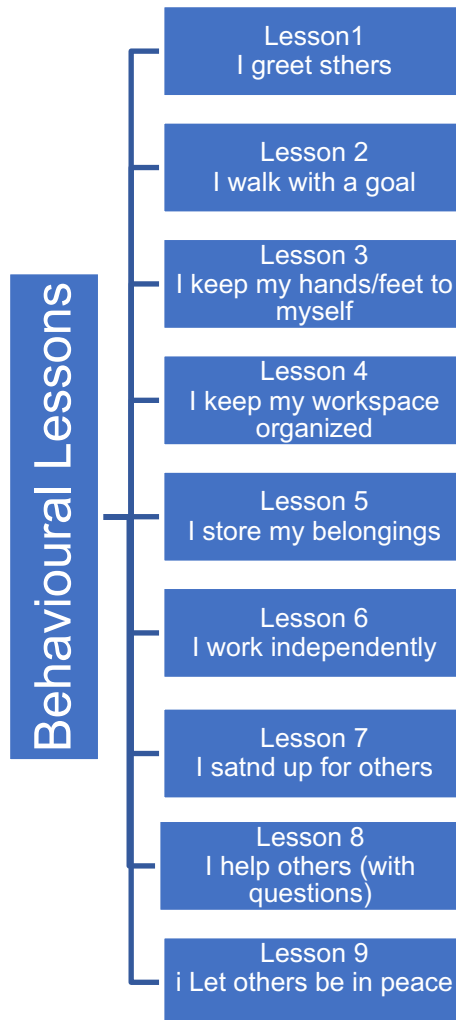
Pilot 3 - Research Design

- ❖ **pre-test/post-test between group design**
to evaluate the effectiveness of the implementation of a **PBIS intervention enriched with AR** compared with the implementation of a content-similar **traditional PBIS intervention**
- ❖ Dutch and Italian students enrolled and divided between 2 educational conditions

PBIS TIER 1 INTERVENTION
AS USUSAL

PBIS TIER 1 INTERVENTION
SUPPORTED BY AR TECH

Pilot 3 - Procedure



- ❖ Nine behavioural lessons
- ❖ One per week
- ❖ Modelling and Practicing phase supported by AR content
- ❖ AR content mediated by the use of an AR application

Pilot 3 - Participants

❖ from *Italy*

- n=125 students
- across 8 (4th to 6th) classrooms
- classrooms equally distributed between educational conditions

Grade	Condition	
	AR	non-AR
4 th	16	13
5 th	17	16
6 th	39	24
Total	72	53

Pilot 3 - Participants

Schoolyear 2021-2022

- n=44 students
- Divided over 4 schools; 2 mainstream and 2 special need
- across 4 classrooms (grade 6th to 8th)

School	Grade	Non-AR
Mainstream primary education	Grade 6	16
	Grade 7	12
	Grade 8	0
Special needs primary education	Grade 6	1
	Grade 7	8
	Grade 8	7
		44

Schoolyear 2022-2023

- n=159 students
- Divided over 7 schools; 4 mainstream and 3 special need
- across 11 classrooms (grade 6th to 8th)

School	Grade	Condition	
		AR	Non-AR
Mainstream primary education	Grade 6	30	8
	Grade 7	18	11
	Grade 8	12	15
Special needs primary education	Grade 6	4	3
	Grade 7	17	5
	Grade 8	36	-
		117	42

Pilot 3 - Measures

- ❖ **Executive Skills Questionnaire - Revised** (Strait et al., 2020)

25 questions on a 4-point scale to assess plan management, time management, organisation, emotional regulation and behavioural regulation

- ❖ **Strengths and Difficulties Questionnaire** (Goodman, 1997/2005)

25 items to assess students' behavioural strengths and difficulties over the following scales: emotional problems, peer problems, behavioural problems, hyperactivity behaviour, prosocial behaviour

- ❖ **Bullying — Olweus Self-report Procedure** (Olweus, 1996)

3 questions answered on a 5-point scale to assess students' experiences about bullying, being bullied, and helping classmates who are being bullied

Pilot 3 - Measures

- ❖ **Classroom Climate Scale** (Donkers & Vermulst, 2014)

 - 16 items on a 4-point scale to assess students' perception of classroom climate (Peer relation quality and Classroom atmosphere)

- ❖ **Self-efficacy Questionnaire for Children** (Muris, 2001)

 - 24 items on a 5-point scale to evaluate students' self-perceived competences and abilities

- ❖ **A desired behaviour rating scale**

 - evaluating students' behaviours from 1 (poor) to 10 (excellent) before and after the intervention

Preliminary Results from Italian Sample - Data Analysis

Paired t test as

Pre-test/Post-test comparisons to estimate assess the effect of TIER 1 intervention within each educational condition (with and without AR support)

Results reported only for measures assessing

students' social, emotional, and behavioural management and development

Pre-test/post-test comparisons AR condition

	Pre-test		Post-test		p-value
	M (sd)	Sd	M (sd)	Sd	
ESQ Total	26.38	9.80	26.36	11.40	0.99
Plan Management	0.98	0.45	0.99	0.53	0.84
Time Management	1.12	0.61	1.12	0.66	0.99
Organization	0.94	0.73	0.85	0.65	0.37
Emotion Regulation	1.16	0.69	1.12	0.75	0.67
Behavioural Regulation	1.20	0.50	1.26	0.54	0.34
SEQ-C Total	78.22	14.38	79.20	14.47	0.59
Academic Self-efficacy	26.52	5.73	27.57	6.10	0.13
Social Self-efficacy	27.39	5.45	27.37	5.73	0.98
Emotional Self-efficacy	24.31	6.77	24.26	5.99	0.95
CCS					
Peer Relation Quality	3.19	0.60	3.13	0.58	0.35
Classroom Atmosphere	3.24	0.43	3.00	0.60	<0.01
OBQ					
Being bullied	0.15	0.53	0.20	0.59	0.52
Bullying others	0.04	0.19	0.13	0.52	0.23
Helping bullied classmates	1.19	1.49	1.48	1.58	0.23
SDQ Total	10.76	5.95	11.21	4.55	0.46
Emotional Problems	3.54	2.25	3.08	2.38	0.11
Peer Problems	2.20	1.60	2.36	1.68	0.52
Conduct Problems	2.08	1.48	1.97	1.56	0.60
Hyperactivity	3.39	2.08	3.35	2.19	0.89
Prosocial Behaviour	7.97	1.74	8.25	1.70	0.39

Note. ESQ = Executive Skills Questionnaire; SEQ-C = Self-Efficacy Questionnaire for Children; CCS = Classroom Climate Scale; OBQ = Olweus Bullying Questionnaire; SDQ = Strengths and Difficulties Questionnaire; M = Mean; Sd = standard deviations

- Generally, no significant differences
- Significant but slight decrease in
Perceived Classroom Atmosphere
- Note: tentative results, given the high number of hypotheses tested and the low number of students involved per condition

Pre-test/post-test comparisons non-AR condition

		Pre-test		Post-test		p-value
		M (sd)	Sd	M (sd)	Sd	
ESQ Total		25.17	11.44	24.97	11.99	0.90
	Plan Management	0.95	0.54	0.96	0.53	0.88
	Time Management	1.02	0.61	0.96	0.63	0.63
	Organization	1.12	0.78	0.9	0.68	0.05
	Emotion Regulation	0.99	0.6	1.12	0.78	0.29
	Behavioural Regulation	1.07	0.42	1.11	0.46	0.69
SEQ-C Total		79.29	14.94	82.86	15.62	0.09
	Academic Self-efficacy	27.43	5.57	28.83	5.91	0.13
	Social Self-efficacy	27.57	5.25	28.03	5.50	0.64
	Emotional Self-efficacy	24.29	6.60	26.00	7.15	<0.05
CCS						
	Peer Relation Quality	3.25	0.61	3.41	0.58	0.16
	Classroom Atmosphere	3.11	1.67	3.28	0.46	<0.05
OBQ						
	Being bullied	0.31	0.96	0.03	0.17	0.10
	Bullying others	0.03	0.17	0.00	0	0.32
	Helping bullied classmates	1.4	1.49	1.54	1.65	0.64
SDQ Total		11.93	6.68	11.10	6.77	0.34
	Emotional Problems	3.72	2.96	3.67	2.66	0.89
	Peer Problems	2.65	1.94	2.34	1.59	0.28
	Conduct Problems	2.13	1.68	1.83	1.83	0.27
	Hyperactivity	3.43	2.11	3.26	2.44	0.63
	Prosocial Behaviour	8.25	1.49	8.86	1.33	<0.05

Note. ESQ = Executive Skills Questionnaire; SEQ-C = Self-Efficacy Questionnaire for Children; CCS = Classroom Climate Scale; OBQ = Olweus Bullying Questionnaire; SDQ = Strengths and Difficulties Questionnaire; M = Mean; Sd = standard deviations

- Generally, no significant differences
- Significant but slight Improvement in
Perceived Classroom Atmosphere
Emotional Self-efficacy
Prosocial Behaviour
- Note: tentative results, given the high number of hypotheses tested and the low number of students involved per condition

Preliminary results from Dutch sample: Data Analysis

Schoolyear 2021 - 2022 (non-AR) control group

- Decrease in executive functioning (medium effect)
 - Plan management (medium effect)
 - Emotional regulation (small-medium effect)
- Bullying, students reported:
 - Being bullied less (medium effect)
 - Less bullying of others (medium effect)
 - Helping bullied classmates less frequently (large effect)

		Pre-test		Post-test			
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>	<i>d</i>
ESQ Total		46.75	13.53	51.30	10.82	.009	-.415
	Plan management	1.90	.61	2.17	.48	.001	-.514
	Time management	1.90	.71	2.08	.64	.111	-.245
	Organisation	1.92	.80	1.92	.77	1	0
	Emotional Regulation	1.89	.79	2.17	.71	.020	-.365
	Behavioural Regulation	1.69	.59	1.71	.50	.860	-.027
SDQ Total		13.70	6.55	12.59	6.81	.187	.202
	Emotional Problems	3.59	2.19	3.05	2.16	.090	.262
	Peer Problems	2.80	1.81	2.70	2.04	.748	.049
	Conduct Problems	2.73	2.42	2.57	2.02	.580	.084
	Hyperactivity Problems	4.59	2.63	4.27	2.94	.463	.112
	Prosocial Behaviour	7.25	1.97	7.09	2.07	.582	.084
SEQ-c Total		81.23	16.32	83.14	15.60	.418	-.123
	Social Self-efficacy	27.43	5.77	27.64	6.14	.811	-.036
	Emotional Self-efficacy	25.27	6.80	26.59	6.25	.168	-.212
	Academic Self-efficacy	28.52	6.01	28.91	5.16	.681	-.062
CCS		-	-	-	-		
	Peer Relation Quality	3.11	.63	3.08	.74	.677	.063
	Classroom Atmosphere	3.01	.66	3.03	.66	.832	-.032
OBQ		-	-	-	-		
	Being bullied	.52	.73	.20	.55	.007	.430
	Bullying others	.39	.87	.02	.15	.008	.420
	Helping bullied classmates	1.84	1.35	.61	1.08	<.001	.937

Note. *N* = 44

Preliminary results from Dutch sample: Data Analysis

Distinction between Mainstream primary education and Special need primary education

Executive functioning:

- Plan management (medium effect)

Bullying, students reported:

- Being bullied less (medium effect)
- Helping bullied classmates less frequently (large effect)

		Mainstream primary education					
		Pre-test		Post-test			
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>	<i>d</i>
ESQ Total		48.21	11.36	52.29	10.36	.054	-.381
	Plan management	1.97	.54	2.21	.48	.016	-.486
	Time management	1.94	.64	2.20	.53	.080	-.479
	Organisation	2.08	.61	1.95	.80	.371	.172
	Emotional Regulation	1.92	.69	2.12	.71	.204	-.246
	Behavioural Regulation	1.70	.54	1.75	.47	.666	-.082
SDQ Total		13.70	6.55	12.14	6.64	.220	.237
	Emotional Problems	3.64	2.47	2.96	2.24	.149	.280
	Peer Problems	2.64	1.83	2.54	2.24	.780	.053
	Conduct Problems	2.71	2.55	2.57	1.97	.715	.070
	Hyperactivity Problems	4.50	2.73	4.07	2.87	.431	.151
	Prosocial Behaviour	7.39	1.91	7.39	2.22	1	0
SEQ-c Total		81.43	16.22	84.54	13.62	.229	-.233
	Social Self-efficacy	27.64	5.34	28.29	5.71	.463	-.141
	Emotional Self-efficacy	25.25	6.55	26.50	5.59	.305	-.198
	Academic Self-efficacy	28.54	6.35	29.75	4.05	.261	-.217
CCS		-	-	-	-	-	-
	Peer Relation Quality	3.20	.59	3.16	.74	.760	.058
	Classroom Atmosphere	3.05	.67	3.14	.63	.488	-.133
OBQ		-	-	-	-	-	-
	Being bullied	.61	.79	.21	.57	.019	.472
	Bullying others	.39	.99	.04	.19	.067	.361
	Helping bullied classmates	1.86	1.27	.75	1.11	<.001	.825

Note. *N* = 28

Preliminary results from Dutch sample: Data Analysis

Distinction between Mainstream primary education and Special need primary education

Executive functioning:

- Plan management (medium effect)
- Emotional regulation (medium effect)
- Bullying, students reported:
 - Less bullying of others (medium effect)
 - Helping bullied classmates less frequently (large effect)

		Special need primary education					
		Pre-test		Post-test			
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>	<i>d</i>
ESQ Total		44.19	16.77	49.56	11.73	.087	-.458
	Plan management	1.78	.71	2.10	.49	.045	-.545
	Time management	1.83	.84	1.88	.76	.800	-.065
	Organisation	1.65	1.01	1.88	.72	.329	-.252
	Emotional Regulation	1.85	.95	2.27	.73	.024	-.630
	Behavioural Regulation	1.69	.69	1.64	.56	.769	.075
SDQ Total		14.06	5.96	13.38	7.25	.610	.130
	Emotional Problems	3.50	1.67	3.19	2.07	.370	.231
	Peer Problems	3.06	1.81	3.00	1.67	.882	.038
	Conduct Problems	2.75	2.27	2.56	2.16	.654	.114
	Hyperactivity Problems	4.75	2.52	4.63	3.12	.868	.042
	Prosocial Behaviour	7.00	2.10	6.56	1.71	.353	.240
SEQ-c Total		80.88	17.03	80.69	18.80	.969	.010
	Social Self-efficacy	27.43	6.62	26.50	6.86	.761	.077
	Emotional Self-efficacy	25.31	7.44	26.75	7.47	.373	-.230
	Academic Self-efficacy	28.50	5.56	27.44	6.57	.557	.150
CCS		-	-	-	-		
	Peer Relation Quality	2.97	.69	2.93	.74	.781	.071
	Classroom Atmosphere	2.92	.65	2.83	.68	.533	.160
OBQ		-	-	-	-		
	Being bullied	.38	.62	.19	.54	.188	.345
	Bullying others	.38	.62	0	-	.029	.606
	Helping bullied classmates	1.81	1.52	.37	1.03	<.001	1.138

Preliminary results from Dutch sample

Schoolyear (2022 - 2023)

- Experienced difficulties in implementing the lessons
 - Teacher shortage -> high work pressure, teachers had to switch classrooms
 - Time investment too heavy
 - Difficulty in using the applications within the classroom
- Decided that we also gather qualitative data:
 - plan **observations** together with schools and **support** teachers where necessary
 - **Interview** children and teachers about their experiences
- Schools did not complete the post-measurement (yet)

Preliminary results from Dutch sample: Data Analysis

Schoolyear 2022 - 2023 (AR and non-AR (control) group)

Equality between groups?

- AR group better executive functioning compared to non-AR
- More hyperactivity problems in Non-AR group compared to AR
- Perceived classroom atmosphere more positive in non-AR compared to AR group
- Less students are being bullied in the Non-AR group compared to AR and and students help bullied classmates less frequently

		AR		Non-AR		
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>
ESQ Total		27.97	11.53	35.59	19.00	.003
	Plan management	1.06	.52	1.36	.90	.012
	Time management	1.24	.69	1.58	.80	.010
	Organisation	1.04	.75	1.38	.92	.019
	Emotional Regulation	1.07	.80	1.47	.94	.009
	Behavioural Regulation	1.25	.55	1.45	.72	.062
SDQ Total		13.21	5.71	13.57	5.87	.730
	Emotional Problems	3.50	2.56	3.50	2.43	.993
	Peer Problems	2.65	1.83	2.64	2.28	.985
	Conduct Problems	2.85	2.05	2.29	1.60	.111
	Hyperactivity Problems	4.21	2.27	5.14	1.98	.020
	Prosocial Behaviour	7.49	1.85	7.36	1.82	.695
SEQ-c Total		83.05	13.41	82.55	13.46	.835
	Social Self-efficacy	27.85	4.96	27.71	5.47	.886
	Emotional Self-efficacy	26.17	6.14	25.24	5.33	.384
	Academic Self-efficacy	29.03	4.98	29.60	4.68	.525
CCS		-	-			
	Peer Relation Quality	3.20	.57	3.16	.71	.701
	Classroom Atmosphere	2.96	.70	3.21	.56	.045
OBQ		-	-			
	Being bullied	.81	1.15	.40	.77	.035
	Bullying others	.47	1.06	.26	.59	.231
	Helping bullied classmates	1.66	1.43	.93	1.30	.004

Next Steps

Further Data Analysis

- ❖ Pre-post comparisons of learned behaviours as rated by teachers within and between educational conditions
- ❖ Pre-post comparisons of all measures between educational conditions
- ❖ Students and teachers experience with the application

Thank you for your attention!

For any additional information,
please contact:

Sui Lin Goei
Engelsman

s.l.goei@vu.nl

Lara

l.engelsman@vu.nl

Crispino Tosto

crispino.tosto@itd.cnr.it

