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A Usability and User Experience Evaluation Technology for Touchable Holographic Solutions

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Doctoral Thesis
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Context

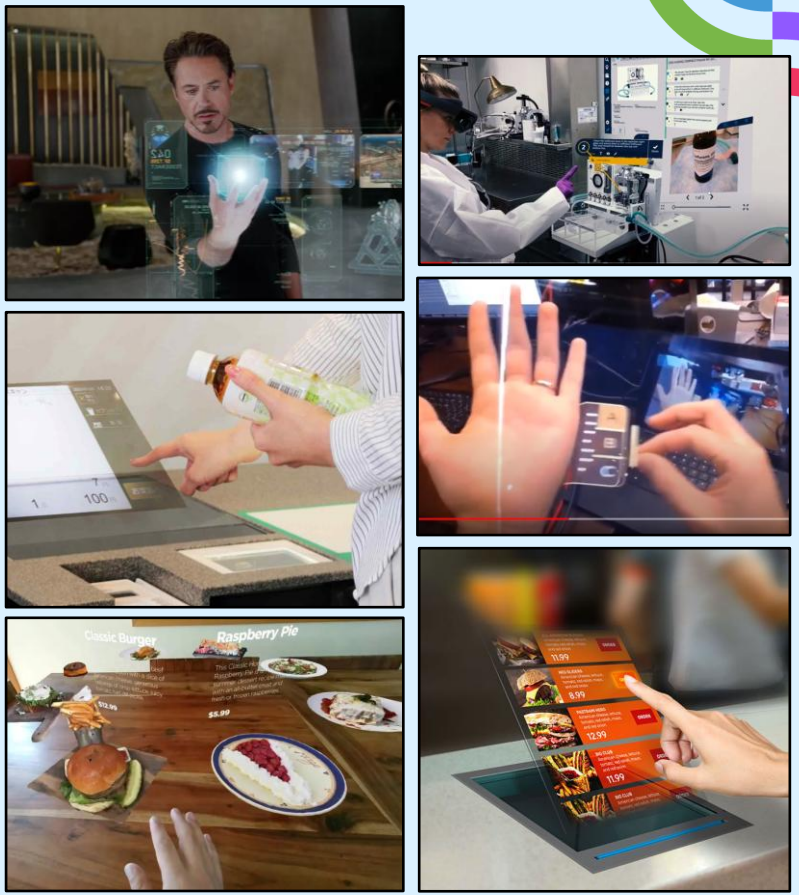
Go beyond 2D touchscreen or mouse/joystick **interaction**.

Holography blends into the real environment, in augmented/mixed reality.

Touchable holography: Use of natural touch gestures directly on virtual objects or interface elements, without feeling them.

Applications in medicine, education, engineering, entertainment, etc.

Ensure the **quality** of these new interactive systems.



Problem and Motivation

Diverse methods: test, inspection, inquiry, and simulation.

Gap: no evaluation tools for SHT usability/UX.

Limits: traditional tools, like SUS/UEQ, miss immersion, presence, mid-air touch.

Need: detect issues, boost satisfaction, increase adoption

Research Question

How can **THS** be evaluated by considering their **unique** interaction features while **integrating** usability and UX in context?

Goals

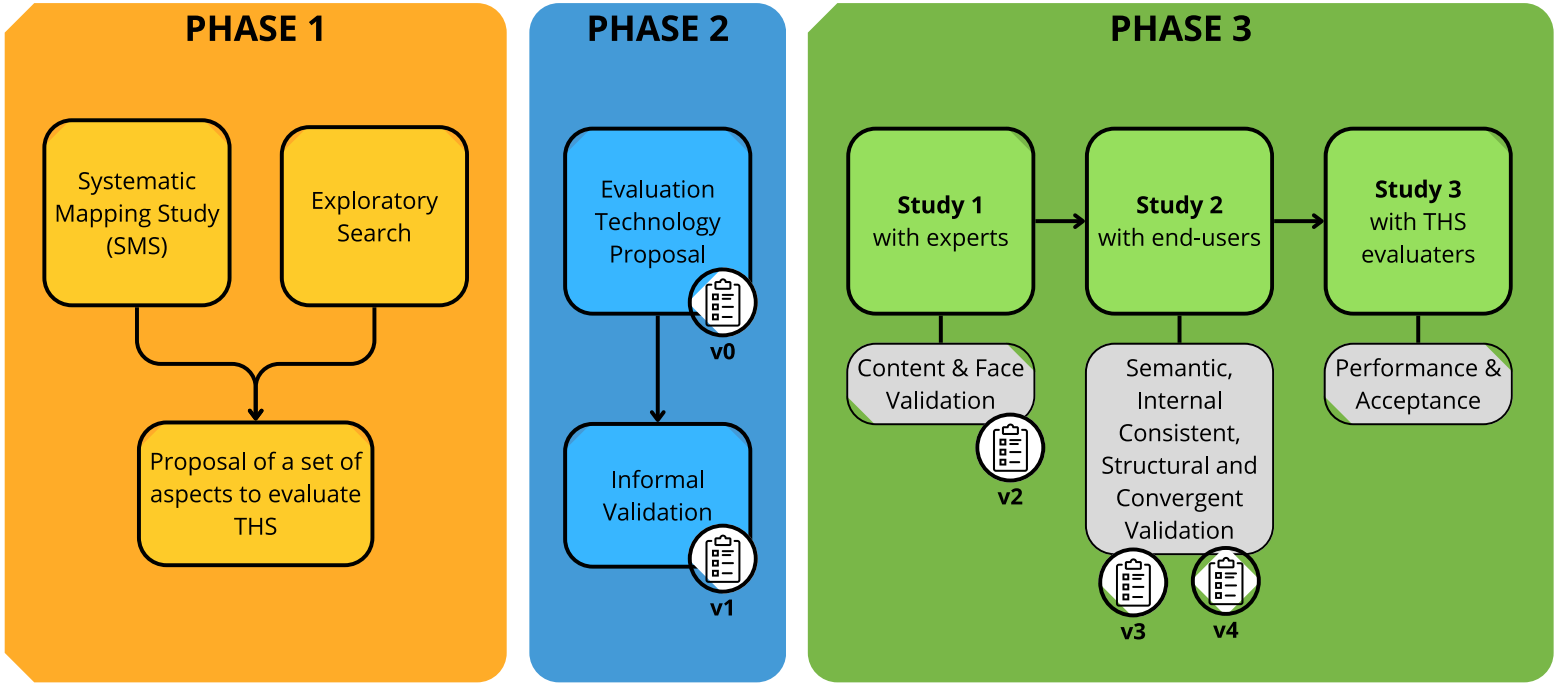
Main

Propose a usability and UX **Evaluation Technology (ET)** for Touchable Holographic Solutions (THS), covering their specific characteristics.

Specific

- **Map** evaluation technologies currently used in THS.
- **Identify** usability and UX aspects relevant to the THS context.
- **Develop** a usability and UX ET for THS.
- **Validate** and **improve** the ET with empirical evidence.

Methodology



Inspired by **Shull et al.** (2001) and **Mafra et al.** (2006) for defining new software technologies.
Integrated with instrument construction and validation guidelines from **DeVellis and Thorpe** (2022) and **Costa** (2021).

Systematic Mapping Study (SMS)

- **Initial** SMS (1): publications until April 25, 2021
- **Extended** SMS (2): April 26, 2021 – April 25, 2023
  - to include recent publications;
  - to capture new trends;
  - to expand the relevance and accuracy of MSL1's findings.
- Protocol based on:
  - **Kitchenham et al.** (2016) and;
  - **Petersen et al.** (2008).

Analyze	Scientific publications
With purpose of	To identify and characterize
Regarding	Usability and UX ETs
From the point of view of	HCI, SE, AR and MR researchers.
In the context of	Scientific publications available in the ACM DL, IEEE Xplore and Elsevier Scopus.

*Goal-Question-Metrics (GQM) – **Basili et al.** (1994)*

Findings of SMS

- **Topic:** relevant, multidisciplinary, but few proposals
- **Integration**: usability & UX rarely combined
- **Evaluation:**
  - each THS → ~4–5 ETs
  - each ET → only 2–3 aspects
- **Coverage:** immersive aspects seldom addressed; overlaps common
- **Quality:** strong reliance on ad-hoc, non-validated questionnaires

Related Publications

Paper *about Initial SMS on* ***IHC*** *(2023)*

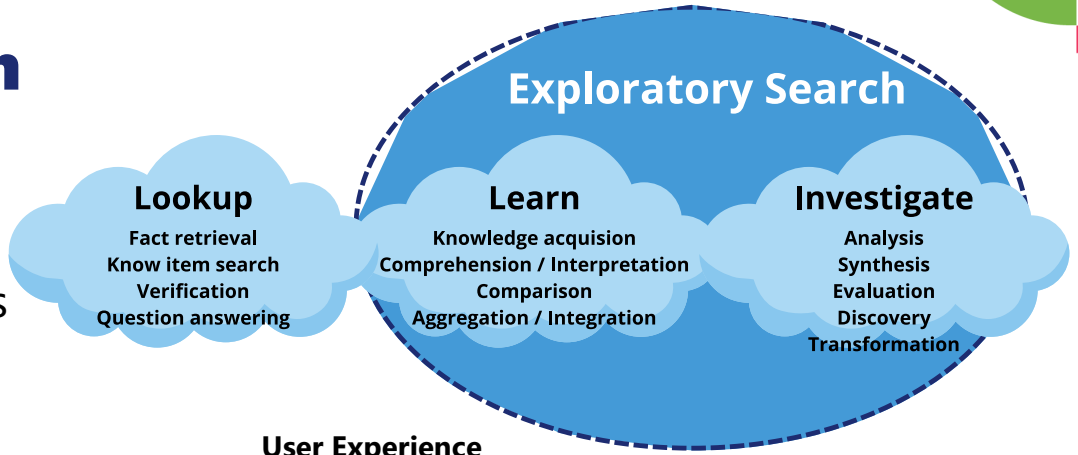
Article *about Extended SMS on* ***JIS*** *(2025)*

Full ***Technical Report*** *about Initial SMS on FigShare (2023)*

Full ***Technical Report*** *about Extended SMS on FigShare (2025)*

Exploratory Search

Aiming to **understand**, **compare**, **aggregate** and **synthesize** aspects/dimensions necessary to evaluate usability and UX;



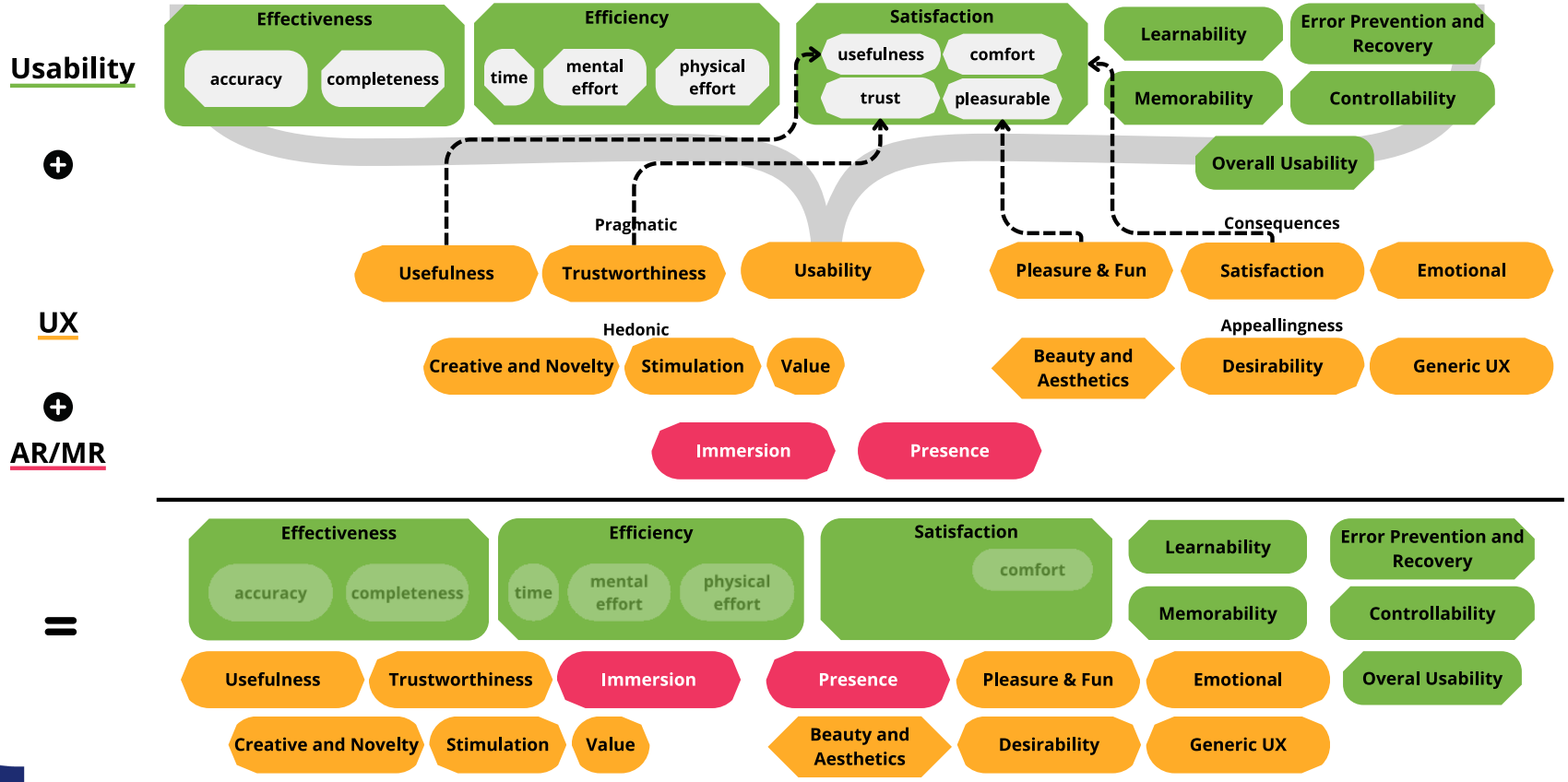
Usability

- ISO/IEC 9241-11:2018
  Usability: Definitions and concepts
- ISO 9241-210:2019
  Human-centered design for interactive systems
- ISO 9241-110:2020
  Interaction principles
- ISO/IEC 25010:2011
  Systems and Software Quality Requirements and Evaluation (SQuaRE) — Quality models
- Nielsen (2012)
  Introduction to Usability

User Experience

- Hassenzahl et al. (2000)
- Hassenzahl (2004)
- Hassenzahl and Tractinsky (2006)
- Hassenzahl (2018)
- Bargas-Avila and Hornbæk (2011)
- Merčun and Žumer (2014)
- Merčun and Žumer (2017)
- Zarour and Alharbi (2017)
- Marques et al. (2019)
- Morville (2004)
- Guo (2012)

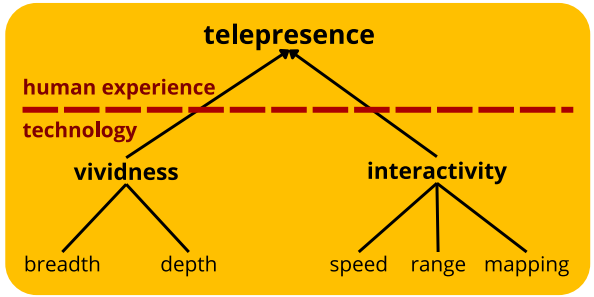
Aspects for THS



Unique Aspects for SHT

Immersion

- **Technical** quality of the system;
- Sensory **fidelity**
  - Breadth and depth of each **perceptual channel**;
  - The degree to which **users can modify** the form and content of an environment in real time.
- Set of **valid actions** that a system allows users.



Adapted from Steuer, 1992

Related Publication

***Article** about Exploratory Search findings on **IJHCI**, Taylor & Francis (2024)*

Presence

- From **"telepresence"**: feeling like you're in another place.
- It's a multidimensional **psychological state**, influenced by technology;
- Human **reaction** to immersion;
- **Not** to be confused with other states of cognitive attention, such as involvement, or psychological, such as flow.

Propose of Evaluation Technology

Goals

- **Integrate** usability & UX (quant. + quali.)
- Focus on **end-user, episodic** & **cumulative** UX (Roto et al., 2011);
- Detect issues, reflect experience;
- Efficient, minimal effort, easy to apply;

Questionnaire

- **Simple**, **low-cost**, **subjective focus**;
- **Easy** handling & administration;
- **Based on 20** identified aspects;
- Named **“Usability and User eXperience Evaluation in Touchable Hologram”** (UUXE-ToH)

Questionnaire Development Process

Item Development

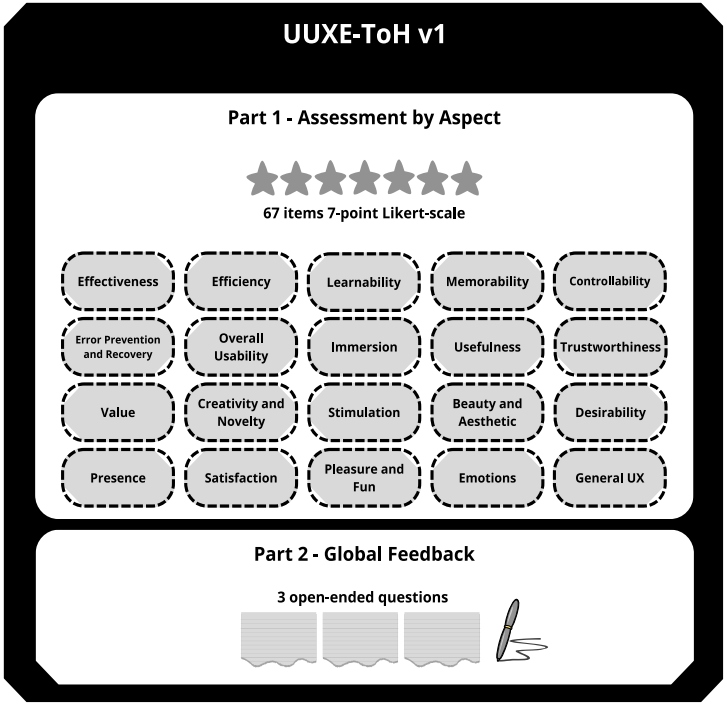
- Items per construct, adapted from existing questionnaires
- 74 preliminary items (**v0**)

Response Options

- 7-point Likert scale (+ N/A, IDK)

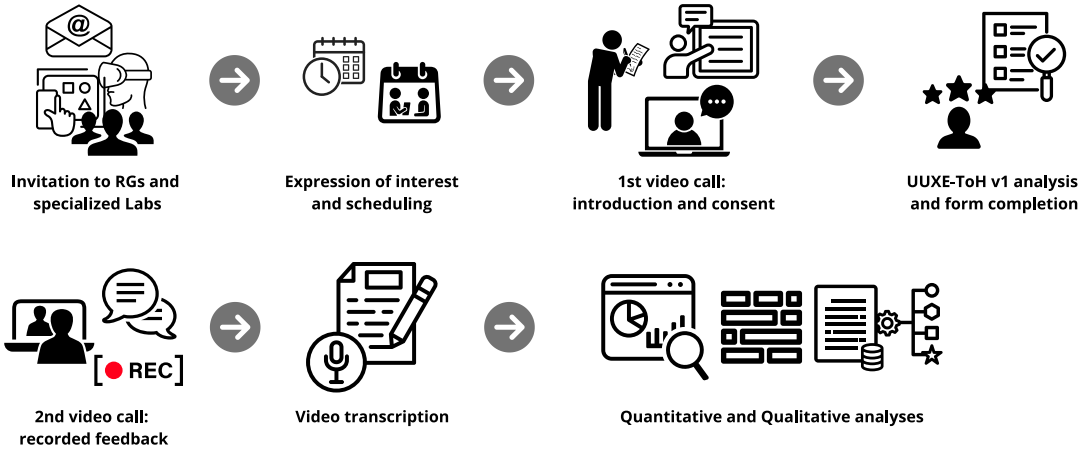
Open-Ended Questions

- Q1: Positive/negative experience
- Q2: Problems faced
- Q3: Suggestions



Study 1 – with Experts

- **Goal**: refine UUXE-ToH v1
- **Validity: content** (relevance/overlap), **face** (clarity)
- **Participants: 13 experts** (CS, Design, Eng., and others);
- **Ethics** approved (June 2023);
- **Data:** June–Aug 2023;
- **Results:** Grounded Theory (Corbin and Strauss, 2014)



Related Publications

***Paper** about Qualitative Results and Evolution on **ICEIS** (2024)*

***Article** about Quantitative Results on **IJHCI**, Taylor & Francis (2024)*

Study 1: Quantitative Results about v1

								50%+			75%+			Yes	No
Q1	P1	P2	P3	P5	P6	P7	P8	P10	P11	P12	P13	P4	P9	84,6%	15,4%
Q2	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	92,3%	7,7%
Q3	P1	P2	P3	P5	P6	P7	P8	P9	P11	P12	P13	P10	P4	91,7%	8,3%
Q4	P1	P2	P3	P6	P8	P9	P10	P11	P13	P4	P5	P6	P12	69,2%	30,8%
Q5	P3	P6	P8	P9	P10	P11	P12	P1	P2	P4	P5	P7	P13	53,8%	46,2%
Q6	P1	P2	P3	P5	P6	P7	P8	P9	P10	P11	P4	P9	P12	76,9%	23,1%
Q7	P1	P2	P3	P4	P6	P7	P8	P10	P11	P12	P13	P5	P9	84,6%	15,4%

Q1 – **Suitable** for evaluating usability/UX in SHT;
Q2 – It **covers** sufficient aspects;
Q3 – Adequacy of the **Likert** scale;
Q4 – Usefulness of **N/A**;
Q5 – Usefulness of **IDK**;
Q6 – UUXE-ToH v1 is **easy** to learn and use;
Q7 – The quantity and content of **open-ended** questions is adequate.

Study 1: Quant. Results about Sentences

S							50%+			75%+				Moda	Mediana	IQR
1	P1	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P13	P9	5	5	0
2	P1	P2	P3	P4	P5	P7	P8	P10	P11	P12	P6	P9	P13	5	5	0
3	P1	P2	P3	P5	P7	P8	P11	P12	P6	P10	P13	P4	P9	5	5	1
4	P1	P2	P3	P5	P6	P7	P8	P10	P12	P13	P4	P9	P11	5	5	1
5	P1	P2	P4	P5	P6	P7	P8	P10	P11	P12	P13	P9	P3	5	5	0
6	P1	P2	P3	P5	P6	P7	P8	P10	P11	P12	P4	P13	P9	5	5	0
7	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P1	P9	P13	5	5	0
8	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P1	P9	P13	5	5	0
9	P1	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P13	P9	5	5	0
10	P1	P2	P4	P5	P7	P8	P10	P11	P12	P3	P6	P9	P13	5	5	1
11	P1	P2	P3	P4	P5	P7	P8	P11	P12	P6	P9	P13	P10	5	5	0,25
12	P2	P3	P5	P6	P7	P8	P11	P12	P13	P4	P9	P1	P10	5	5	2
13	P2	P3	P5	P6	P7	P8	P10	P12	P4	P9	P13	P1	P11	5	5	1
14	P1	P2	P3	P4	P5	P6	P7	P8	P11	P12	P10	P9	P13	5	5	0
15	P1	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P9	P13	5	5	0
16	P1	P2	P3	P5	P7	P8	P10	P11	P6	P13	P4	P9	P12	5	5	1
17	P1	P2	P3	P5	P6	P7	P8	P10	P11	P4	P9	P12	P13	5	5	1
18	P1	P2	P3	P4	P5	P6	P7	P8	P10	P11	P12	P13	P9	5	5	0
19	P1	P2	P3	P4	P5	P7	P8	P10	P11	P6	P9	P12	P13	5	5	1
20	P1	P2	P4	P5	P6	P11	P12	P8	P13	P3	P7	P9	P10	5	5	1,25

Contributes a lot

Contributes a little

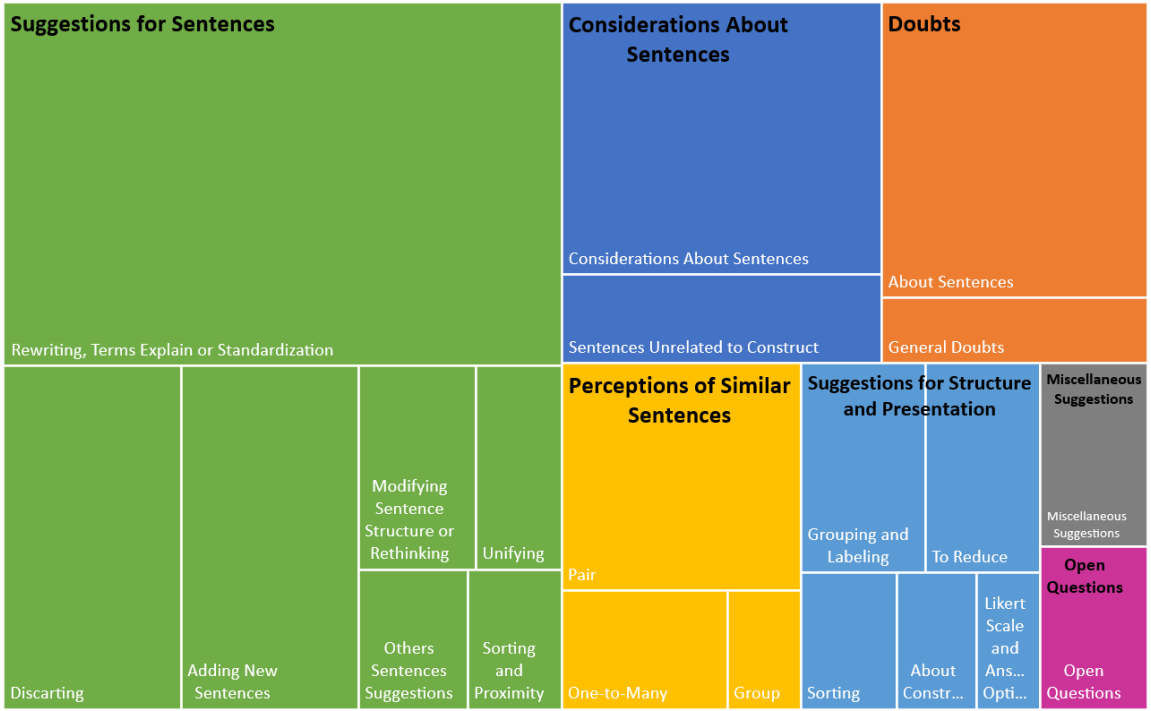
Does not disturb or contributes

Disturbs a little

Disturbs a lot

Did not answer

Study 1: Qualitative Results



The sentence 20 could be excluded to shorten the questionnaire, as it may already be included in others.

P10

P8

I think maybe grouping them into themes.

The sentence 8 is like the 2.

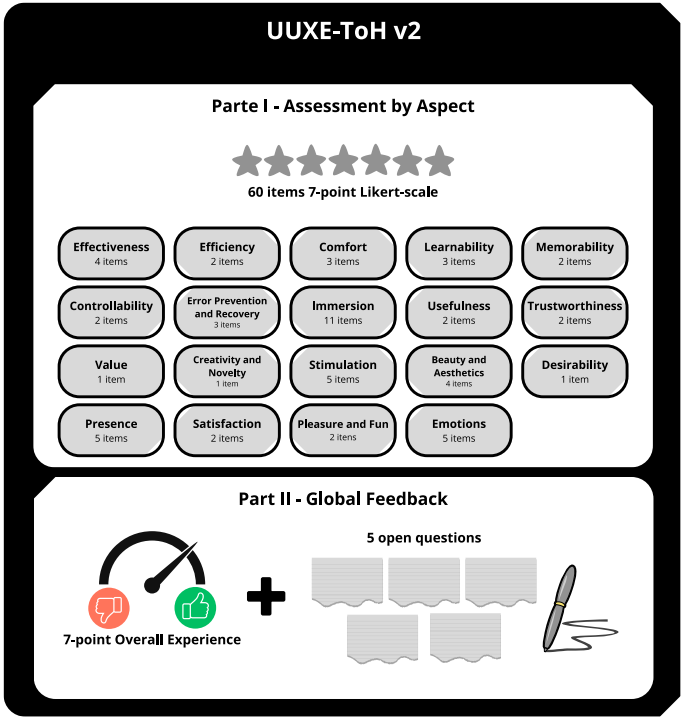
P3

P2

I was unsure between holography and hologram (...) Is holography the same as hologram? Will the user know the difference?

Processing of Results to v2

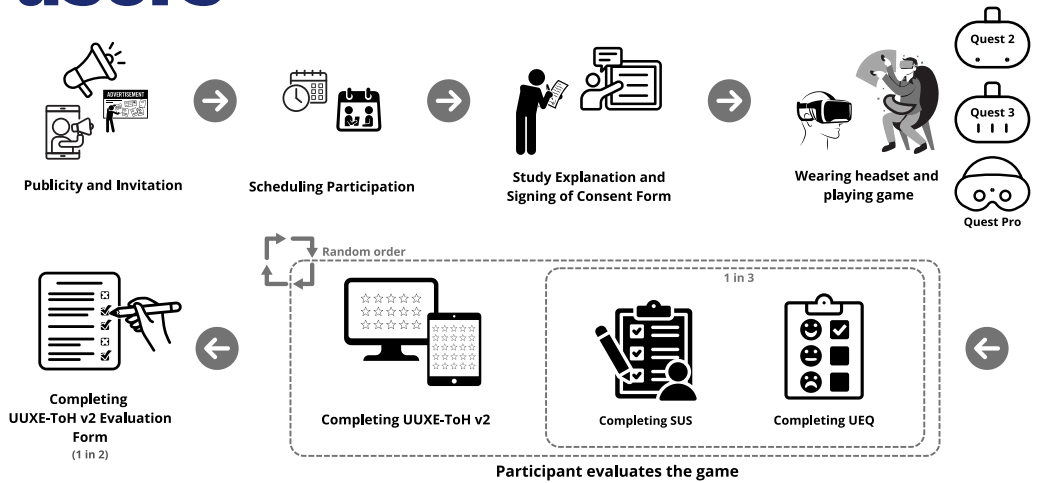
- **Removed:** General Usability, General UX
- New construct: **Comfort** (S7, S8, S54)
- Excluded IDK responses
- **Items:** –14, +7
- **Emotions** → 5 primary
- Standardized **wording**
- S38 → open-ended; Q1 → split
- Added 1 **semantic differential** (±)
- Items grouped, labeled; glossary added



Study 2 – with end-users

- **Goal**: refine UUXE-ToH v2
- **Reliability:** internal consistency
- **Validity:** semantic, structural, convergent (vs SUS & UEQ)
- **Ethics:** UFPR + partners (UTFPR, UDESC, UFOP), Mar-Jul 2024;
- **Data:** May–Aug 2024;
- **Participants: 260** (5 cities: Londrina, Cornélio Curitiba, Joinville, Ouro Preto);
- **THS:** Meta Quest 2, 3, Pro → Cubism

Cubism's Trailer (Bouwel, 2025)



Related Publications

***Paper** about Cubism Evaluation on **SVR** (2024)*

***Chapter Book** about **Semantic Validation and Evolution to UUXE-ToH v3** on **Springer LNBIP** (waiting publication)*

***Article about all Validations and Evolution to UUXE-ToH v4** on **JIS** (in revision)*

Study 2: Semantic Validation

130 answers about:

I1 – **Clear** and **easy-to-understand instructions**

I2 – **Sentences** and **questions** were easy to understand

I3 – Questionnaire **covered** important aspects of the experience

I4 – **Online** format was easy to use

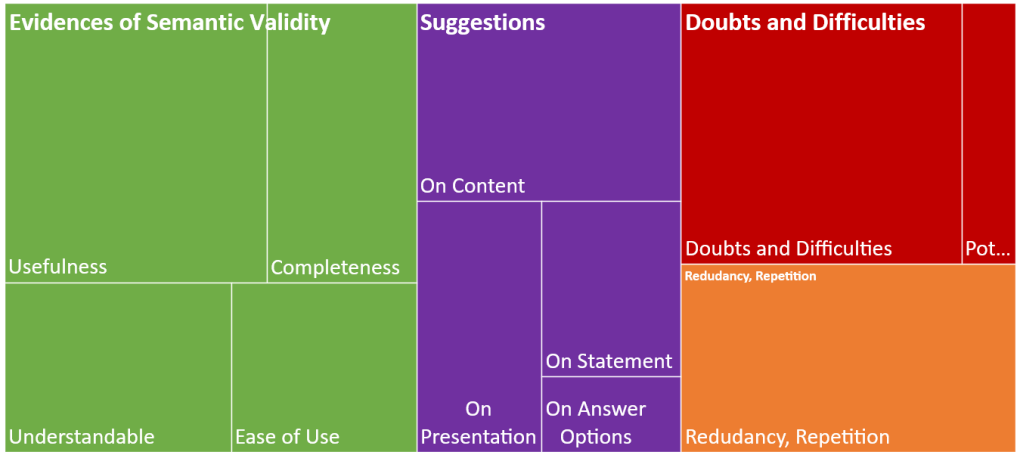
I5 – Is there **repetition** or **redundancy** between items?

Item	Average	SD	Median
I1	4.77	0.58	5
I2	4.63	0.66	5
I3	4.58	0.76	5
I4	4.75	0.68	5

Cronbach's **α**: 0,767
McDonald's **Ω**: 0,85

I5: Yes	I5: No
20	109
15.4%	83.8%

User Feedback Categories



P104: *All questions were clear and easy to understand. I liked the format of the questions with their direct, clear and objective statements.*

P27: *The explanation of occlusion was not clear.*

P37: *There were two questions that basically used different words to ask the same thing.*

Study 2: Internal Consistency Analyses

It checks the **reliability** of each construct;

Based on **α** de Cronbach e **Ω** de McDonald.

George e Mallery, 2016	
> 0,90	Excellent
> 0,80	Good
> 0,70	Acceptable
>0,60	Questionable
> 0,5	Poor
< 0,5	Unacceptable

Constructs	α	Ω	
Immersion	0,808	0,808	**good**
Emotions	0,775	0,801	
Controllability	0,772	0,772	
Pleasure & Fun	0,762	0,762	
Comfort	0,760	0,784	**acceptable**
Stimulation	0,746	0,773	
Effectiveness	0,732	0,768	
Usefulness	0,725	0,724	
Presence	0,686	0,716	
Beauty and Aesthetics	0,645	0,652	questionable
Satisfactions	0,685	0,685	
Memorability	0,620	0,620	
Trustworthiness	0,592	0,593	poor
Learnability	0,470	0,473	**unacceptable**

Study 2: Structural – Discriminant Validity

Weak or slightly moderate correlations are expected

Schober et al. 2018	
> 0.90	Very Strong
> 0.70	Strong
> 0.40	Moderate
> 0.10	Weak
> 0	Negligible

rho > 0.6

0.5 <= *rho* <=0.6

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A	0.474	0.346	0.409	0.321	0.542	0.413	0.376	0.559	0.380	0.278	0.247	0.360	0.256	0.305	0.444	0.395	0.237
B		0.150	0.335	0.346	0.415	0.288	0.253	0.324	0.281	0.124	0.201	0.298	0.141	0.063	0.293	0.241	0.247
C			0.256	0.264	0.252	0.320	0.221	0.296	0.259	0.228	0.217	0.189	0.206	0.243	0.288	0.331	0.188
D				0.378	0.458	0.358	0.315	0.399	0.349	0.231	0.318	0.302	0.267	0.205	0.343	0.325	0.299
E					0.401	0.364	0.303	0.385	0.251	0.238	0.311	0.287	0.221	0.200	0.359	0.385	0.392
F						0.528	0.389	0.544	0.416	0.331	0.331	0.450	0.238	0.220	0.575	0.429	0.374
G							0.503	0.567	0.391	0.304	0.369	0.540	0.260	0.277	0.508	0.379	0.295
H								0.468	0.478	0.447	0.457	0.476	0.433	0.342	0.489	0.494	0.333
I									0.542	0.310	0.377	0.509	0.266	0.354	0.508	0.423	0.300
J										0.481	0.449	0.437	0.371	0.270	0.547	0.495	0.284
K											0.494	0.323	0.404	0.224	0.443	0.429	0.289
L												0.372	0.432	0.242	0.481	0.511	0.281
M													0.361	0.330	0.549	0.432	0.244
N														0.225	0.367	0.484	0.320
O															0.396	0.329	0.199
P																0.621	0.423
Q																	0.484

Highest correlations (>0.55):

0.621 – Satisfaction vs Pleasure & Fun

0.575 – Controllability vs Satisfaction

0.567 – Trustworthiness x Immersion

0.559 – Effectiveness x Trustworthiness

Presence

Comfort

Weak correlations against all

Legend: Each letter represents a construct in UUXE-ToH. A - Effectiveness, B - Efficiency, C - Confort, D - Learnability, E - Memorability, F - Controllability, G - Immersion, H - Usefulness, I - Trustworthiness, J - Value, K - Desirability, L - Stimularion, M - Beauty and Aesthetics, N - Desirability, O - Presence, P - Satisfaction, Q - Pleasure & Fun, and R - Emotions

Study 2: Exploratory Factorial Analyses

Approaches

- **A:** ≤20 items (36 EFAs / 6 scenarios)
- **B:** Constructs ≥ 3 items (8 constructs, 39 items)
- **Criteria:** RMSEA<0.05, CFI>0.95, remove weak items

Findings

A: factors → Comfort, Controllability, Emotions

- **Overlaps:** Stimulation–Desirability, Immersion–Trustworthiness
- **Discarded:** S12, S50, S56, S30, S34, S42, S45

B: factors → Comfort, Emotions, Stimulation, Presence

- **Link:** Immersion ↔ Aesthetics (visual quality → immersiveness)
- **Discarded:** Effectiveness, Learnability, some Immersion/Presence/Aesthetics

Table 4. Factor Loadings for Group A in Scenario 3

	F 1	F 2	F 3	F 4	Uniqueness
S7		0.832			0.327
S8		0.492			0.663
S9		0.786			0.371
S13				0.508	0.548
S14				0.702	0.508
S15			0.841		0.319
S16			0.704		0.390
S57	0.704				0.461
S58	0.816				0.307
S59	0.833				0.351
S60	0.563				0.535

Study 2: Convergent Validity

Method

- Subsample answered SUS & UEQ
- Spearman correlations (construct medians)

Results

- All Pragmatic aspects ↔ SUS
- Hedonic aspects ↔ UEQ
- All ↔ UEQ

Discussion

- Confirms consistency with traditional tools
- Adds Immersion & Presence (missing in SUS/UEQ)
- UUXE-ToH usable as complementary or standalone

Positive moderate correlations are expected

Table 15. Correlation for Usability in UUXE-ToH vs SUS Score

UUXE-ToH Construct	ρ	p-value
Effectiveness	0.62592267	3.1889E-09
Efficiency	0.32466828	0.00507181
Comfort	0.32064883	0.00567879
Learnability	0.27723047	0.01757172
Memorability	0.19327560	0.10135213
Controllability	0.25775797	0.0276921
Usefulness	0.44455999	8.1387E-05
Trustworthiness	0.36904677	0.00131384
Satisfaction	0.46589953	3.2693E-05
Immersion	0.18553807	0.11605356
Traditional Usability	0.55547620	3.3813E-07
Trad. Usability + Immersion	0.51047226	3.9526E-06

Table 16. Correlation for UX in UUXE-ToH vs UEQ

Comparison	ρ	p-value
UEQ vs Q1/UUXE-ToH	0.4575003	3.681416e-05
Efficiency/UEQ vs Effectiveness, Efficiency, and Comfort / UUXE-ToH	0.4273898	1.459477e-04
Dependability/UEQ vs Controllability and Trustworthiness / UUXE-ToH	0.3687768	1.224574e-03
Perspicuity/UEQ vs Learnability and Memorability / UUXE-ToH	0.4992576	5.95533E-06
Stimulation/UEQ vs Stimulation and Pleasure & Fun/UUXE-ToH	0.4069831	3.200525e-04
Novelty/UEQ vs Creativity and Novelty, and Desirability / UUXE-ToH	0.4930889	8.06814E-06
Attractiveness/UEQ vs Beauty and Aesthetics, and Satisfaction / UUXE-ToH	0.4544422	4.75767E-05
Attractiveness, Stimulation and Novelty / UEQ vs UX constructs in UUXE-ToH	0.3990910	4.279510e-04
UEQ aspects vs all items of UUXE-ToH	0.6573284	1.999383e-10

Processing of Results to v4

Integration

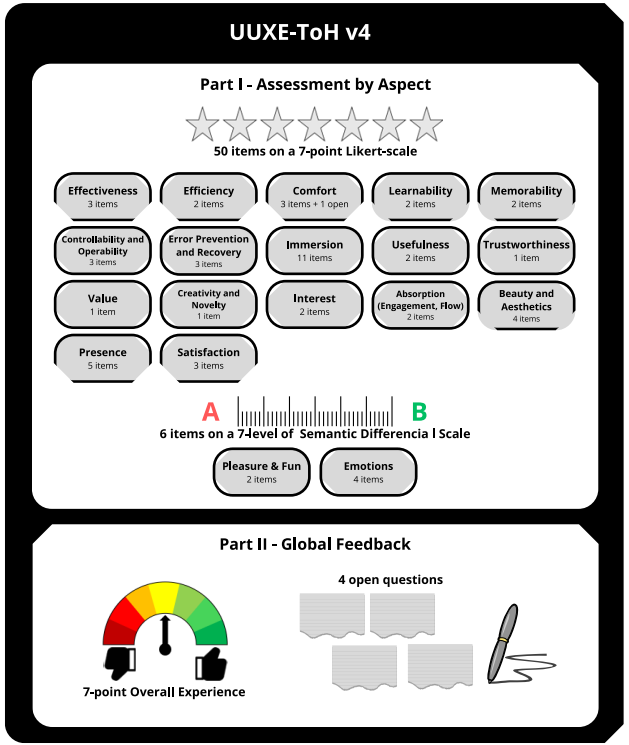
- Combined semantic, structural, discriminant, convergent, reliability
- Identified strong vs. weak constructs

Refinements

- Removed redundant/problematic items
- Split Stimulation / merged overlaps (e.g., Stimulation & Desirability)
- Adjusted Learnability, Presence, Satisfaction for clarity/reliability

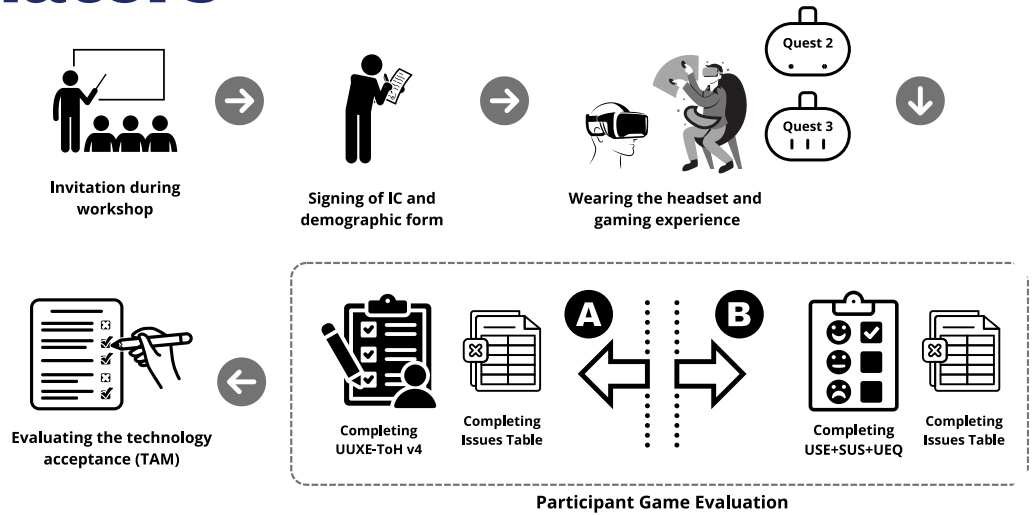
Final Outcome (v4)

- Balanced constructs, theory-based
- Multidimensionality with less redundancy
- Stronger Immersion & Presence coverage
- Clearer wording, better comprehension, shorter time



Study 3 – with evaluaters

- **Goal**: assess UUXE-ToH v4 about:
  - **Performance:** effectiveness and efficiency to identify issues
  - **Acceptance:** TAM 3 and user feedback
  - **Two Groups:**
    - A: UUXE-ToH v4
    - B: USE + Slater-Usoh-Steed (SUS) + UEQ
- **Ethics:** Set 2024;
- **Data:** Oct. 8, 2024, during workshop on IHC 2025, in Brasilia, DF;
- **Participants:** 14



Related Publications/Submissions

Paper *about Performance and Acceptance of UUXE-ToH v4 on* ***ICEIS*** *(2025)*

Article *about Evaluation of a MR Puzzle Game Using Questionnaires on* ***JIS*** *(2025)*

Chapter Book *about Evaluation of Usability and UX in AR and VR on* ***IHC*** *(2025)*

Study 3: Performance Results

	Grupo A UUXE-ToH v4	Grupo B USE+SUS+UEQ	Total
Unique Issues (UI)	**26**	14	40
Duplicated Issues (DI)	**5**	1	6
Total Issues (TI)	**31**	15	46
Identifiable Issues (II)	**29**	15	43
II Coverage (IIC)	**67.4%**	34.8%	
Average / Participant	**~4.1**	~2.1	
Velocity (IT/minute)	**2.82**	2.50	

	Teste	Estatística	df	p
PT	Student	2.874	12	0.014
	Mann-Whitney	43.000		0.017
Cobertura	Student	2.868	12	0.014
	Mann-Whitney	43.000		0.017

Significant difference
p-value < 0.05

	Teste	Estatística	df	p
Minutos	Student	0.819	9	0.434
	Mann-Whitney	16.000		0.925
VPT	Student	1.321	9	0.219
	Mann-Whitney	20.000		0.410

Non-significant difference
p-value > 0.05

Aspect	A	B
Effectiveness	5	1
Efficiency		
Comfort		1
Learnability	2	1
Memorability		
Controllability and Operability	10	6
Error Prevention and Recovery	5	1
Immersion	5	5
Usefulness		
Trustworthiness	2	
Value		
Beauty and Aesthetics	1	
Interest		
Absorption (Engagement, Flow)		
Presence	1	
Satisfaction		
Pleasure and Fun		
Emotions		
Total	**31**	**15**

Study 3: Acceptance Results

Id	Grupo	PU1	PU2	PU3	PU4	PU	PEOU1	PEOU2	PEOU3	PEOU4	PEOU	BI1	BI2	BI3	BI
P1	A	7	7	7	7	7	7	7	7	7	7	7	7	7	7
P2	A	6	5	7	7	6,5	7	5	6	7	6,5	6	6	3	4,5
P3	A	7	6	4	7	6,5	7	7	7	7	7	7	7	6	6,5
P4	A	7	7	7	7	7	6	7	7	7	7	7	6	6	6
P5	A	7	7	7	7	7	6	6	6	7	6	6	6	4	5
P6	A	7	7	7	7	7	6	7	7	7	7	7	7	7	7
P7	A	6	7	7	7	7	7	7	7	6	7	7	7	6	6,5
P8	B	5	5	5	6	5	5	5	3	4	4,5	5	6	3	4,5
P9	B	7	7	7	7	7	6	7	7	7	7	7	7	3	5
P10	B	7	7	7	7	7	7	5	7	6	6,5	7	7	7	7
P11	B	7	6	7	7	7	7	5	7	7	7	7	7	4	5,5
P12	B	7	7	7	7	7	7	7	7	7	7	4	4	4	4
P13	B	6	6	7	7	6,5	7	5	6	6	6	4	3	3	3
P14	B	7	7	7	7	7	6	6	6	6	6	7	6	5	5,5

	Teste	Estatística	df	p
BI1	Student	1.470	12	0.084
	Mann-Whitney	31.000		0.185
BI2	Student	1.342	12	0.102
	Mann-Whitney	31.000		0.200
BI3	Student	1.796	12	0.049
	Mann-Whitney	36.500		0.066
BI	Student	1.886	12	0.042
	Mann-Whitney	37.000		0.061

Significant difference for BI3 and BI p-value < 0.05

	U	df	p
PEOU1	26.000		0.442
PEOU2	36.500		0.053
PEOU3	29.000		0.273
PEOU4	35.500		0.056
PEOU	33.000		0.127

P-values close to 0.05 for PEOU2 and PEOU4, but not below.

Limitations

- **Methodological:** limited scope (until Apr 2023), small Brazilian sample, single MR game/device
- **Operational:** scarce & costly equipment, few THS apps, in-person recruitment, short sessions, low diversity
- **Instrumental:** long questionnaire, excluded items, small/uneven samples

Future Works

Expand Scope: Disseminate UUXE-ToH, encourage broader use, collect feedback;

Tools: Official site, manual, digital platform with interactive reports;

Cross-Cultural: Translation & adaptation, study cultural influences;

Research: Use Structural Equations Modeling (SEM) for construct analysis, develop shorter/modular versions.

Publications & Research Products

Publications

- International Journal of Human-Computer Interaction (**IJHCI 2024**)
- Journal on Interactive Systems (**JIS 2025**) – **two** articles
- Lecture Notes in Business Information Processing (**LNBIP 2025**, accepted)
- Brazilian Symposium on Human Factors in Computing Systems (**IHC 2023**, **2024**)
- Symposium on Virtual and Augmented Reality (**SVR 2024**)
- International Conference on Enterprise Information Systems (**ICEIS 2024**, **2025**)

Questionnaire

- **UUXE-ToH Questionnaire** (v1–v4) – validated in multiple studies
- **User Manual** with guidelines and examples
- **Official Website & Digital Platform** – forms, dashboards, interactive reports
- **Technical Reports** from Systematic Mapping Studies
- **Porifera Tool** – collaborative system for systematic reviews and mapping studies
- **Publications about Porifera**:
  iSys (2023), SBES (2022), and SBSI (2022)

Contributions

- **Classification** of THS and evaluation technologies
- **Theoretical basis** for usability & UX in immersive systems
- **Structured methodology** for questionnaire validation
- **UUXE-ToH**: integrates pragmatic & hedonic aspects

- **Applicable** across contexts, devices, and user profiles
- **Delivers HCI community a validated tool tailored to THS evaluation.**

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Download the slides and all presented content here.

IHC 2025 Belo Horizonte

Organização

Realização

Patrocínio

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