Between Game Mechanics *and* Immersive Storytelling: Design Using an Extended Activity Theory Framework

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Abstract. This paper outlines the latest work of an on-going long-term sustained research effort to extend and operationalise Leontiev's original hierarchical activity theory framework to model and support the design, development and analysis of games, virtual environments and virtual reality for purpose. While previous work extended Leontiev's activity theory to incorporate both task-based and experiential-based activities and actions performed within a sphere of engagement - corresponding to Huizinga's "play-grounds", "arenas" and "magic circle", and mechanism to analyse and assess the success of purpose, the focus of this earlier work was largely on narrative, scenario and story-based activities, and didn't capture or extend well to gameplay mechanics. The framework described herein describes initial work that builds on and extends earlier work to provide a tool, notation, grammar and building blocks that informs both HCI and practice-based approaches to represent gameplay mechanics *and* narrative, scenario, story-based activities; from game design concepts and ideas, through modelling and analysis, to informing implementation, development and creative practice. The framework is intended to support all delivery platforms and extend to all purposes/sectors (education, health, esports, business, documentary, tourism, social impact, culture, etc.) across the serious games continuum: from games for purpose to experiential environments for purpose. To highlight the versatility of the initial work to extend the activity theory framework, described herein are several examples of serious games, interactive storytelling and immersive VR for purpose developed in research projects, and in the professional immersive storytelling content creation Singapore-based studio Warrior9 VR.

Keywords: Narrative · Story · Mechanics · Games · Serious games · VR · Immersive · Interactive storytelling · Interactive narrative · Framework · Activity theory · Notation · Grammar · Design · HCI · Creativity · Practice-based · Reflective practice

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1 Introduction

The design, development, and creation of games, serious games, VR, AR, immersive worlds, etc. arguably follows one of two approaches – using methodologies from the design and analysis discipline of Human-Computer Interaction (HCI), and practice-based approaches typically embraced by the arts, creative practitioners, and in games and immersive VR studios. While there is some crossover, these two groups largely co-exist independently.

HCI has a long and successful history in iterative design and development, user/player-centered, participatory-design, prototyping, and analysis, evaluation, and assessment of interactive and digital media. While HCI has long looked to the arts to inform methods, and includes creatives, performers and artists in HCI design and development teams, the arts and creativity within HCI typically is incorporated within a traditional engineering and technical design and development iterative cycle.

Practice-based is another successful approach that has a long history in creativity, creative arts, design and making cultures and disciplines. Practice-based approaches are part of a larger family of reflective practice and action-based approaches following Schön's "The Reflective Practitioner" [1] which includes disciplines outside the arts such as, healthcare, medicine, and education, etc. At the heart of action-based approaches is an action-reflection cycle. In the arts, this is iteratively performed in a cycle of making and creating, evaluating/reflecting-in-action, and informing making, and so on. Although creative, making, and practice-based approaches have typically dominated the games industry, and despite the games industry being one of, if not the most profitable interactive digital media industry, over several years there has been several criticisms, and calls for more formal approaches and tools to support and inform game development practitioners in game studios/industry. The advantages being to better support large-scale projects, keeping them on-track, within time and budget, and so help to reduce costs.

As Katherine Neil identifies in her 2016 Gamasutra article [2] "How we design games now and why", that over the years, numerous calls have been made in the games industry to address the making-focused approaches, and make available more games design tools, methods, and formal approaches to support games design and game design thinking in the games industry. For example, going back as early as 1999, game designer Doug Church proposed the need to develop 'formal, abstract design tools' in his well-known article published in the industry's trade magazine *Game Developer* [3]. Later, Raph Koster (2005) drew our attention to "the imprecision of natural language as a tool for designing gameplay", and proposed a graphical notation system in his well-known Games Developers Conference presentation "A Grammar of Gameplay" [4]. While game designer Dan Cook (2007) disparagingly said games design occurred accidentally through habit and guesswork [5].

One thing is clear, that as game and serious games designs and projects became larger, the design documentation also correspondingly became larger. This increases the difficult in managing and keeping track of projects. We've come a long way since these early days with a host of standard texts from writer-practitioners on games design [e.g. Ernest Adams, Tracy Fullerton, Chris Crawford, Katie Salen and Eric Zimmerman, David Perry, etc.] used throughout the world, to introduce, educate, inform and enlighten game practitioners and students (of games design courses and degrees), and

researchers, academics and students of HCI and interaction design interested in learning about the craft of game design. In particular, more recently one driver for the HCI communities comes from the strong interest in gamification – applying game elements and characteristics to digital, interactive, online, apps, and services, etc.

Similarly, in the emerging discipline of serious games we witnessed early calls for serious methodologies and design approaches incorporating both research *and* development to address the spate of published work focused on development and practice alone [e.g. 6, 7, 8]. While more recently we've seen an escalation in reports, publications, workshops and conferences focused on serious games design and thinking, and in particular focused on mechanics in serious games these typically adopt HCI focused approaches over art, making, creativity, and practice-based approaches.

Herein, it is argued that both approaches have advantages and could inform and inspire, and feasibly be incorporated with one other. Interestingly, at the heart of both HCI and practice-based approaches is an iterative approach. In HCI, it's the iterative design, development, analysis, evaluation and playtesting cycle; and in practice-based, it's the iterative making/creating, evaluating/reflecting-in-action, and informing making cycle. So for example, it's not difficult to imagine a practice-based creative iterative approach incorporated within an HCI iterative design and development cycle, and vice versa. This paper describes an approach that informs both the HCI design and development cycle and an action-based/practice-based approach for the design and creation of games, serious games, VR and immersive environments. This paper outlines the latest work of an on-going long-term sustained research effort to extend and operationalise Leontiev's (1981) original hierarchical activity theory framework [9]. The framework described herein describes initial work that builds on and extends earlier work to provide a tool, notation, grammar and building blocks to represent gameplay mechanics *and* narrative, scenario, story-based activities; from game design concepts and ideas, through modelling and analysis, to informing implementation.

This paper is organised as follows. In section two, related and previous work to extend and operationalise Leontiev's (1981) original hierarchical activity theory framework is described. Section three describes the notation, grammar and building blocks of the extended framework, and provides examples of serious games, VR and immersive environments gameplay mechanics *and* narrative, scenario, story-based activities represented through the framework. Section four concludes the paper summarising the work and advantages of the framework.

2 Previous and Related Work

Previous work building on the hierarchical activity theory based framework and approach [10–16] has made considerable advances to extend and operationalise Leontiev's (1981) original activity theory to model and support the design, development and analysis of serious games, virtual environments and virtual reality for a variety of purposes along the serious games continuum [17], as shown in Fig. 1.

Fig. 1. Serious games continuum: showing from left to right, games for purpose (with traditional game characteristics) to experimental & experiential environments for purpose (with minimal game characteristics), as follows: Oceans We Make [18] third activity with game characteristics with purpose to collect plastics in the ocean; The Reef Game [19] game-like to slow down or stop harmful human activities to the Great Barrier Reef (second activity); VR Slow Reef Experience [20] swimming through the beauty and wonder of the Great Barrier Reef (first activity); Oceans We Make [18] first activity preparing to go for dive in the ocean

While the previous work [21] developed a framework using activity theory, and interestingly draws on and mixes concepts and frameworks from the two main activity theory systems of Engestrom (1987) [22] and Leontiev (1978) [23], the focus of this work is exclusively on educational serious games. Other earlier activity theory work similarly focusing exclusively on learning games is for example [24]. So while several other published work has explored activity theory and games and serious games, invariably this work focuses on [22] version or hybrid of [22] and Leontiev's later and revised works [23], and focuses on learning or educational games. Interestingly, the English translation of Leontiev's [23] second publication appeared in print before Leontiev's [9] first publication which was translated from Russian to English and published in 1981.

Our activity theory work focused on Leontiev's [9] original activity theory containing the powerful activity concepts of motive and objective that define "activity proper". Our earlier work, referred to as HABS (Hierarchical Activity-Based Scenario approach) focused on interactive narrative, scenario and story-based activities, composed largely of written description or statements of actions/play, similar to a script/scriptwriting, although structured accordingly in a hierarchy of activity, actions, operations, and intention/motive, directed towards objective.

The framework's lens-like ability provided a way to describe and represent any level of abstraction from high-level descriptions of activity to zoom-in to any low-level of actions, sub-actions, sub-sub-actions, and so on, and use of tools and artifacts responding to conditions of action. In [10], we presented the first-steps demonstrating the flexible and powerful ability of the HABS framework applied to the learning game "2020Classroom" (NSF-funded) to zoom-in to any level of detail and complexity, and study results demonstrated the mechanism to analyse, assess and reason about the success of purpose (for undergraduate students to learn about processes of human organs) – through *objective outcome coinciding with motive*. Further refinement to this work was presented in [13].

While this earlier work focused on task-based single-activity and multiple-actions we further extended Leontiev's (1981) activity theory to incorporate experiential-based activities through the *outcome of objective merging with motive*, as well as task-based multiple-activities and actions [14] performed within a Sphere of Engagement [16] corresponding to Huizinga's "play-grounds", "arenas" and "magic circle" [26]. However, the focus of this earlier work on narrative, scenario and story-based activities didn't capture or extend well to gameplay mechanics of loops of interactive play activity/actions that is key to reinforcement of an idea through repeated action [27, 28] and that typically characterise games and games for purpose. Considering the serious games continuum [17] that captures all purposes from all sectors irrespective of platform, it can be seen that our previous work focusing on interactive narrative, scenario and story-based activities, was less effective at capturing or extending to games for purpose with game elements, characteristics and mechanics identified predominately on the left-hand side of the continuum.

Therefore, this called for the next phase in the evolution of the Leontiev's [9] activity theory, to further extend and operationalise our activity theory-based framework and approach to capture core and other game mechanic loops of play activity/actions that typically characterise games and games for purpose, as well as, represent interactive narrative scenario story-based activities.

3 Extended Activity Theory Framework: Notation, Grammar, Building Blocks for Mechanics, Narrative and Story

In this section we present the initial work that builds on and extends earlier work to provide a tool, notation, grammar and building blocks that informs both HCI and practice-based approaches to represent gameplay mechanics *and* narrative, scenario, story-based activities. The framework is intended to facilitate and inform HCI transition from requirements, ideation, design to implementation, and helps practice-based approach transition from ideation, design docs to creation. It's intended to support all delivery platforms and extend to all purposes/sectors (education, health, esports, business, documentary, tourism, social impact, culture, etc.) across the serious games continuum: from games for purpose to experiential environments for purpose.

As demonstrated in our previous work, blending both mechanics and narrative/story provides powerful strategies for design of serious games and immersive environments for purpose. For example, as demonstrated through our exhibited, showcased and published works: The Reef Game [19] and Oceans We Make [18] which incorporate both gameplay mechanics for purpose and experiential environments for purpose, and the VR Slow Reef Experience [20] that incorporates an experiential environment for purpose. As these serious games and immersive VR environments extend across the serious games continuum (Fig. 1), we focus on these examples in this section to demonstrate the extended activity theory framework.

Following Koster (2005), at the heart of our framework is notation and grammar that we have developed. Notation systems are found in the arts, dance and music. As shown in Fig. 2, examples include, the Labanotation which is a visual notation used to record and analyse human movement and the staging of dance and design of choreographed movement sequences, and Musical Notation used to visually represent music played with instruments through the use of symbols and other signs such as for durations, rests, tone dampening and sustaining. In our framework, the notation is derived from extended activity theory concepts and games and serious games design elements and characteristics.

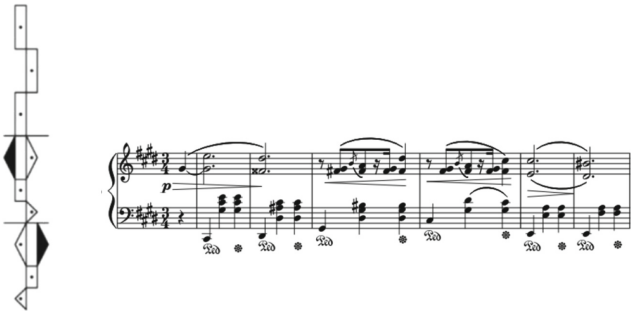
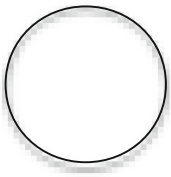
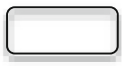
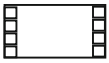


Fig. 2. Notation Systems: (left) Labanotation records human movement sequences for archive and choreography of dance, and (right) Musical notation represents music through symbols and other signs for durations, rests, tone dampening and sustaining.

In the next section we describe the extended activity theory framework, notation and grammar for narrative, story and mechanics, and provide a number of examples including the exhibited, showcased and published works: The Reef Game [19] and Oceans We Make [18] which extend across the serious games continuum (Fig. 1), and the experiential environment VR Slow Reef Experience [20] to demonstrate the versatility of the framework.

<table>
<tr><th colspan="4">3.1 Activity Theory Framework, Notation & Grammar for Narrative, Story & Mechanics</th></tr>
<tr><td colspan="2">  </td><td colspan="2">Sphere of Engagement (SoE): corresponds to the environment, “play-grounds” “arena” and “magic circle” (Huizinga’s 1955), in which one or more activity is performed – and provides a boundary / demarcation between that which is external / outside of the sphere to that which is internal through either focus of attention / engagement / play or enveloped by technological platform e.g. VR, virtual and game world, gameplay map, and maintain the illusion [25]. Can incorporate either or both task-based and experiential-based activities and actions</td></tr>
<tr><td colspan="2"> 
</td><td colspan="2">Objective and Motive (O & M) Coincides: task-based activity / actions - towards the fulfilment of goals until objective is fulfilled and / or condition is met. Relationship between O & M provides a means to frame activity and a mechanism to assess / reason about the success of activities / actions through the degree to which outcome of objective *coincides* with motive.</td></tr>
<tr><td colspan="2"> 
</td><td colspan="2">Objective and Motive (O & M) Merges: experiential-based activity / actions - relationship between O & M provides a means to frame activity and a mechanism to assess / reason about activities providing an experience as objective outcome *merges* with motive. Merges doesn’t necessarily suggest an end point (like task-based) but suggests that as long as actions are contributing to the merging, then motive is being fulfilled or satisfied</td></tr>
<tr><td>  </td><td>Game Start: start of game or experiential encounter; entry to SoE or magic circle (left)</td><td>Game End: identifies end of game or experiential encounter (middle)</td><td>Transition / Link: linear sequential transition; with direction from one activity / action to (right)</td></tr>
<tr><td colspan="2">  </td><td colspan="2">Game Mechanic Loop: activity / action(s) performed repeatedly again and again in a loop. Represents the core or other game mechanic loop of *essential play, narrative, environmental storytelling, or experiential activity / actions*</td></tr>
<tr><td colspan="2"></td><td colspan="2">Choice, Decision, Branching, Synchronisation: marks the point at which a choice, decision, branch / branching occurs (can be mandatory or optional) or is synchronisation for players to begin at the same time e.g. start of a race, contest – see examples below.</td></tr>
<tr><td>  </td><td>  </td><td>Message: title screen, end credits, instructions on gameplay, UI or controls, etc.; introduce or update backstory; can be text, visuals, voiceover.</td><td>Cut scene: denotes linear presentation video or animation and duration - to introduce or update story/game, tutorial on gameplay or controls, etc.</td></tr>
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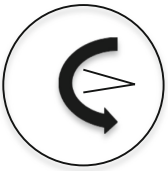
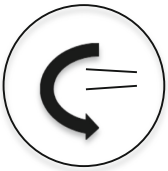
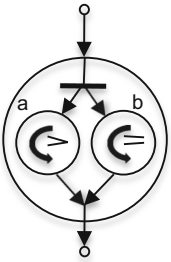
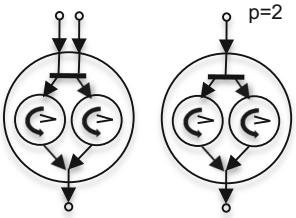
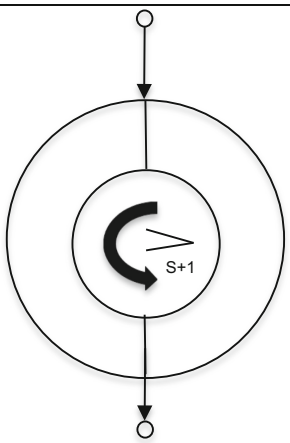
	Task-Based Loop: activity / action(s) performed within SoE / "play-ground" repeatedly again and again in a loop towards a goal until fulfilment and / or condition(s) is met / end-game state reached / questions correctly answered, etc. when objective outcome coincides with motive e.g. core or other game mechanic loop of *essential play activity / actions* towards a goal – may be incorporated or nested with experiential-based activity(ies) / actions with goal e.g. to explore / experience an environment / space. Associated conditions, variables or states are labelled and adjusted (+/-) or comparison (=, <, >) each time around the loop or until a certain point, stage, target is reached e.g. +1; -1; does x = 0? or time = 0? then end. Activity may represent sections, scenes, units, missions
	Experiential-Based Loop: activity / action(s) performed within SoE / "play-ground" by wandering, meandering, exploring, travelling, discovering, observing, and / or engagement in / experience content – not necessarily driven by (known) goal or challenge e.g. core mechanic is to explore an environment or space, walking (or swimming, flying, outer space travel, looking, etc.) simulator games, narrative games, or environmental storytelling – may incorporate or nested with, or choice to perform, task-based actions e.g. to hunt, or search for something. Associated conditions or variables are adjusted, or comparison made or until point reached e.g. if time = 0 then end. Activity may represent sections, scenes, units, missions.
	Choice, Decision, Branching: activities within the sphere of engagement, play-ground, magic circle, arena shown opposite – shows player's possible choices between two activities (branching could also be result of condition): a. task-based b. experiential-based
	Synchronisation: between more than one player to begin task-based activities at the same time e.g. start of a race, obstacle course, challenge. The notation opposite shows two players starting a game at the same time – on the left hand-side the two players are shown explicitly and on the right a shorthand notation identifies the two players by p=2

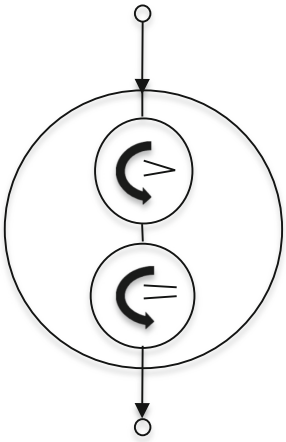


3.2 Basketball Waste Disposal and Recycle Game

Purpose: player learns about the types of trash and the appropriately coloured bin to dispose / recycle it i.e. general waste-green lid; recycle-yellow lid; green waste-lime green lid – learn while playing a fun game!

Activity Statement: task-based, repeatedly sorting waste and recycling trash by shooting baskets into one of three coloured bins, incrementing score s+1 for correctly sorted trash, against the clock-until end game time reached (e.g. 2 minutes). Creates competition between players to get highest number of baskets.

Motive: recycle trash
Objective: sort into correct coloured recycle bin by scoring baskets
[student serious game on BA Games Design, GFS]



3.2.1 Beach Clear – Pollution-Trash

Purpose: intended to evoke uplifting feeling of accomplishment; beautifying environment creates positive experience. Message: Clean-up & don't litter!

1. Activity Statement: first activity is task-based, repeatedly picking-up trash scattered around the island and loading on a boat until no more trash on island (e.g. with 20 pieces of trash, the core mechanic is repeated 20 times until no trash). As trash is cleared, island progressively becomes more beautiful, sky and sea becomes brighter and bluer, increase in fish swimming and jumping, and birds flying and singing.

Motive: clean-up / clear island of pollution and trash.
Objective: pick-up trash and load on-board boat

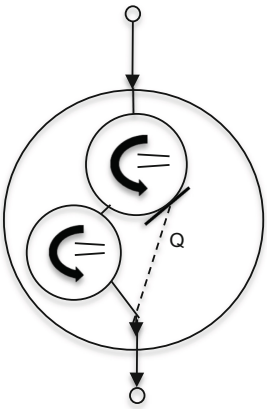
When Motive and Objective outcome coincide the activity ends.

2. Activity Statement: second activity is experiential-based, sail away on boat into the sunset

Motive: escape island - enjoy the experience!
Objective: sail boat into / across open sea into sunset

NOTE: the second activity could be incorporated in the first but separating these emphasises the task-based clean-up activity from experiential-based positive and uplifting experience of sailing away into the sunset.

[student serious game on BA Games Design, GFS]



3.2.2 VR Reef Experience

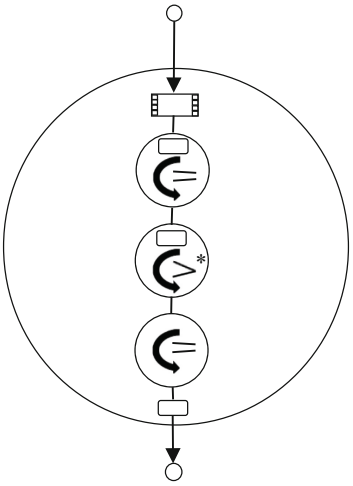
Purpose: To experience contrast between the healthy beautiful, tranquil Great Barrier Reef (GBR) and glimpse a possible future with destroyed, lifeless, dead Great Barrier Reef. Awareness of that the Reef is under threat of further sustained damage. Message to take care of the GBR, reduce harmful effects and causes of climate change.

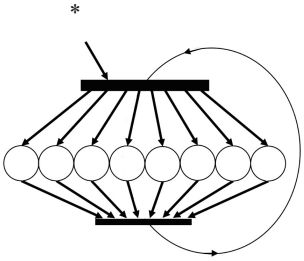
1. Activity Statement: first activity is experiential-based, swim anywhere in any direction, for as long as you please, through the tranquil, beautiful GBR – swim with clown fish, shoals of fish, turtles, dolphins, sharks, jelly fish, and around corals and rocks. Prolong stares brings-up the name of the fish. Option to quit "Q", but as all participants need to experience 2nd activity to fulfil purpose, the transition from 1st to 2nd activity was positioned in the player's line of sight after predetermined times to encourage transition to 2nd activity.

Motive: experience healthy, tranquil, beautiful GBR
Objective: swim in any direction, for as long as you please

2. Activity Statement: second activity is experiential-based, swim anywhere in any direction, for as long as you please, through the destroyed, lifeless, with dead fish, and bleached and destroyed corals of the future Great Barrier Reef

Motive: awareness of harmful human activities and climate change to GBR
Objective: swim in any direction, for as long as you please





Harmful human activities: farming run off, construction run off, speeding water sports, plastic bags, crown of thorns starfish, over tourism, heavy shipping and smoke / pollution from local industry

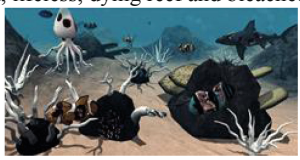
3.2.3 The Reef Game – tablet / smartphone

Purpose: To experience contrast between the healthy beautiful, tranquil Great Barrier Reef and glimpse a possible future with destroyed, unhealthy GBR. Awareness of harmful effects to the Reef from human activities during fun game play. Message to take care of the GBR, reduce harmful effects & climate change. Message: Slow Down / Stop harmful human activities

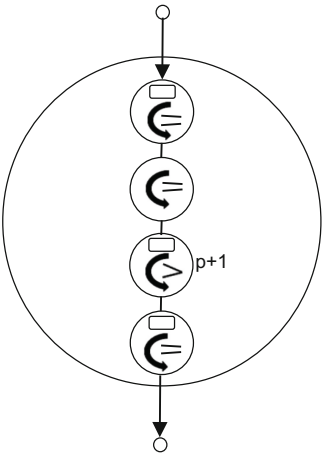
First, cut scene opening shot moving closer to the game title.
1. Activity Statement: first activity is experiential-based, UI instruction invites the participant to swim and explore anywhere in any direction, through the tranquil, beautiful GBR – swim with clown fish, shoals of fish, turtles, dolphins, sharks, jelly fish, and around corals and rocks – 1 minute.

2. Activity Statement: second activity is task-based, UI instructions to tap on harmful human activities. Game loop is shown opposite; as the harmful events occur in a seemingly random order, the player taps on them to slow down or stop harmful activities. A fun game that gets faster and faster, increasing the challenge, but the ocean inevitably becomes darker, polluted, unhealthy, and game play ends ~1.30mins.

3. Activity Statement: third activity is experiential-based, participant to swim and explore anywhere in any direction, for as long as you please, through the destroyed, lifeless, dying reef and bleached corals.



Reef Game ends with thought-provoking message. Further design details can be found in [30, 31].



3.2.4 Oceans We Make – VR

Purpose: The purpose of OWM is to give participants an experience of what plastic polluting the sea is like, just like an actual experience a scuba diver might have. Developed by Warrior9 VR, it was based on a real scuba diving experience. This way the issue of sea pollution is not a theoretical concept left to the imagination, but an experienced understanding of how it could manifest in real life. For entertainment purposes it's gamified and exaggerated.

Message: Use less plastic!

1. Activity Statement: Boat trip, preparing for diving.
Experiential-based activity to provide an establishing scene to give participants a moment to situate themselves on a boat on the ocean and to get used to being in an immersive space. The narrative is also set-up by voiceover suggesting this is going to be a fun dive in pristine waters. Participants have mentioned that it can be scary being underwater in VR so this is a way to ease them into it.

2. Activity Statement: Submerged in the sea, and journeying through the beautiful ocean.
Experiential-based activity, participants enter the ocean and get a sense of how beautiful and magical the ocean environment is - particularly those who are afraid of going beneath the surface or who would never get to experience it as they don't Scuba dive. In other words, take people to a place they can't usually get to without a lot of effort. We also purposefully had a shark swim by to make the point that - for the most part - sharks keep to themselves and are not the aggressive villainous creatures portrayed in the media.

3. Activity Statement: Plastics appear, gameplay core loop to capture plastics
Task-based activity; the initial piece of plastic appearing is intended to be a surprise to participants - they're not aware that it is coming. And then slowly the participant sees more pieces of plastic and they are encouraged through UI and audio instruction to enjoy the game-like play loop of trying to collect all the trash using one or both the hands. For each item of plastic successfully collected, a sound is heard and score is incremented. The enjoyment is supposed to take the attention away from the fact that it's actually a bad thing that there's so much trash in this supposedly "pristine" sea. Because that realisation comes later.

As the trash becomes more, the participant struggles to keep-up with the collection, and begins to realise that the game is unwinnable... and is intended to shift their attention back to the fact that actually the sea is horribly polluted, and that's sad/disappointing.

4. Activity Statement: Dive ends, taken out of ocean
Finally, the experience concludes as the participant is pulled out of the sea to see all the trash floating on its surface, as a way of giving participants a bird's eye view of the problem, so they can put it in context, and realize the scale of pollution that overshadows the beautiful ocean - along with an impact statement to show how many pieces of plastic they've collected

	versus how much is reported to be in the sea. Ultimately the hope of this sentence is to emphasise the fact that using less is the only way that we can reduce the problem, because we can't collect it all. 

4 Conclusion

This paper presents on-going research to extend and operationalise Leontiev's (1981) original hierarchical activity theory framework. This is the latest work of an on-going long-term sustained research effort. In particular, the main focus of the work presented herein was to extend our activity theory framework to mechanics *and* narrative, scenario and story-based activities performed in sphere of engagement equivalent to Huizinga's "play-grounds" – from high-level to low-level. The framework herein provides a tool, notation, grammar and building blocks that can be incorporated into both HCI and practice-based approaches. The framework is intended to support all delivery platforms and extend to all purposes/sectors (education, learning, health, science, esports, business, tourism, social impact, social justice, cultural heritage, etc.) across the serious games continuum: from games for purpose to experiential environments for purpose. To highlight the versatility of the initial work to extend the activity theory framework, we described several examples of serious game and immersive VR for purpose developed in research projects, and in the professional immersive content creation Singapore-based studios of Warrior9 VR.

References

1. Schön, D.A.: The Reflective Practitioner: How Professionals Think In Action. Basic Books, New York (2008)
2. Neil, K.: How we design games now and why. Gamasutra (2016). https://www.gamasutra.com/blogs/KatharineNeil/20161214/287515/How_we_design_games_now_and_why.php
3. Church, D.: Formal Abstract Design Tools. Gamasutra (1999). https://www.gamasutra.com/view/feature/131764/formal_abstract_design_tools.php
4. Koster, R.: A grammar of gameplay. In: Game Developers Conference (2005)
5. Cook, D.: The Chemistry Of Game Design. Gamasutra (2007). https://www.gamasutra.com/view/feature/129948/the_chemistry_of_game_design.php
6. Zyda, M.: Creating a science of games. Commun. ACM **50**(7), 27–29 (2007)

7. Marsh, T.: Informing design and evaluation methodologies for serious games for learning. In: Proceedings of Learning with Games 2007, Sofia Antipolis, France, pp. 479–485 (2007)
8. Marsh, T., Wright, P., Smith, S.: Evaluation for the design of experience in virtual environments: modelling breakdown of interaction and illusion. J. CyberPsychol. Behav. Spec. Issue Being Presence **4**(2), 225–238 (2001)
9. Leontiev, A.N.: Problems of the Development of the Mind. Progress, Moscow (1981)
10. Marsh, T., et al.: User experiences and lessons learned from developing and implementing an immersive game for the science classroom. In: Proceedings of HCI International 2005, Las Vegas, Nevada, USA (2005)
11. Marsh, T., Yang, K., Shahabi, C.: Game development for experience through staying there. In: Sandbox 06 Proceedings of the 2006 ACM SIGGRAPH Symposium on Videogames, vol. 1, pp. 83–89 (2006)
12. Marsh, T.: Staying there: an activity-based approach to narrative design and evaluation as an antidote to virtual corpsing. In: Being There: Concepts, Effects and Measurement of user Presence in Synthetic Environments, pp. 85–96. IOS Press (2003)
13. Marsh, T.: Activity-based scenario design, development and assessment in serious games. In: Gaming and Cognition: Theories and Practice from the Learning Sciences, pp. 213–225. IOS Press (2010)
14. Marsh, T., Nardi, B.: Spheres and lenses: activity based scenario/narrative approach for design and evaluation of entertainment through engagement. In: Pisan, Y., Sgouros, N.M., Marsh, T. (eds.) Entertainment Computing - ICEC 2014, vol. 8770, pp. 42–51. Springer, Cham (2014). https://doi.org/10.1007/978-3-662-45212-7_6
15. Marsh, T., Nardi, B.: Narrative in HCI: interactions, play, games, stories, fictions and envisioning futures using activity theory. In: ACM SIGCHI 2015 - Workshop on Ecological Perspectives in HCI: Promise, Problems, and Potential (2015)
16. Marsh, T., Nardi, B.: Framing activity-based narrative in serious games play-grounds through objective and motive. In: Marsh, T., Ma, M., Oliveira, M., Baalsrud Hauge, J., Göbel, S. (eds.) Serious Games, vol. 9894, pp. 204–213. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-45841-0_19
17. Marsh, T.: Serious games continuum: Between Games for Purpose to Experiential Environments for Purpose. Entertain. Comput. **2**(2), 61–68. Elsevier (2011)
18. Thomas, A., et al.: Oceans we Make, Virtual and Augmented Reality. ACM SIGGRAPH Asia, ACM Press, Tokyo (2018)
19. Marsh, T.: The reef game. Available from Google Play. The reef game prototype, showcase. In: Joint Conference on Serious Games-JCSG 2015 (2021)
20. Marsh, T., Jenson, N., Constantine, W., Miller, E.: VR immersive slow reef experience. In: Marsh, T., Ma, M., Oliveira, M., Baalsrud Hauge, J., Göbel, S. (eds.) Serious Games, vol. 9894, pp. 293–296. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-45841-0_34
21. Carvalho, M.B.: An activity theory-based model for serious games analysis and conceptual design. Comput. Educ. **87**, 166–181 (2015)
22. Engeström, Y.: Learning by Expanding: An Activity-Theoretical Approach to Developmental Research. Orienta-Konsultit, Helsinki (1987)
23. Leontiev, A.N.: Activity, Consciousness, and Personality. Prentice-Hall, Englewood Cliffs (1978)
24. Oliver, M., Pelletier, C.: Activity theory and learning from digital games: implications for game design. In: Digital Generations: Children, Young People and New Media. Institute of Education, London (2004)
25. Marsh, T., Wright, P.: Maintaining the illusion of interacting within a 3D virtual space. In: 3rd International Workshop on Presence, Delft, The Netherlands (2000)
26. Huizinga, J.: HomoLudens: A Study of the Play-Element in Culture, Beacon Press (1955)

27. Bogost, I.: Videogames and ideological frames. Popular Commun. **4**(3), 165–183 (2006)
28. Barab, S.A., et al.: Pedagogical dramas and transformational play: narratively rich games for learning. Mind Cult. Act. **17**(3), 235–264 (2010)
29. Marsh, T.: Designing for positive and serious experience: devices for creativity, engagement, reflection and learning. In: Göbel, S., Ma, M., Oliveira, M., Wiemeyer, J., Wendel, V. (eds.) Serious Games, vol. 9090, pp. 3–10. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-19126-3_1
30. Marsh, T.: Slow serious games, interactions and play: designing for positive and serious experience and reflection. Entertain. Comput. **14**, 45–53 (2016)