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Identifying and classifying learning entities for designing location-based serious games

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Abstract*— This paper investigates the development of a classification of features inherent in the design and development of Location Based Experiences (LBEs) with a special focus on games for teaching and learning. The paper aims to identify and associate learning features, such as feedback, activities, outcomes and assessment with location-driven mechanics, such as location-based activities, entities, conditions and actions that constitute the overarching elements of a proprietary location-based games authoring tool. We anticipate that this will pave the way for developing a model taxonomy that may be utilised to support and optimise future end-user profiles for serious game creation, games design for informal learning paths in science museums, science centres and field trips, learning methodologies development and metadata creation. The classification draws on the findings of a tailored approach applied to design and develop an authoring environment, the MAGELLAN platform, for creating location-based games and mobile location-driven scenarios directly influenced by end-user requirements and evaluation of trainee's feedback. Ultimately, the classification is conceived as part of a broader framework that defines and enables the creation of location-driven games by associating them with learning elements, through visualised design for expert and non-expert users as potential game authors. In an iterative process, the MAGELLAN Authoring Tool and subsequent user training and piloting process is featured as a test-bed, where the proposed taxonomy will be applied and evaluated.

***Keywords:* location-based games, location-based game mechanics, learning attributes, serious games, game design, science teacher professional learning**

I. INTRODUCTION

A Location-based Game is a game that uses the player's physical location (or any other location) as a means of input to generate or access location-based information. Location-based games made their first commercial appearance in 2002 with the arrival of Botfighters Jeannie (2008) [1], the first pay-per-locate GPS game. Since then, location-based games have gained considerable popularity. Their proliferation is due to the widespread use of mobile devices, like smart phones, with advanced location sensing capabilities, for example GPS satellite positioning. These games provide players with distinct gaming experiences, not only from player to player, but also from location to location, effectively increasing the game's longevity and its possibilities. With the advent of indoor tracking systems, these games have overcome poor performance of indoor positioning systems that made such games unplayable indoors. However, although location-based gaming is an industry on the verge of explosive growth, the creation and deployment of such experiences, especially those involving multiple participants, is simply out of reach for the vast majority of creative authors because of the complexity and inherent limitations in using a multitude of state-of-the-art technologies required for the creation of such games.

Location based games, as other genres of serious games, are being studied with respect to their capacity to induce learning. De Souza [2] has observed that location based game activities produce learning that is social, experiential and situated. Learning, however, is related to the objectives of the game designers. In a survey of location-based games by Avouris and Yiannoutsou [3], it was observed that in terms of the main objective, these games may be categorized as ludic (e.g. games that are created for fun), pedagogic (e.g. games created mainly for learning), and hybrid (e.g. games with mixed objectives). The role-playing version of ludic games (as opposed to those action-oriented) is claimed to have a higher learning potential, although this is yet to be confirmed through more extensive empirical studies. On the other hand, the social interaction that takes place and skills related to strategic decisions, observation, planning and physical activity are the main characteristics of this strand in terms of learning. Serious games might involve participatory simulators, situated language learning and educational action games. Finally, hybrid games are mostly museum location-based games and mobile fiction, or city fiction.

Location based experiences (LBEs) are pervasive and aim to merge the real and the digital world in the form of mixed realities. When designed within an educational context, they tend to place the user or learner at the centre of the educational experience. It is yet to be studied, understood and systematised how learning is induced by such experiences to enable teachers, as well as instructional and game designers, to master the creation of location-driven serious games as formal and informal learning activities that support in-class learning and teaching. The development of visual authoring environments that allow learning and game designers with minimal or no technical skills to address their needs for creative educational content design is also conducive to the same objective.

In support of this goal, the current study aims to identify the main attributes of location based games and to demonstrate how they can be mapped to learning attributes to aid the design process and to constitute a reference for future research in the field. By carrying out this mapping process, this study aims to

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support games and learning designers, game developers, teachers and learners in co-designing LBEs that augment the teaching and learning process, making it a fun and memorable experience. The inferences presented are based on a case study that refers to the MAGELLAN research project that aims to address and extend associated issues as argued by Balet et al. [4]. MAGELLAN primarily aims to deliver an authoring environment based on visual authoring and natural user interface principles to enable non-programmers to author and publish multi-participant location-based experiences. It also aims to deliver a scalable web platform supporting the sharing, browsing and execution of a massive number of such experiences.

II. Methodology

The methodology followed in this investigation towards mapping learning attributes with location-driven game mechanics draws on empirical evidence and case studies of location-based experiences' (LBEs) design. It builds on the concept that learning attributes are correlated with location-driven game mechanics through the LBE design context i.e. through the mapping performed empirically by actual LBE authors (whether game design experts, instructional designers or teachers creating educational materials) as the outcome of reflexive practice. In this sense context and activity are intertwined and structure each other. Therefore, by understanding the LBE design process in real-life case studies, the correspondence between learning attributes and game elements may be evidenced and examined.

The LBE design process drawn from the MAGELLAN project case study is followed closely and decomposed into consecutive stages and iterative steps. By analysing each stage in the process breakdown, meaningful associations between learning attributes (i.e. learning objectives, learning outcomes, feedback and assessment approaches) and game mechanics that enable the design of LBEs are discerned. In this sense, features of location-driven games like activities, actions and conditions are examined as to how they are employed in the design of LBEs to promote learning goals, lead to desired outcomes and substantiate assessment methods as conceived in the learning design phase. The analysis of the design process, adopted in the MAGELLAN research project, is followed by an investigation towards correlating game mechanics utilised to create location-driven games with learning attributes. The mapping process draws on the classification and methodological approach carried out by Lameras et al. [5], which consolidates materials gathered from a review of 165 papers reporting conceptual and empirical evidence on how learning attributes and game mechanics may be planned, designed and implemented.

This structured mapping exercise yields useful associations between learning design and games' features, which may be used as the basis for modelling a taxonomy that informs the LBE design process for educational purposes in the future. It also informs future iterations of any Training Framework targeting the development of training processes and materials for educating teachers and learners, game and instructional material designers on how to introduce and support their targeted learning attributes (objectives, activities, feedback, activities and learning outcomes) during the location-based games planning and design process. It is axiomatic, therefore, to create a classification that identifies and delineates location-based features, designed as part of the MAGELLAN platform, with learning outcomes that form a hierarchy from less- to more- completed.

III. Studying the LBE Design Process: The MAGELLAN Case Study

The MAGELLAN project, a research and innovation action partly financed by the European Commission, provided the case study context where the methodology of this investigation was applied. The MAGELLAN aimed at researching and implementing a unique authoring and gaming platform, based on visual authoring principles, natural user interfaces and the latest interactive, mobile and geo-localisation technologies, for multi-player location-based experiences. The objective of the MAGELLAN pilot phase was the design and implementation of 5 location-driven and mixed reality games by a group of end-users. The MAGELLAN end-user group consists of 5 complementary creative SME organisations interested in the creation of location-based experiences. They worked in close collaboration with the project's technology providers to produce the end-users' requirements for developing the authoring tool and platform, to create the game scenarios and relevant data, and to carry out the implementation of the pilot demonstrators, while evaluating the consecutive releases of the MAGELLAN Authoring Tool (MAT). In an iterative process, the end-user teams designed, published and organised a comprehensive set of complementary pilot demonstrators of location-based experiences, in which an end-of-cycle evaluation provided both feedback to the end-users on their game scenarios and informed the ongoing technical development of the MAT. The end-user partners functioned not only as real-life end users, but also as multipliers that promote future use of the authoring tool.

The MAGELLAN LBE design process commences with the *Games Design* phase, during which the authors conceive the objective of the location-based experience and storyboard their game scenario. In case the LBE is designed for an educational purpose aimed to augment the in-class learning experience with an informal out-of–the-classroom activity, the authors use this stage to create the activity's learning design. The learning design encompasses all learning attributes commonly associated with a structured learning activity, i.e. learning objectives, learning outcomes, learning strategies, methods of assessment, and feedback.

The *Games Design* phase pragmatically informs the *User Requirements Identification* phase aimed at registering the desired features of location-based experiences and presenting them to the technical teams responsible for ensuring that the MAT fully supports the games' implementation process. The technical team was responsible to develop a visual authoring tool, which is equipped with game features and location-driven elements that enable end-users to design their LBEs. This work takes place in *the Visual Authoring Tool Development* phase, which requires an effective interpretation of end-user game scenarios and user-defined requirements into game mechanics and resources in the authoring tool and platform that accommodate the envisaged functionality.

The MAT feeds into the *Training Framework Design* stage that follows. The purpose of this stage is to extract training requirements based on i) the functionality and new features of the MAT and ii) the background and experience of the targeted end-users. All together, the methodological approach for soliciting these requirements, the training materials planning process and their implementation, as well as the structured training delivery approach comprise the MAGELLAN Training Framework (MTF) presented by Clarke et al [6].

The *End-user Training Delivery* stage utilises the MTF to implement face-to-face and online training sessions that familiarise the end-users with the tool's operation and capabilities and respond to their inquiries related to the implementation of their game scenarios through the MAT. Training delivery is accompanied by a formative evaluation step that registers end users' feedback on three aspects, i.e. the quality and relevance of training materials, the quality and relevance of training delivery including trainers' effectiveness, organisation & administration of the training sessions, and the benefits drawn by the trainees in terms of enhancing their capacities and confidence in using the MAT. Important conclusions are drawn from analysing this feedback, leading to a new iteration in the design process, which includes refining user requirements, developing the tool's functionality further to suit end-user needs and polishing the training framework. With every new release of the MAT, a corresponding round of end-user training is implemented to provide support and close the loop in this iterative development process.

Immediately after the first instance of end user training and continuously running afterwards, the *Games' Deployment* stage takes over for the actual design, implementation and testing of the LBE game demonstrators. During this stage, the MAT's functionality and its affordances are utilised to give form to the end-users' game scenarios; and initiating a process of inculcating learning attributes into game mechanics. However, this stage also reveals misconceptions or weaknesses both in the game scenarios and in the tool's capacities or design characteristics. Accordingly, a new iteration of user requirements' refinement and MAT design improvement is launched, to identify and apply remedies and modifications that adapt and expand the tool's capabilities. The LBE design process concludes successfully into the deployment of the targeted game demonstrators through numerous iterations i.e. in the MAGELLAN project three major iterations led to alpha, beta and final MAT releases, but also to several intermediate sub-version releases before public release of the tool.

The desired mapping between learning attributes and LBE game mechanics is therefore discovered by correlating the *Games Design* stage, where the game scenario is ideated and the learning design is planned with the *Games Deployment* stage, where the features of the game are determined.

IV. Learning Attributes

The design of in-game learning activities in serious games is a situated action, triggered from the game's objectives and sub-level goals [5]. Learning activities are assigned by the teacher/ instructor and sought for interaction with the learner. In-game learning activities, especially in the context of location based games, embed mental elements (e.g. recall and explore evidence of important historical events in situ), game elements (e.g. quizzes, narratives, rewards) and physical elements (e.g. QR codes, beacons, compasses, sensors). Learning activities can be grouped based on the nature/ purpose of the activity, i.e. as information transmission (teacher-led), individual (teacher or learner led), collaborative (teacher or learner directed) and, discussion and argumentation (reflective teacher or learner directed) in order to deliver specific learning processes within a game.

Learning outcomes are mapped to learning activities in the game as in Table I. Bloom classified learning into three domains: cognitive, affective and psychomotor. For this study, the focus is on the cognitive domain that advances learning and knowledge and are integrated throughout in-game learning experiences. Bloom's taxonomy consists of six categories designed to scaffold teachers' effort to link learning activities with learning outcomes, i.e. remembering, understanding, applying, analysis, evaluating, and creating.

TABLE I. BLOOM'S CLASSIFICATION OF LEARNING OUTCOMES

Category	Outcome
Remembering	Learner can memorise and recall information
Understanding	Learner can comprehend, explain and predict.
Applying	Learner can use information and solve problems
Analysis	Learner can analyse data patterns or concepts and findings can be discerned to prior evidence
Evaluating	Learner can compare and make justifiable judgments about the value of ideas, methodologies or products
Creating	Learner can design, build, invent, plan and produce knowledge and transferring it to new contexts for making a contribution to the society

V. Location Based Game Mechanics

Games are structured to comprise rules and challenges for learners. Game rules are broadly understood as game attributes, although it is still unclear in the literature whether game mechanics are synonymous to game attributes or the later comprise also other game design sub-features that form an actual game. Rouse [7] approached game attributes from an overall user-game design perspective in terms of "*investigating what the player is doing in the game, how it is done, and how this leads to a memorable and compelling (learning) and game experience*". To compensate for this ambiguity, in this study we use game mechanics in close correlation with game attributes and adopt a broad consideration of game mechanics used in LBE games to manage a holistic interpretation of game attributes. A game may consist of several attributes and attributes can be part of several games. Learning enhancement and performance improvement stems from learning that originates in task completion [8].

In-game meaningful feedback is vital for helping students to achieve the embedded learning goals and also for encouraging students to reflect on misconceptions and transfer learning to new contexts [9]. Jones et al. [10] developed the SCAMP framework (Social, Cognitive, Affective, Motivational for reviewing Progress) shown in Table II linking game mechanics to Feedback Progress Indicators (FPIs). *Social* feedback is embedded in game mechanics that indicate learning activity from student's interactions with: Non Player Characters (NPCs), and peers or teachers involved in playing simultaneously the game. Example includes "liking" a game progress. *Cognitive* feedback focuses on the formation of cognitive patterns. Examples include formative feedback provided by the system focusing on correcting knowledge misconceptions and accuracy of understanding. *Affective* feedback is about attitudes and moods, feelings and emotions. Game rewards tor enhancing motivation such as in game gifts such as extra characters, apparels and objects may increase student's confidence, lack of anxiety and tolerance of level failures. *Motivational* feedback in games should aim to create situations that trigger students' curiosity to start playing the game (i.e. motivation) and then it should maintain students' curiosity, intention to learn, attention and involvement by balancing fun (game mechanics) with learning (learning elements) to achieve engagement. *Progress* feedback in games captures and analyses the increasing competency of the students towards mastery, which enables the performance of in-game learning tasks and the transfer of the knowledge gained to realistic contexts.

TABLE II. FEEDBACK PROGRESS INDICATORS: THE SCAMP FRAMEWORK

FPIs	Game mechanics	Example
Social	Visual feedback (emoticons), discussion thread	"Linking" gaming progress through an in-game discussion mechanics
Cognitive	Prompts; in-game hint; assessment tool; game levels, gaining/loosing lives;	Selecting the correct choice out of an in-game dialogue script
Affect	Scoring, achievement	Avatar visual indicators in terms of solving correctly or not a puzzle
Motivational	Experience points, game levels; lives/ virtual currencies used for buying game items from an online inventory	Winning currency for finishing the treasure hunt mini-game. Winning XP points for passing a games level
Progress	Progress bar, achievements, assessment tool; dashboards	Game journal; goal progress in the form of visual feedback; level badges to highlight learning mastery

Attempting to classify game mechanics according to their capacity to induce learning, while creating an engaging and usually fun experience, we study the game design process. In this study, game mechanics are considered as constructs of game rules or attributes designed for interaction with the game state. We examine the game mechanics made available to the end-users of the MAT, in the MAGELLAN case study, during the process of designing location-based games. A classification of these game mechanics is presented in Table III. In this classification, game mechanics are grouped into three major types or categories *activities*, *actions* and *conditions.* An *activity* is the overarching part of the game design process and it engages the players into certain situations. An example might be to solve a puzzle, or to select a team, to respond to a question or to show a video. Activities lead into two outcomes, one related to "Success", signifying successful conclusion of the task related to the activity, and another corresponding to "Failure", triggered when the activity is not successfully completed. An *action* is an invisible process that runs into the background and does require action from or interaction with the player in the game, as opposed to an activity. Examples of actions include changing the players' avatar in the game, raising an event/flag to be checked elsewhere in the game, or even as simple as playing a sound to alert, inform or amuse. Finally, a *condition* represents a check point in the game logic, where a specific condition is evaluated as true or false.

TABLE III. CLASSIFYING LOCATION-BASED GAME MECHANICS

Type	LBE Game mechanics	Explanations/ Examples
Activities	Quiz	ask questions, create multiple choice quizzes for assessment or to create game branching points
	Select Team	assign specific characteristics/powers to player, create teams for collaborative activities
	Media player	play multimedia asset (sound, image, video) to inform, alert, amuse player
	Message	provide information to player, give instructions, provide feedback, provide rewards
	QR code	scan QR code to indicate proximity to a specific location
	Puzzle Game	provide information/instructions, assess skills, provide feedback, give a reward
	3D activity	display 3D characters or objects to create a game scene, to inform/guide/ amuse in the virtual 3D scene
	Augmented reality (AR)	display and interact with AR object in a real location, provide feedback and rewards
	Panorama	display AR objects on 360 degree panorama images of a real scene to interact, provide feedback and rewards
Actions	Set avatar	set up an avatar for the player's game representation
	Drop item	drop an item from the player's inventory at a specific location, loose points/rewards, share items with players
	Get item	pick up an item to store in the player's inventory, earn points/rewards
	Play sound	create an alarm, provide feedback through sound, inform player about rules/instructions
	Send Analytics	send Google analytics to share information with other players, to assess skills/ achievement
	Read text	provide feedback, inform player about rules/instructions
	Raise event	trigger a user event in the game to inform participants about a status reached in the game
	Set Profile	assign specific present variables to the player to personalise the game
	Give Role	assign a specific role to a specific player, personalise the game, allocate specific skills/capacities
Conditions	Participant-based	assess a player's profile (personalised characteristics), check items/rewards/points gathered
	Event-based	check proximity to objects, position in the indoor environment, achievement being accomplished
	Location-based	check individual player or team location (indoor/ outdoor), check proximity to objects or other players
	Time-based	check timed events/activities
	Graph-based	check if one or several activities have been completed

VI. MAPPING LEARNING ATTRIBUTES TO GAME MECHANICS

Mapping learning attributes to location-driven game mechanics in this study adopts the approach defined in [5]. In this respect, linking learning attributes to game mechanics also extends to demonstrate a relation with learning outcomes, feedback and assessment. The outcome of this identification and mapping process that links learning attributes (activities) with location-based game mechanics is presented in Table IV. It demonstrates that while different game mechanics are utilised to deliver the desired learning outcomes, the teacher switches from a role of conveying content and information via the game to, a role of guiding and facilitating the learning process, when designing game learning activities that focus on student engagement, motivation and assessment. Utilising this classification, practitioners will be able to create location based learning activities in games whilst appropriating what the teacher does in conjunction to students prior knowledge, the desired learning outcomes, feedback and assessment.

This mapping of learning principles to game attributes attempts a classification for advancement of games' research by analysing and relating features of location-driven experiences to the design of learning activities. The different categories of the learning attributes may be combined for providing a constellation of activities, and game mechanics. For example, a teacher-designer may use both the information transmission and the collaborative activities that in turn make use of 3D, different teams to be processed by more than one player.

TABLE IV. MAPPING LEARNING ATTRIBUTES TO LOCATION-BASED GAME MECHANICS

Learning attributes (activities)	LB game mechanics	Learning Outcomes
Information Transmission (teacher-led)	*Activities*: Message, multiple choice Quiz, media player, 3D, AR, Panorama *Events*: Read text, play sound *Conditions*: Time based	Remembering
Individual activities (teacher and student-directed)	*Activities*: Quiz/Question, Message, QR code, Puzzle Game, 3D, AR, Panorama *Events*: Set avatar, Drop item, Get/Give item, Send Analytics, Raise event, Set Profile *Conditions*: Participant based, Event based, Location based, Time based, Graph based	Understand, applying, analysis
Collaborative activities (teacher and student-directed)	*Activities*: Select Team/Role, Message, Question, Puzzle, QR code, 3D, AR, Panorama *Events*: Give Role, Set avatar, Drop item, Get/Give item, Raise event, Set Profile, Send Analytics *Conditions*: Participant based, Event based, Location based, Time based, Graph based	Applying, analysis, evaluating, creating
Discussion and argumentation activities (Reflective teacher and student-led)	*Activities*: Question, Message, Media Player, 3D *Events*: Give Role, Set avatar, Get/Give item, Raise event, Set Profile *Conditions*: Participant based, Event based, Time based, Graph based	Evaluating, understanding, analysis

VII. DISCUSSION

Balancing learning outcomes with location-based features is a key association to be embedded in the design stage as means of galvanising games to afford *motivation, learning construction* and *transferability*. Such associations are challenging, however, due to the lack of a consistent classification or taxonomy that maps learning with game attributes, it is complex to align learning outcomes with location-based game attributes [11]. As noted, practitioners and researchers alike are overwhelmed by how game attributes may afford specific instances of learning and thereby create inconclusive evidence on how location-based games can be used for learning, inquiry and creativity. There is no explicit understanding, therefore, as to differentiate variations of experiences of using games and 'why' they are perceived as effective teaching and learning tools. Hence, there is little understanding in terms of identifying particular mechanisms in games that afford specific types of learning. For example, there is no awareness of what types of attributes or mechanics in location-based games can support formative feedback perpetuating a pattern of in-game guidance and support to the learner pre-, during and post- game activity. The lack of inducing learning awareness in games, whose primary purpose is to entertain rather to educate, nurtures vague understandings of what makes a game appropriate for learning.

Amory [12] designed a theoretical framework based on units that includes relationships and dependencies with one another. The model negotiates features such as game space, visualisation space, elements space, actor space and problem space. The model provides an abstract and generic interpretation of pedagogical and theoretical components without attempting to provide a mere classification of learning to game features. Possibly, the framework explicitly focuses on a higher-design level depicting theoretical constructs of game objects. Similar to Amory's framework, the SGM lacks in providing a genuine mapping of learning with game attributes in a more categorised-structured approach in order to contribute on a systematic and constructive solution to learning-game mechanics classification. Bedwell et al. [11] carried out a game's attribute taxonomy, derived from a literature review analysis. A limited number of categories emerged, such as action language, assessment, conflict challenge, control, environment, human interaction, immersion, rules/goals and game matrix. The same study links the categories with training outcomes based on the research approach followed (empirical, non-empirical) and attributes individual attributes found in the literature. The framework provides a classification of game attributes with outcomes but it doesn't delimit possible instantiations of learning activities linked to game attributes and outcomes [13].

VIII. CONCLUSIONS AND FUTURE RESEARCH

This study has analysed, presented and discussed findings on how learning features and location-driven game properties can be planned, designed and implemented by teachers, instructional and game designers interested in using games for informal activities that support teaching and learning in any level of education. It also contributes to the efforts of the academic community to understand and evidence how games and particularly location-based experiences (LBEs) may support learning. It provides an initial investigation on classifying learning attributes, such as learning activities, learning outcomes, feedback and assessment indicators (FPIs) with location-driven game attributes and, more specifically, game mechanics. The results of this study can be used for reviewing existing cases and ultimately, increasing our understanding in order to shape our insights into designing the next generation of applications of this kind.

Essentially, by studying the game design process holistically in the MAGELLAN case study, this investigation may support the development of authoring tools for designing LBEs, addressed to expert game designers, as well as to non-experts, who wish to connect their location-driven games to a specific learning goal. It links and displays the iterative character of three major stages in the development of game authoring environments, i.e. user requirements' identification, authoring environment development and user training framework design and delivery. In this sense, it highlights the inter-linkages between these steps and alerts to the significance of their consideration in support of future design processes. This will pave the way for a next generation of authoring environments, within which players can define their own goals and write their own stories. The authors acknowledge that different location-based game mechanics are inherent to different tools and therefore their association with specific learning elements would be disparate.

Drawing on the study's outcomes, it is clear that more qualitative research is needed, towards understanding the essential features of LBEs' design and alignment with learning modalities and teaching strategies, conducive to particular academic disciplines (e.g. science, social sciences and humanities). Further investigation is also needed to understand the social dimension, which is predominant in this type of games, to support the view that location based games are particularly suitable means for teaching skills that are mostly needed in our times, such as interpretation, multimodal thinking, problem solving, information management, teamwork, flexibility and civic engagement. In particular, future research is needed for:

- Understanding how location-based games may be used for learning in informal settings.
- Understanding what learning nuances are required to support learning outside of the classroom by deploying location-based games.
- Broadening the scope by studying variations in designing location-based games by teachers and used by students for learning.
- Specifically addressing empirical associations between particular learning features and game mechanics for optimising key learning aspects (e.g. feedback and progress indicators in games; or learning outcomes) based on game genres.
- Establishing a comprehensive and common vocabulary for describing location-based experiences for learning and teaching.
- Exploring how to create meaningful inferences between in-game learning features and geo-localised objects (e.g. museum exhibits).

It is envisaged that this paper is the point of departure in terms of creating a research agenda in conjunction to understanding 'disjunctions between espoused and enacted' personal theories of using location-based games as means to identify variations in ways games are designed and used in formal and informal learning settings. This will shed light in the underdeveloped research area on qualitatively different ways of understanding experiences of using location-based games. Hence it will pave the way for identifying an inclusive hierarchy for describing ways, frames and discourses of experiencing the phenomenon and contextualising it in particular science disciplines and connecting it to particular instances of informal learning settings, such as collecting data during a field trip or exploring, curating and visualising scientific content from a visit to a science museum.

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