

# A Serious Game for Amplifying Awareness on Multimodal Teaching: Game Design and Usability Study

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**Abstract**— STEAM is a serious game developed as a medium for helping teachers to experience multimodality for teaching and learning. A design-based paradigm is adopted to elucidate how in-game design elements coupled with learning may visualize in-game multimodal representations. Multimodality is experienced as a process of creating meaning through connecting and combining different modes, semiotic resources and semiotic ensembles. In this paper, we present the design and usability evaluation of the game. The usability study was conducted with (n=32) school teachers completing an online survey after playtesting the game for identifying, capturing and fine-tuning in-game usability aspects. The findings indicated that the game's core mechanics, the in-game dialogues and card-game, represent and visualise the content and process of multimodal in-game ensembles whilst the development of in-game feedback and progress indicators was perceived as having the capacity to guide understandings on in-game multimodality and to track in-game progress.

**Keywords**—serious games, multimodality, teaching, usability, game design

## 1 Introduction

This paper provides a discussion on and analysis of the design and usability evaluation of a serious game developed to help school teachers to understand the concept of multimodality as a pedagogically-rich approach to enhancing learning and teaching. Multimodality is an activity-based and student-centred approach to teaching in which a series of different tools, technologies, resources and environments are deployed transcending the basic idea of reading and writing to multiple-form of mixed-print representations (Jewitt, 2008 [1]). Games for learning and teaching have been perceived as a medium for instigating playful learning aligned with rich-

mediated content to achieve in-game learning goals. The overarching aim of such games is to infuse learning content amalgamated with teaching models, frameworks assessment and feedback in-game representations for discerning a more constructive, reflective and memorable learning experience (Belloti et al., 2012 [2]; Blanco et al., 2012 [3]; Boot et al., 2008 [4]).

There is a widespread view from different commentators across disciplines (e.g. Cope & Kalatzis, 2009 [5], Cowan & Kipriani, 2009 [6]) that school teachers seem to be overwhelmed by the plethora of teaching representations such as technologies, resources, pedagogies and tools that may be used for enacting teaching in more activity-oriented ways that would allow to design activities that encourage students to be actively involved in situated learning instances in or out of the classroom. Multimodality is indeed an ill-defined concept encompassing social and cultural shaped resources with an emphasis on the inherently social negotiated character of meaning (Lave, 1991 [7]).

The following sections start by elucidating on the design of the STEAM game encompassing analysis of high-level goal, scenarios and learning objectives along with an analysis of the core game mechanics. Then we continue with presenting the methods employed and the findings of the game's usability evaluation. We conclude by providing a discussion on usability considerations and implications for multimodal learning and teaching, limitations and future research.

## **2 Game design**

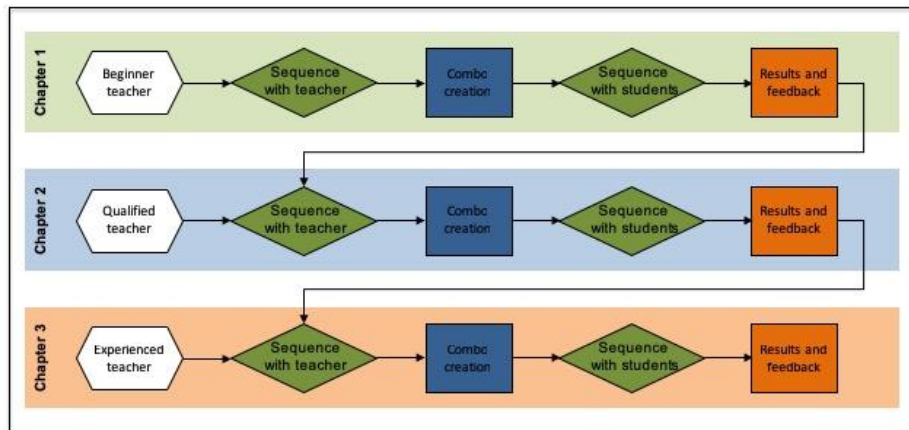
STEAM is a simple point-and-click game that may be played through a web browser. The game play sets-up a blend between non-linear dialogues with a Non-Player Character (NPC) with a set of choices for the player to choose from along with a mini card game for players to select the correct card combinations for establishing a multimodal teaching environment.

### **2.1 In-game goals and outcomes**

The game's narrative sets the player to have the role of a newly appointed teacher interested to learn more about multimodality and how (e.g. resources, pedagogies, modes, technology) it can be practiced. The main in-game goal therefore is to create an awareness of what is multimodality and how it can be practiced. The player commences the game as having the fictional character of 'Mary' a newly appointed mathematics teacher at Charles Darwin School that attempts to transcend theory and practice as means to enhance teaching by using multimodal tools, pedagogies and strategies. Interactions with the students and ways of delivering content is influenced by the dialogue responses given by the player, which in turn enable the collection of game cards for designing lesson plans.

## 2.2 In-game scenarios

To situate multimodality into a learning context, we have designed 3 chapters encompassing four learning scenarios in which multimodal teaching challenges are presented to the player. The flow of each scenario determines the in-game sequence aligning the dialogue and cards game mechanics and the actions of the player (see Figure 1).



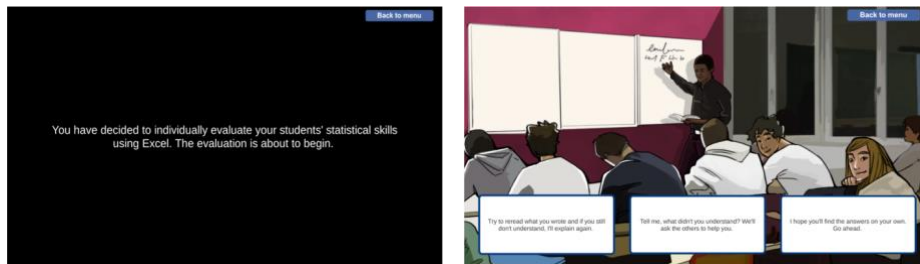
**Fig. 1.** The flow of a scenario is a logical path for the player to demarcate narrative sequences, dialogue sequences and card-deck combinations with colleagues and students

Each chapter may be played as a way of introducing the player to three multimodal in-game objectives following the subject content and flow of each scenario. When the player loops out of the introduction sequence, then the scenario starts by introducing the *narrative sequence* as a means for the in-game *dialogue mechanic* to engage the player with the teacher NPC for getting information about what multimodality is and to highlight that it reflects a range of pedagogies, tools, technology and resources amalgamated together to form an interacting and multimodal learning experience within and beyond the classroom context. Then, the player is introduced to the next core game mechanic, the *game cards* which are combined together to form a particular multimodal situation that the teacher would favor. A new *dialogue sequence* follows, with students contemplating on and articulating about the choices the player has made during the dialogues and possible applications in the real-world teaching domain.

## 2.3 Core game mechanics

We have designed our core game mechanics to prompt for progressively learning the objectives of each chapter whilst to rapidly comprehend the multimodal aspects

that the dialogue conveys to the player. The dialogue mechanic drives the multimodality learning process and twins the pedagogical objectives of each scenario with player's chosen response. The dialogue mechanic is part of the *narrative sequence* in which the player responds to questions asked either by colleagues or by students. The player has three options to choose from: one of the dialogue options is the correct, the other is intermediate and the third is not correct. (see Figure 2).



**Fig. 2.** Left chart: The dialogue challenge is set for the player to respond. Right chart: The player has 3 in-game options to choose from

When the player selects a dialogue option it is highlighted with a green frame as a visual representation to denote the choice is correct, with a yellow frame to show that the choice is intermediate and with a red frame to signify that the choice is not correct. The general consensus is to guide players understandings on how multimodality may be viewed in multiple perspectives that would likely increase student's in-game learning and engagement. As the player correctly responds to questions, up to ten cards are available separated into different categories such as strategies, activities and locations. The cards need to be correctly combined in order to form a particular multimodal situation. (see Figure 3).



**Fig. 3.** Left-chart: The player gains cards to be used for designing a multimodal situation comprised of strategies, activities and location. Right-chart: the player combines cards together to design a multimodal situation that influences students' engagement levels.

When the initial engagement is low, the player should select a highly engaging combination. In contrast, when the students start the session with likely high engagement levels, teacher should select a combination that will not further increase their engagement levels. Hints about the outcome of each card combination are provided to support the player's choice. Based on the card selection the player decides the engagement level bar increases or decreases thereby affecting the average level's grade. This means that there are certain card combinations, which are valid, and others that are not. This does not imply that a teacher may perceive multimodality differently from what is defined by the game's script, however the game's inner logic presupposes some combinations to be more favorable than others as for the system to provide the necessary feedback to the player thus structuring the game's scoring system.

#### 2.4 In-game feedback and progress indicators

In-game feedback is augmented in different ways for helping the players to comprehend both their in-game progress but also to understand the concept of multimodality during the dialogue sequences and card game. For example, the engagement bar and the learning bar indicating engagement of students and their learning level. This visual representation type of feedback is displayed during the dialogue sequence with the students for the player to have instant information on his/her progress for quickly adjusting performance. We have integrated this type of visual feedback for the players to be able to comprehend easily the meaning of the feedback received thus to get extrinsic feedback on their performance (see Figure 4).



**Fig. 4.** Visual representation of the 'Engagement level' and 'Learning level' of the students during the dialogue sequence (top left corner). Textual feedback may be obtained by clicking on the "?" icon (top right corner).

Suggestions on how to employ alternative pedagogical approaches, technologies and resources are provided by looking in the library and search for inspiring card combinations. The design of the multimodal card deck library had a dual feedback purpose: Firstly, for players to reflect on the combinations already made, and assimilate the multimodal features chosen and secondly, to experience and understand new multimodal card combinations, not selected during game-play, that would help to understand different ways and variations of using multimodality. Players may choose any of the card decks from strategies, tools and locations categories and then suggested combinations are provided by the game. For example, if players select the argumentation debate card from the strategy category then a suggestion pops up combining a blog tool and a home location (see Figure 5).



**Fig. 5.** Top-left chart: Setting a multimodal strategy by using the ‘argumentation debate’. Top-right chart: Selecting the ‘audio’ tool. Bottom-left chart: Selecting a ‘classroom’ location card. Bottom-right chart: Selecting a museum location card.

The number of card combination that a player can make is indicated and also the game highlights the available cards for activities and location, once a strategy has been selected as a way for grouping multimodal strategies with associated tools and locations. Encompassing different ways of assimilating and accommodating feedback through involving both formative and summative strategies felt it would provide a balance between players who would wish to constantly and rapidly accumulate their progress just as when playing entertainment games and for players who would perceive feedback more of a continuous learning process that would help them understand distinctive ways of practicing multimodality by attempting to make diverse combinations of multimodal strategies, tools and locations.

### **3 Usability evaluation method**

The aim of the usability evaluation was to understand how teachers experience the features of STEAM as means to help refining the usability of the game as part of an iterative, systematic and user-focused game design process. The method we used for the evaluation is premised on the concept of inductive reasoning, for inferring the meanings and outcomes of the data collection and analysis and then investigating related issues to work-out a usability evaluation synthesis stemming from the following research questions: (1) How teachers perceive STEAM's usability features as means to represent and visualise in-game user interface, multimodal content, core-game and feedback mechanics? (2) What are the implications of teachers' STEAM usability satisfaction on game uptake in the classroom for increasing awareness on multimodal teaching?

#### **3.1 Data collection**

We were quite promiscuous in our ways of selecting the participating teachers making sure that they were from different cultural backgrounds, subject-topics, years of teaching experience and dexterity in playing games or familiarity in using games for learning and teaching. This variation in participants' characteristics and the purposive sampling approach that we employed allowed for a more diverse set of responses adhering to reliability and validation procedures in terms of identifying usability aspects derived from the data. Thirty-two (n=32) school teachers participated in the usability study. Participants has to playtest the game for 40 minutes and then they had to complete a three-point scale usability online questionnaire. Starting with the playtesting process, we have introduced the game to the participants and we have elaborated the objectives of the study. We have made explicit all ethical procedures such as rights to withdraw at any time, data management, handling and storage, their voluntary participation and the right to withdraw at any time. Then, participants started to playtest the game experiencing the game's interface, content and the dialogues and card game mechanics, contemplating on how multimodality was inferred and how progress and feedback indicators were related to goals, objectives, in-game dialogue, and card combinations. Then, participants started to fill in the online questionnaire with special focus on assessing the extent to which the game's usability objectives and user satisfaction were achieved.

#### **3.2 Data analysis**

The analysis embarked a quantitative approach to analyse the game usability data with closed questions underpinning a value in terms of how usability was measured on an average scale. The analysis was focused on extracting data on specific usability aspects: (1) general usability aspects (e.g. user-interactions, visual aspects) (2) aesthetics and interface (layout, amount of information), (3) learning the system (game difficulty, feedback). Data were then grouped by a researcher to the

overarching usability themes against the data and then they were validated for consistency between the themes from the research team through a participatory process of probing, debating and reflecting on the data, the themes and associated relationships. This helped on mitigating aspects related to validity and reliability and biased processes of analysis often emanated from a researcher's presuppositions and interpretations.

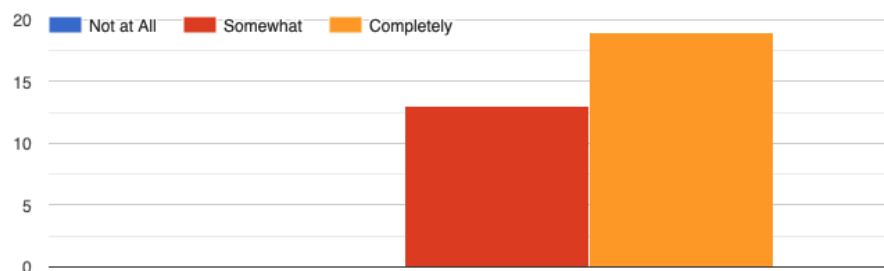
## 4 Usability results

In what follows, we present the results of the STEAM's usability study. We have categorized responses in themes stemmed from the online questionnaire. We provide a description of each usability response followed by a visual graph representing the collective responses of the participants.

### 4.1 Game's usability

Responding to a generic question in terms of 'how well were you able to use the game', participants felt that there were completely and somewhat being able to use the STEAM in terms of interacting with the point & click input mechanism to select a dialogue, continue with the pace of the text and also selecting a particular game card (see figure 6).

#### How well were you able to use the game



**Fig. 6.** Overall game usability

In line to this, the game's visual aspects seemed to contribute to participants' engagement levels as n=5 reported they were 'completely satisfied' and n=21 and 6 said that visual elements did not engaged them into game-play. Visual elements were



key interface components for helping the players to understand the rules, goals and progress (see figure 7).

### How much did the visual aspects of the game engaged you?

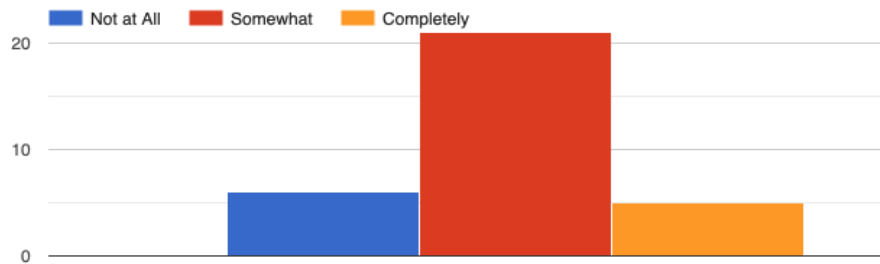


Fig. 7. Visual aspects

## 4.2 Aesthetics and interface

On a scale from 1-9, participants felt that the GUI was aesthetically pleasing n=20 (scales 6-9) and n=7 (scales 1-4) perceived that improvements may be needed mainly due to observations in terms of missing a back button for going back to the questions answered previously and also because sometimes there was a mismatch between the visual feedback icon with the overall score at the end. Also, some text felt a bit small hence larger text could be implemented in the next game iterations (see figure 8).

### Overall Reactions to the GUI

32 responses

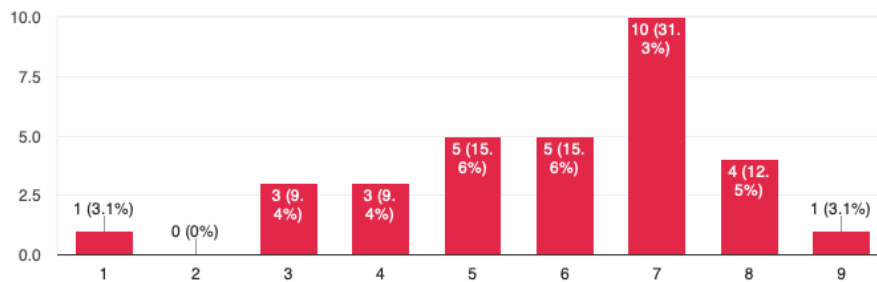


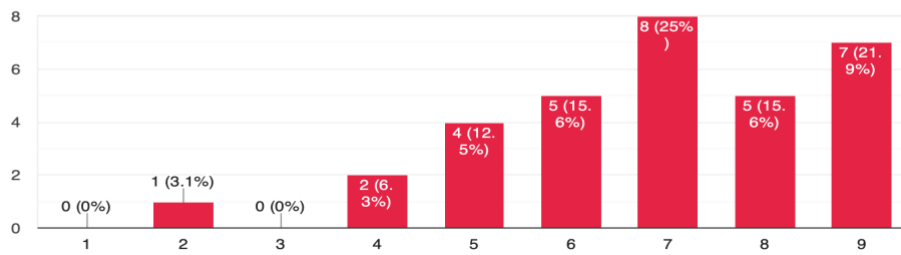
Fig. 8. Overall reactions to the GUI

Understanding the amounts of information passing from one screen to the next was key in providing a balanced approach to how participants perceived information

overload. Participants (n=25, scales 6-9) felt that there were efforts to enhance game screens in a consistent way and 3 felt that information was overloaded (see figure 9).

**The arrangement of the game screens and the information contained within them was**

32 responses



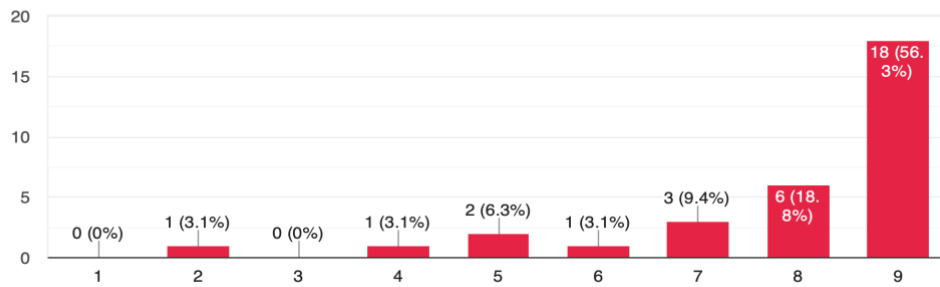
**Fig. 9.** Arrangement of information between game screens

**4.3 Learning the system**

Participants (n=28 6-9 scale) perceived the game as easy to start playing it. 5 Participants (1-4 scales) felt sthe game was moderately easy due to its straightforward dialogue selection process and the drag& drop card selection functionality (see figure 10).

**How difficult / easy it was to start playing the game?**

32 responses



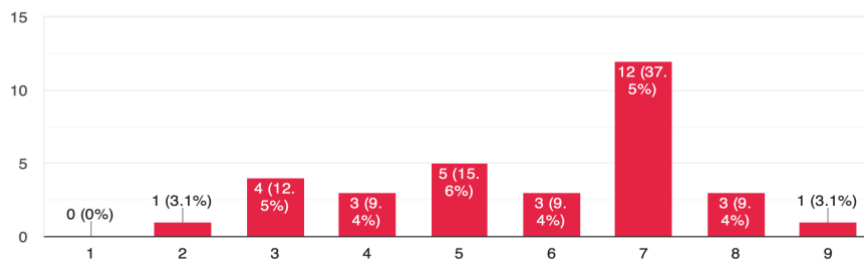
**Fig. 10.** Level of difficulty of playing the game

Feedback provided in terms of responding to a question was found positive with 19 responses (scales 6-9) perceived as helpful in terms of responding to the next question

and reflecting on how multimodality may be experienced. There were some concerns about the association between the dialogue chosen and the feedback provided as sometimes, a feedback response would not focus on what the player needs to do in order to correct the false answer or even if the answer is correct, how does this relate to multimodal teaching? Due to this reason, 8 participants said that feedback was ‘somewhat’ helpful in terms of understanding a question (see figure 11).

### How did you find feedback provided in terms of helping you to respond to a question?

32 responses



**Fig. 11.** Usefulness of feedback for responding to a question

## 5 Discussion

The aim of the usability study was to discern teachers’ responses and satisfaction levels on the STEAM’s usability features as means to refine and fine-tune the game’s overall usability, interface and player’s adaptability in terms of learning how to play the game. This will pave the way for introducing the game into schools in general and for developing teachers’ experiences on multimodal teaching through STEAM.

Contemplating on the usability findings there are certain usability and game design implications for employing the game into the classroom as a medium to develop teachers’ awareness on multimodal teaching.

From a usability and game design perspective, the game should focus on a closer-integration between the core game mechanics as means for players to understand the essence of different multimodal situations discerned from the dialogues and being extended through the selection of the strategy-tool-locations cards combinations. There is also an implication in terms of how feedback is rendered, visualised and represented after making a choice and also when selecting a card combination. Feedback therefore should be aligned with the choice made by the player but also with the game cards selection. Achieving consistency not only between player’s action and dialogues outcome but also between dialogue’s and game card outcome would facilitate the process of alignment between interfaces and core mechanics.

## 6 Conclusion

This paper presented the design and usability evaluation of the STEAM serious game as a medium for helping teachers to experience multimodal teaching. The game's design features have been discussed and analysed along with its game objectives, scenarios and content coupled with the two core game mechanics, the dialogue and the game cards.

The findings from the usability study showed that user interface elements are perceived as logically structured rendering the content, process and mechanics in a usable way for the users to be able to learn procedural game-play and multimodal content. While the usability study provides evidence of game features that need to be refined and fine-tuned to achieve a streamlined game-play experience, there are also some limitations: Firstly, the sample was relatively small to capture the entire spectrum of a plethora of usability aspects that may be hindered and secondly generalisability of usability results may not be possible to be replicated due to contextual, cultural and technical considerations. To understand how the game enhanced experiences of multimodality, a study that delimits in-game experiences of multimodal teaching and how game design aspects influenced such experiences will shed light to teachers' ways of understanding multimodality.

## 7 Acknowledgements

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