Insights into Competence Development Through Playfulness in a Cooperative Game Scenario: A Preliminary Study

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ABSTRACT
This paper presents the design and first rehearsal of a game proposal for a play-enabled, gender-related social innovation by working self-efficacy in collaborative, playful environments. Our main goal at this stage is to study how a gender-neutral proposal would get appropriated and generate insights about how it could promote change through play and cooperative dialogue. Specifically, we aimed to gather evidence on how participants became empowered to develop basic competences that help them trust their ability to perform in-game actions. Sixteen players were involved in paired gameplay rehearsals, assisted by the researcher as a facilitator of the game rules and responses in tabletop format. Through video recording, content analysis was performed to code for meaningful events: competence development, playfulness factors, modes of cooperation and emotions. We were able to get insights on how the design proposal promoted competence development related to computational thinking, its connections with playful engagement and cooperative dialogues, and the players' perception of gender-neutrality of the game.

Keywords
Playfulness, cooperative gameplay, STEAM, playful probing, gender-neutrality, social innovation.

INTRODUCTION
Research on the underrepresentation of women in science, technology, engineering and mathematics (STEM) has been focused on understanding the contextual reasons for this tendency, attempting to promote solutions that might reduce these discrepancies (Sullivan and Bers 2016; Imasogie et al. 2018; Ganley et al. 2018). Sociocultural and labor market gender biases, psychosocial influences and stereotypes associated with traditional female gender roles, and the lack of motivation were indicated among the leading causes of female gender underrepresentation in STEM and successful careers (Fortin 2005; Beede et al. 2011; Cvencek et al. 2011; Petersen and Hyde 2014; Sullivan and Bers 2016; Song et al. 2017; Imasogie et al. 2018; McGuire et al. 2020). The continuing foundation of social gender role stereotypes continues to proliferate in our

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societies through the media, the school environment, the technology industries as well as the pressure of family and peers (Leaper et al. 2012; Padwick et al. 2016; Kim et al. 2018; Iyer and Nishime 2020). These means of propagating gender stereotypes play a significant role in the individual's credibility about their abilities, leading them to believe in the stereotype and behave accordingly (Hippel et al. 2001; González-Pérez et al. 2020).

Performance-based studies have identified that females tend to underperform when faced with negative stereotypes (Beasley and Fischer 2012). The effect of relying on or accepting a certain stereotype has been observed among women in STEM areas (Petersen and Hyde 2014; Kim et al. 2018; Iyer and Nishime 2020; McGuire et al. 2020) in which, at younger ages, they show high interest. However, when exposed to negative stereotypes, there is a deterrent to progress (Beasley and Fischer 2012; Sullivan and Bers 2016; Song et al. 2017) promoted by the discrediting of skills, which helps to unjustifiably spread the notion that STEM areas are especially suitable for males (Kim et al. 2018). We could not find clear evidence of the influence this issue may have beyond the male-female identification, which may signal a need for less stereotypical approaches to study the issue. Awareness of these stereotypes influences the individual, reducing their performance and interest in areas that are stereotyped against their gender identification (Burke and Mattis 2007; Steele et al. 2007; Cvencek et al. 2011; Petersen and Hyde 2014; Song et al. 2017), not only due to the perception that they exist, but also that they are true, reinforcing the distorted idea of gender exclusion from these areas (Burke and Mattis 2007; Steele et al. 2007; Petersen and Hyde 2014).

Nardi (2010) explored the concept of gender-neutrality in a study of WoW, referring to this game's potential to engage players in diverse forms of game play, crossing gender boundaries. The author goes to the extent of considering that "WoW was, then, quietly subversive in its gender dynamics, enabling the unremarked enactment of cross-gender activities as an aspect of character development". This performance allows breaking down traditional gender barriers in activities and play, with individuals participate in activities without the constraints of societal expectations and gender stereotypes.

It is necessary to deconstruct the prejudices about the social roles of gender abilities and skills of the female gender in STEM, thus enabling a re-envisioning of professional opportunities (Metz, 2007; Padwick et al. 2016; Sullivan et al. 2016; Peixoto et al. 2018). A possible solution that might help deconstruct these stereotypical tendencies from an early age is the creation of experiences that promote positive playful contact, thus encouraging participation, trust, and capacity building on the part of the female gender (Kelleher and Pausch 2006; Kazakoff and Bers 2012; Sullivan and Bers 2016; Pila et al. 2019).

Play as an Opening

Play represents a significant role in the development of humans. It is the first occupational activity, and its impact is reflected in the development of motor capability as cognitive, social, and academic skills (Parham 2008; Bundy et al. 2009; Román-Oyola et al. 2018; Marguerite Loudoun 2021). Through play, children practice and exercise their new skills, contributing to the individual's learning and development (Afonso and Roque 2015).

Playfulness has been defined as a disposition to play, the way that children approach the act of playing, and therefore, suggested as one of the most important aspects of play (Skard and Bundy 2008). Playfulness can be determined by the presence of three elements (Skard and Bundy 2008): a) Intrinsic motivation: The involvement in the play is achieved because the player wants and likes to do the activity; b) Internal control:

The player controls their activity, deciding what they want to play, how, and who to play with, having total control over choosing when to suspend the play; c) Freedom to suspend reality: The player can choose how close the play can be to reality or to pretend. The presence of these elements can indicate the existence of playfulness in the activity.

Identifying the presence of playfulness in this type of experiment can be useful in recognizing events and artifacts impacting on the acquisition of new competences and as a facilitator of social behavior (Afonso and Roque 2015). The predisposition to play in children is essential for success in their learning process. The manifestation of attributes such as involvement and participation, planning and organization, concentration, and reflection become necessary for the foundation of this process (Wood 2007).

Taking into account the importance of play, we propose the development of a collaborative game experience based on running a colony of Meerkats. We will present our design proposal aiming at indirectly promoting a positive and gender-neutral contact with computational challenges in disguise, through a playful attitude, which can enthrall and provide competences of basic computing skills to anyone. A low-res prototype is presented, which we used as part of a playful probing to perform gameplay rehearsals for analysis of modes of engagement. This paper ends with a preliminary analysis and discussion of insights identifying interactions players go through while manipulating the prototype, how they establish a cooperative dialogue to solve challenges within the game, and the gender-neutral design effectiveness.

RESEARCH PROCESS

Our research design aims to create and rehearse a design proposal for a play-enabled intervention for social innovation through the deconstruction of gender-related stereotypes related to STEM, while influencing self-efficacy, raising trust or sensing the possibility to acquire competences in the gameplay exercise. At this stage, we intend to study how such a proposal would get appropriated and generate insights about how it could promote change through play and cooperative dialogue. Our research design is loosely structured as a Design Science Research iteration. It starts with the awareness of the problem (already described in the Introduction) and research into design inspirations from which a design proposal was synthesized. The design proposal is developed as part of a playful probing approach (Bernhaupt et al. 2007) focused on using play activities as a data collection process to investigate how participants engage with a process or artifact modeled in a playable context.

In the current case, we aimed at gathering data on how participants became empowered to develop basic competences that could help them trust their ability to perform in-game with enablers of computational thinking. A low-res prototype was created as a proof-of-concept that the game could be played and used as part of the playful probing to perform gameplay rehearsals for analysis of modes of engagement. To test the viability of prototype and gameplay dynamics, sixteen players were involved in paired gameplay, and rehearse-played the game with the assistance of the researcher as a facilitator of the game rules and responses.

Sessions of approximately two hours were recorded and content analysis was done on video content (actions and speech) based on an axial coding on categories related to meaningful events, competence development, playfulness factors, modes of cooperation, and emotions. Coding was cross-checked, and issues were discussed among three researchers for consensus and consistent coding.

A preliminary analysis of the results was done, with write-up, debate and revision. In this process, the thematic focus was put on: 1) identifying mechanisms players go

through while manipulating the prototype, 2) evidence signaling competence development related to computational thinking, 3) evidence establishing a connection with the playful engagement, and 4) evidence of cooperative dialogue towards gameplay resolution. Drafting and discussion of insights for further reworking of the proposed design and potential usefulness or efficacy towards the social innovation goal or stereotype deconstruction through a gender-neutral experience.

Design Proposal

Research has identified that women are more attracted to programming when it incorporates visual design, storytelling, relationship dynamics, and social interaction (Fristoe et al. 2011; McAdams 2018). We attempted to develop a genderless game that could promote social interactions, more specifically collaboration, a category of action preferred to the female gender but extendible to others. Collaborative play encourages interaction between individuals and promotes interdependence, learning to trust and rely on others while fostering positive emotions, as there is support from one another to solve emerging problems.

From the premise of collaboration, theme proposals for the game were identified that could use references, objects, and actions from the real world, taking advantage of the gamers' familiarity with these references to promote the involvement (Flannery and Bers 2013; Bers 2017; Pugnali et al. 2017; Wang et al. 2021). To that effect, due to the bond that children have with animals (Jalongo 2015; Moriya et al. 2022) and the fact that the collaborative features were part of the main game mechanics, we searched for animal species with collaborative social organizations, based on task, but not fixed role, division between its members to ensure the survival of the colony. We found the example of the meerkat, which aside from the appealing figure, has a social structure that seemed to fit those desired parameters. An in-depth analysis of this species allowed the development of the game's structure based on its behaviors, adapting them into actions to be performed in the game, with the main goal of raising a colony. With this goal in mind, three main functions were defined as the basis of the game's mechanics: territory discovery and development, predatory-defense action, and sustenance.

After defining the theme, we studied how programming concepts such as action sequences, conditions and flow could be learned. The application of these "programming concepts" would then be performed in the guise of meerkats' behaviors in the game by the players themselves. For that, we designed a solution based on Petri Net (PN) models in games (Araújo and Roque 2009) by associating their structure with the programming components for constructing the game character's actions.

A PN consists of four elements: places, transitions, arcs, and tokens. Graphically, it is described by diagrams where the places are represented by circles, transitions by rectangles, arcs by directed arrows (connects places, transitions, and tokens), and tokens by small circles (fill). Each place may contain one or more tokens representing conditions, resources or information required to producing the action (Araújo and Roque 2009). Therefore, when the place (conditions, input/output, information, or resources) holds the token (resources, true or false), it will activate the transition (events, tasks, clauses), causing the token to change from the original place to the next place, as depicted in Figure 1.

Taking this into account, we adapt this modeling device to develop the construction of the game's actions, as indicated in Figure 1. We associated the representation of place of the PNs with the condition and result area of the game's actions, and the representation of transitions of PNs to the action area of the game's actions. The construction of game's actions is carried out through defining conditions, actions, and results.

Considering this structure, the game's actions operate when the defined conditions are satisfied, through the existence of the element in the game, or the direct contact of the meerkat with the element (e.g. the player finds the element hidden in the game board). This process triggers the action associated with this condition, thus producing the player's specified result.

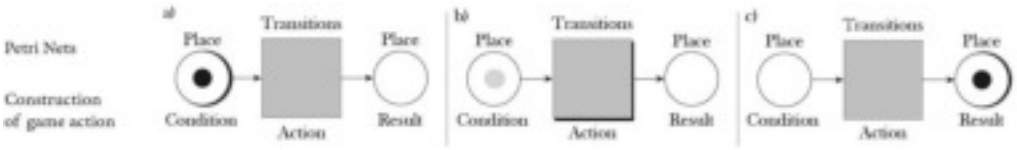


Figure 1: Adaptation of PNs to the construction of the actions. Process: a) Token in the place/condition; b) Activation of the transition/action; c) Token has moved through the transition to the following place/result. Adapted from Araújo and Roque (2009).

Prototyping

The game consists of a player panel (Figure 2b), for constructing the actions that meerkat can perform; and a main board (Figure 2a), where the meerkats would act according to player choices (action defined in the player panel). The player panel was designed mimicking the PN's graphic structure and is formed by a set of cards, each with a condition area with three circles; an action (transition) square; and a result area with three circles (Figure 2b). This construction gives the player the freedom to set various conditions to trigger the same action. In this way, the player can apply specified conditions and results to actions.

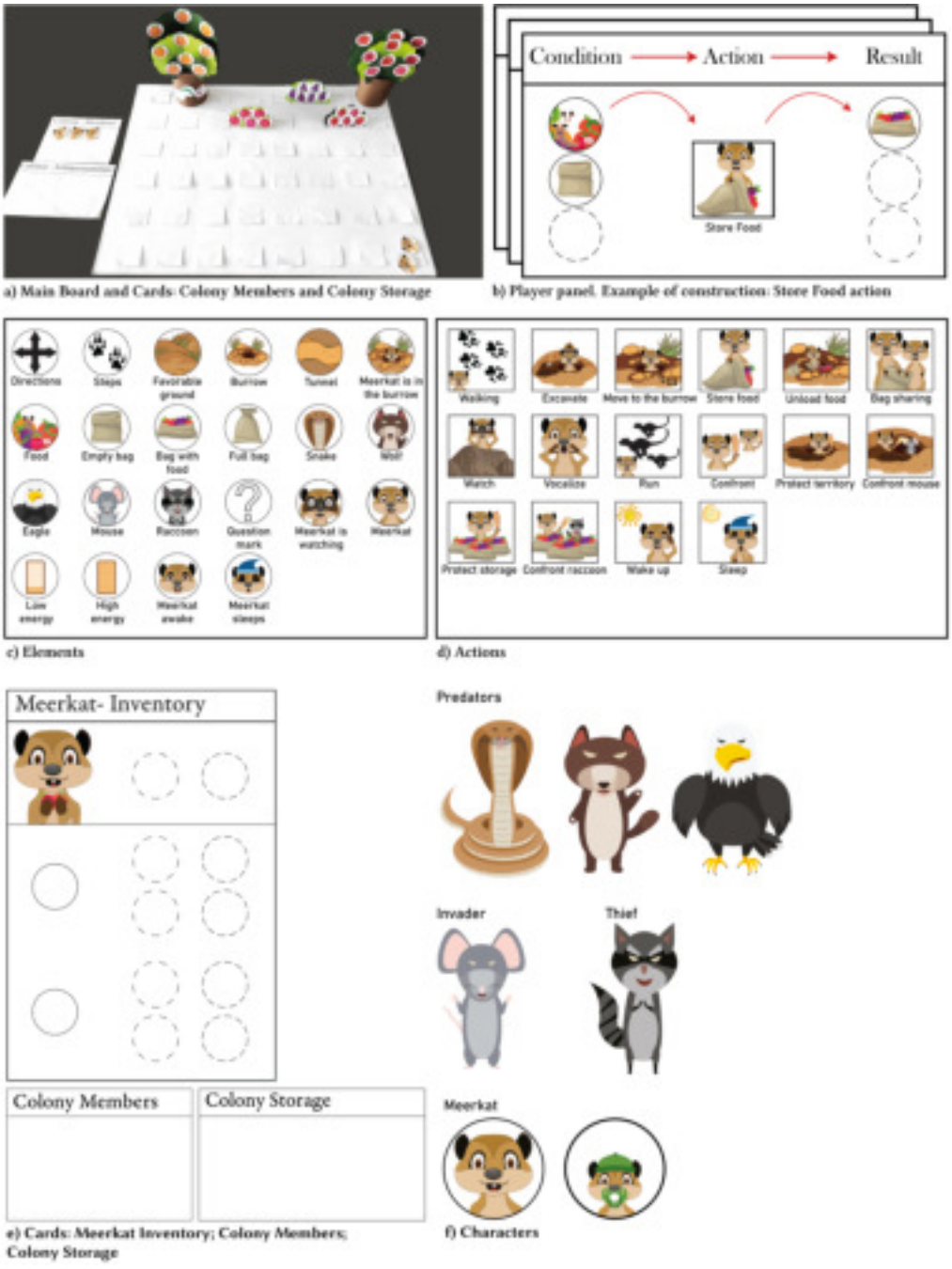
Considering the method for defining the game's actions, we developed the elements (places) (Figure 2c), that would enable the actions (transitions) (Figure 2d). Those same elements would be used in each player's action panels and the main board. If those elements are found on the main board, when the character goes by, they trigger the token of the same element in the condition area at the player panel, activating the transition (action) and thus moving to the output places (action result).

Iteratively exploring this process resulted in the emergence of the following actions based on the meerkat's natural behaviors (Figure 2d): *Walking*; *Excavate*; *Move to the burrow*; *Store food*; *Unload food*; *Bag sharing*; *Watch*; *Vocalize or warn*; *Run*; *Confront*; *Protect territory*; *Confront mouse*; *Protect storage*; *Confront raccoon*; *Wake up*; *Sleep*. The actions and elements are not bound to each other, and may be combined separately. The previous development process resulted in the following elements (Figure 2c): *Directions*; *Steps*; *Favorable ground*; *Burrow*; *Tunnel*; *Meerkat is in the burrow*; *Food*; *Empty bag*; *Bag with food*; *Full bag*; *Snake*; *Wolf*; *Eagle*; *Mouse*; *Raccoon*; *Question mark*; *Meerkat is watching*; *Meerkat*; *Low energy*; *High energy*; *Meerkat sleeps*; *Meerkat awake*.

The next step was to create the visual components for representing the colony (Figure 2e), namely: 1) a card with colony members, for keeping track of its number, 2) a card for storage to represent the players' deposit of collected food, and 3) a meerkat inventory, for the players to know the amount of food they carry, both in their hands and in the bag.

For opponent characters (Figure 2f), their representation would appear on the main board when activated, which consisted in a) Predators: Snake, Eagle, and Wolf; b) Invader: Mouse; c) Thief: Raccoon.

The main board consisted in two overlapping A3 paper sheets, with the upper sheet divided into 6x8 cell cuts to reveal game elements hidden in the cell. This design allows hiding elements and opponents on the main board that activate actions defined in the player panel when discovered by the player. Trees and shrubs were also created to visualize food rewards, encouraging the player to explore them.



a) Main Board and Cards: Colony Members and Colony Storage
b) Player panel. Example of construction: Store Food action
c) Elements
d) Actions
e) Cards: Meerkat Inventory; Colony Members; Colony Storage
f) Characters

Figure 2: Game components.

Game mechanics

The players have access to a player panel consisting of up to eight cards, where they define, in each turn, the actions to be performed on the main board. The player panel is collaboratively defined by the two players, allowing each one to choose the action to perform with their meerkat. Meerkat actions will depend on any player defining them and their conditions satisfied through actions on the main board. The execution of

actions may also depend on creating appropriate changes in the game context (e.g unload action depends on having excavated a burrow, fast movement in tunnels depends on tunneling, etc). Changes to the player's action panels can be made at the beginning of each round.

At the beginning of the game, the main goal, building a colony, is explained and it is provided a dice and a meerkat to each player. The meerkat is placed on the main board and will be used to perform the actions defined in the player's panel by acting on the main board. Each meerkat has an inventory that will be used to store, carry food (and other items), and unload it later in the colony. The players start with four cards in the player panel, the actions walking and excavating, and the elements directions, steps, favorable ground, and burrow. During the game, they will gradually unlock player panel cards as well as more actions and elements, depending on the discoveries made during the game (exploration of the cells or changes in the game context).

Each player has a dice that they will roll together. The number obtained on the dice will give the number of possible actions (meerkat behavior steps) plus movements that the meerkats can perform on the main board in each round. This number of actions (obtained in the dice) can be shared between the players, allowing freedom of choice in deciding the amount they wish to share among them. A round develops in three stages: 1) building of actions on the player panel; 2) rolling the dice; 3) executing actions specified on the player panel with characters acting on the main board.

The players can perform a series of behaviors on the board to promote the growth and maintenance of the colony, namely the construction of a burrow, food collection, territory expansion and protection. Depending on this process, new members will appear or leave the colony. The game ends when all cells are explored, all available food is collected (cells, trees, and bushes), and when the meerkats have confronted all the predators, invaders, and thieves present on the board. At the end of the game, the number of meerkats present in the colony is counted, and the number of members will indicate the victory or failure of the players.

GAMEPLAY REHEARSALS / PLAYFUL PROBING

Eight gameplay rehearsal sessions were performed in groups of two individuals: five tests with multiple gender representation, one test by female subjects and two by male subjects. Explicit permission was obtained for audiovisual recording of the sessions for content analysis, with camera focus on the board and pieces (Figure 3). The duration of rehearsals was influenced by the users' approach to play, ranging from 01:10h to 01:54h.

Figure 3: Gameplay test.

The population consisted of a heterogeneous convenience group composed of 16 individuals, Table 1 (six female individuals; nine male individuals; one individual who preferred not to specify the gender), aged between 22 and 60 years old, who had diverse knowledge backgrounds (engineering, science and education).

Test	Player	Gender	Age	Background/field of study
1	P1	Female	37	Design and multimedia
	P2	Male	22	Design and multimedia
2	P3	Male	27	Electrical engineering
	P4	Male	25	Anthropology
3	P5	Female	60	Education
	P6	Female	33	Civil engineering
4	P7	Female	24	Design and multimedia
	P8	Male	28	Design and multimedia
5	P9	Male	22	Informatic engineering
	P10	Choose not to say	25	Design and multimedia
6	P11	Male	25	Electrical engineering
	P12	Male	24	Electrical engineering
7	P13	Female	24	Education
	P14	Male	24	Management
8	P15	Female	23	Design and multimedia
	P16	Male	22	Electrical engineering

Table 1: Sample categorization of the study.

At the beginning of each session, the researcher presented the game's theme and components, the dynamics and rules of the game, action definition on the player's panel, and demonstrated condition-action-result construction with a walking example. During the game session, doubts and arising problems were clarified with the least possible interference by the researcher. In the end, the researcher collected the players' testimonies via individual interviews.

Content Analysis

The content analysis involved players' answers, the observation of the videos, the selection of relevant evidence and coding for categories, namely related to competence events and playfulness factors. Regarding the category of competences (Figure 4), three subcategories were defined: Reading and interpretation; Condition-action-result; Action chaining.

The *reading and interpretation* subcategory focused on the individual's ability to read and understand the construction carried out in the player panel. This process involves the capability to understand the illustrations and the way the game works in terms of dependencies/conditions, consolidating the knowledge necessary to construct the player panel.

In the *condition-action-result* subcategory, we retrieved the threefold element of identifying the need for certain elements to trigger the desired action to obtain a determined result. This skill is the basis for the player's panel construction in the game, in which the user must define the necessary elements to activate a specific action.

Regarding the *action chaining* subcategory, in terms of programming, it is related to the need to develop an action to create conditions for another action. This category

helps to identify the chaining logic, leading players to think about the behavior necessary to achieve a particular end.

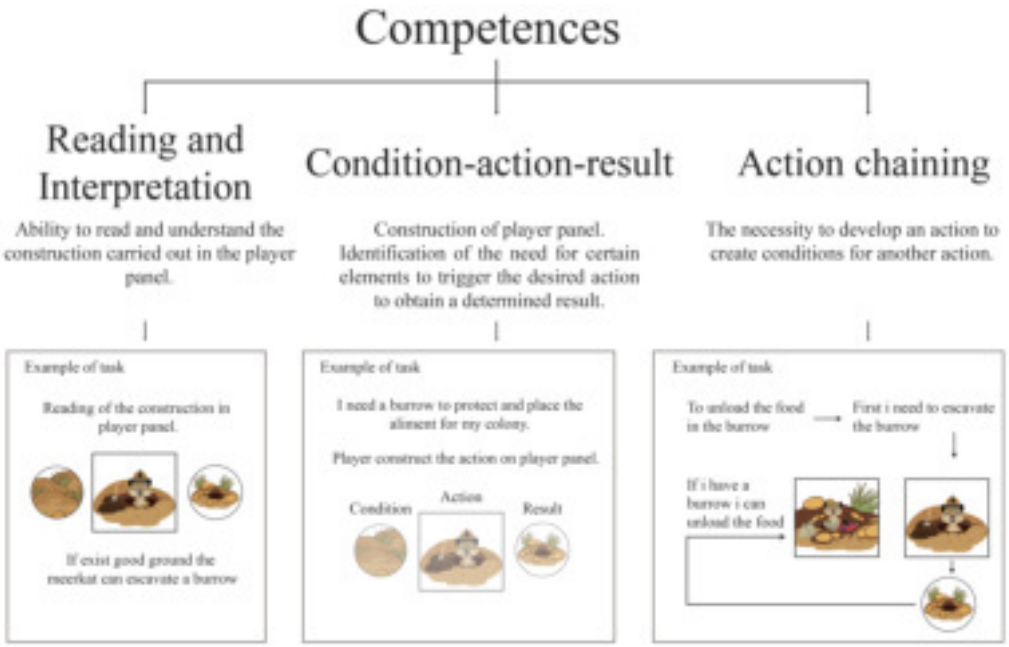


Figure 4: Subdivision of the Competence category, with examples of tasks to be performed.

The *Playfulness* category was subdivided into the three proposed elements (Skard and Bundy 2008), the subcategories of *intrinsic motivation*, *internal control*, and *freedom to suspend reality*, and parameters retrieved from the same study (Figure 5).

Within the *intrinsic motivation* subcategory, we considered moments demonstrating positive emotions during play, such as verbal and gestural expressions associated with fun. The more positive emotions felt, the more the player would feel motivated to continue playing.

In the *internal control* subcategory, several parameters were considered as indicators of the existence of control by the player, as defined in the Test of playfulness (ToP) (Skard and Bundy 2008), namely:

1. *Decides*: concerns to decision-making. Regardless of the pressure of peers, the player makes decision about what to do and how to do it;
2. *Negotiates*: regards to situations where request or negotiations are made, demonstrating easiness and delicacy in the process;
3. *Engages in social play*: was considered interactions between players during the activities, more specifically, the existence of involvement between players;
4. *Supports play of others*: concerns to the ease with which the player supported the play of the other player, by encouraging the performance of the activity, up to the suggestion/sharing of ideas to assist the other player's activity;
5. *Shares*: was considered the ease with which the individual shared their belongings with their partner, namely their game pieces and ideas;
6. *Interacts with objects*: regards to the ease with which the player interacted with them.

For the subcategory *freedom to suspend reality*, the parameters of:

1. *Mischief or teasing*: situations in which the player was involved in situations of provocation (playful teasing) or minor infractions of the rules in order to make the game more fun;
2. *Pretends*: situations in which there was a pretense by the player in the context of doing something, or that something was happening;
3. *Jokes*: antics and jokes performed by the player during the activities, from telling jokes or funny stories to exaggerated and swaggering behavior with the purpose of gaining the attention of the other, were considered as qualitative indicators of this subcategory's presence.

Figure 5: Subdivision of the Playfulness category, based on ToP.

After identifying the categories, the first stage of the axial coding was performed, through the analysis of 30-second portions of the videos, during which evidence was collected and categorized through the signaling of subcategories. In the second stage, all the data gathered from the eight tests were merged into a single document, resulting in 5934 lines of evidence. From this gathered evidence, the subcategories were verified and rectified by three researchers. Finally, a correlation between the analyzed categories was carried out, identifying possible trends and patterns in the skill evolution of individuals.

Concerning the attempt of developing a gender-neutral game design, the individual interviews included a set of gameplay and gender-related questions, such as:

> Q1. Did you identify with this game? Why?;
> Q2. Tell us an episode where you felt that the gender issue influenced the way you played;
> Q3. Do you feel that this game is oriented to a specific gender? Why?.

We executed the transcription of the individual questionnaire interview and analysis with the evidence retreat to the observation of the video to have insight into gender matters.

DISCUSSION AND INSIGHTS

Development of diverse competences across gameplay time

Collected evidence on how competences were acquired and evolved indicates differences in the players' behavior, observed in situations that required the execution skills at different times of the game. We observed that this evolution might be influenced by the player's own practice when performing the activity, as well as by observing the partner's performance, which could lead the individual to understand how he/she can perform the activity. It was noticed opportunities for change in player

behavior concerning the construction of actions. During gameplay, the player moves from a passive attitude towards the construction of actions to an active and autonomous attitude, which allows sharing of the player's knowledge about carrying out the actions, as well as exposing their understanding of the elements, which makes it possible for others to correct their constructions. In other cases, we noticed a need for approval from the other player, demonstrating a lack of confidence regarding the choices made for the construction of actions. However, with practice, the individuals found opportunities to build confidence in each other, reaching a stage where they did not need or seek the approval of the other player, no longer questioning its own constructions.

Illustrating this, @00:15:30h-00:16:00h: In the first phase, P4 has a more passive attitude to the construction of actions in the player's panel (competence: condition-action-result). Player P3 performs the action construction, while P4 only agrees:

> P3 builds the store food action.
>
> P4 confirms the other player's build.
>
> The players removed the store food action in favor of another action in the player panel.

@00:16:30h-00:17:00h: In a second moment, P3 encourages P4 to execute the construction:

> P3 suggests that P4 inserts in the result the element burrow.
>
> P3 inserts the favorable ground element in the condition area, and the element burrow in the result area.
>
> P3 verbalizes the construction, "*It's good ground, isn't it?*".
>
> P4 confirms the construction of the other player, "*That's it*".
>
> P3 verbalizes the construction, "*Build the burrow. It's like that, isn't it. . . Does it make sense?*".

During this process, there is a change in P4 behavior, in which he switches from approving the other's construction to making his suggestion and executing it:

> P4 confirms the construction of the other player, "*Yes... And then, this part comes here*", referring to the store food action. Inserts the store food action in the player panel and the food element in the condition area of that action.

@01:17:30h-01:18.30h: In a later stage of the game, it is identified that P4 quickly changes the player panel without resorting to the other player, demonstrating a better interpretation of the elements and the action than the other player:

> P4 builds the sleep action. Inserts the meerkat sleeps element in the condition area of the action. However, when selecting the low energy element, notice that the sleeping meerkat element is in the wrong area of the construction and removes it from the condition and replaces it with the low energy element. Ends up putting the meerkat sleeps element as a result of the sleep action.
>
> After P4 finishes the construction, player P3 observes and asks about the meaning of the sleep action.

Development through players' cooperative dialogue

Illustrating this point, a player supports the other player by encouraging them to perform an action. When the player does that, he/she can identify the need to define another action, perceiving the dependencies between specific actions, which in turn leads the player to add the necessary action in the player panel. Illustrative example:

> P6 analyzes the situation of the other player, "*The mother now has two pieces of fruit there, isn't it... And then she'll have to unload them and pick up more*".
>
> P6 asks the other player if he wants to unload the food in the burrow. Informs that first they have to define the action, "*But wait, we have to define the action*".
>
> P6 builds the unload action. Asks if it is necessary to use the element meerkat in the burrow or the element food in the construction of the unload action.

As a player summarizes:

> P14 commented, "*It's interesting because you can build something that helps you, you can cooperate to achieve the expected result... And it's unpredictable and fun because you do not know what may appear*".

Influences of playfulness in competence development

After identifying evidence of the categories of competences acquisition and playfulness, we searched for links between these categories, specifically how the support for playfulness could influence the learning and development of competences. In one illustrative case, playfulness was initially signaled through internal control, more specifically through the subcategory supports the play. The need to assist the other player, not only contributes for the player to identify the chain of actions but also promotes the creation of the actions, assisting in the practice of the activity, which consolidates the knowledge about condition-action-result. Indicating the disposition for playfulness:

> P11 commented, "*Yes, very amusing ... promotes interaction and the fact that we are discussing with each other what is better for the team than for us… I liked it... I liked it, it's interesting*".
>
> P1 commented, "*The more you play, the more exciting it becomes. It may be related to the fact that the game is phased, there is a sense of progression, and you can do more. Even in the course of the actions, you start by walking and then exploring... A good hierarchy*".

An example where collaboration and playfulness combine, involves contributions to facilitate competence development is a combination of social engagement, support of play and decision (internal control). In this case, P6 interacts socially with the other player commenting on the findings made by P5. This involvement led P6 to suggest the behavior that P5 could perform, promoting support for the performance of P5. P5, through the subcategories of engages and support, makes the decision to perform the action, being supported by P6 in the construction of the action in the player panel:

> P6 reacts to the snake "*A snake appeared to you (laughs*)". Indicates what the things that snake will do, "*Steals land... Kills the meerkats*".

P5 reacts to the statements made by P6 about what the snake will do, "*Noooooooo!*".

The actions related to the snake are exposed to construct the panel.

P5 reacts to the action run, "*Running away? No. Running away? No!*".

P6 question P5, "*What do you want to do? I think we must confront*".

P5 responds to P6, "*Always confront... To see if it disappears… Confront!*".

P6 encourages the construction of the action, "*You have to take the action*".

P5 question P6, "*This is the one to confront?*". Inserts the action in the panel, "L*et's confront*".

P6 verbalizes, "*I'm going to win! (laughs)*".

P6 and P5 win the confrontation, and both expel the snake from the board while laughing.

P5 verbalizes, "*Now I'm starting to understand this better*".

In this illustrative case, we observe a social interaction between the players, which in turn promotes support of play, resulting in cooperation between the players to solve the game's problems. This support of play helps the learning process by encouraging the players to perform constructions on the player panel, practicing the condition-action-result competence, and clarifying doubts that may arise. This practice makes the individual feel more confident in performing simulated actions in the future, extracting positive feelings not only from their performance but also from the interaction and support provided by the partner, which may promote the player's motivation to continue performing the activity.

Player perceptions concerning the gender-neutral game

The video analysis revealed no gender-specific differences in game performance. All players completed the game's challenges. In relation to the individuals' interviews, it was possible to receive insights about the players' perception of the experience to clarify if the neutral game design aim was achieved and if players identify differences in performance between genders.

The questions presented in the individual interviews aimed to identify the following information:

Regardless of gender, if the players enjoyed the game (Q1.).
If there were performance differences between players that could be related to gender (Q2.).
If there were any features in the game that would lead to an association with a specific gender (Q3.).

In relation to Q1. the participants mentioned that the game was entertaining, funny, unpredictable, strategic, interactive (dynamization performed by the researcher), and collaboration led them to enjoy the game:

"I enjoyed the game... I was entertained and a lot.... As they say... immersed."

“Yes, very funny. I like board games because it also promotes interaction and the fact that we are discussing what is better for the team than for us... I liked it. I like it; it's interesting.”

“Yeah, because... It's interesting because you can build something that helps you and cooperate to achieve the expected result... And it's unpredictable. It's fun because you don't know what might come up.”

Regarding to gender being associated with specific performance in the game (Q2.), it was found that the players did not identify the existence of differences in behavior. In some situations, there were reactions of astonishment from the participants when this question was raised:

“Ok, that's a bit strange.”

“What do you mean? The gender issue? (Laughs) I don't think it influences anything, why would it? I don't think it influences.”

In other cases, because the game session was with individuals of the same gender, it led to assumptions that if they had played with individuals of the opposite sex, maybe there would be differences in the strategy adopted:

“Maybe if I had played with a person of the opposite sex, maybe the strategy would be different.”

It should be noted that the hypothesis raised by the player refers to the strategy and not to problem-solving skills. One player alerted that the question isn't in the gender but in the experience of the player in games, and that maybe influences the performances of the players:

“It's not a question of gender, but a question of experience.”

Concerning to Q3., that points to the game being gender specific, the participants referred that there was no gender specification. They stated that:

a. Characters do not present gender:

“In the character, there is no gender, and all the actions are possible to execute whether they are women or men.”

“No. Because, in this one, there was no difference here. None of the meerkats... There wasn't a male or female meerkat.”

b. The category of the game (collaborative, cooperative, and strategic) does not highlight gender differences:

“There's no stereotyping here, and I think that's quite positive. There is nothing on the aesthetic level and the level of the game dynamics.”

“No, no, because I think this is a collaborative and strategic game, to a certain extent, and it's not because I'm a man that I'm going to have a better strategy or collaboration. I think that's made-up ideas. I don't think it's that way. Everybody collaborates; it's not just for one sex or gender.”

"We had the same opportunities for play and points; we even cooperated with the points, so no... It's cool."

c. The theme/objective of the game. The fact that it is about a colony in which the members have to perform the same tasks:

"It's a family, but both works to achieve a goal, there is no differentiation, so I don't think there is a gender difference."

Through this analysis, it can be conjectured that perception of player regardless the game and the intention of creating a gender-neutral design was successful since:

i) Both genders enjoyed it, referring to the collaborative characteristics of the game and the fact that it was challenging, interactive, and fun led to the involvement of the participants: 93.75% (15/16) of participants reported that they enjoyed the game. From the 15 participants that enjoyed the game, 60% (9/15) identified with the male gender, 33,34% (5/15) with the female gender, and 6.66% (1/15) preferred not to specify gender.

ii) The participants did not identify aesthetics, theme, and performance characteristics that could be attributed to a specific gender. 12.5% (2/16) referred that, if differences exist between players, concerning to the behavior, it may be influenced by the background: individuals who had specific knowledge and practice in games would be more able to develop more efficient strategies and constructions.

CONCLUSION

As part of a STEM diversity balancing initiative, we presented a design proposal for a play-enabled intervention for social innovation that aims to promote self-efficacy through players' cooperative dialogue, while aiming for a gender-neutral proposal that could generate insights for future designs. Our main goal at this stage is focused on gathering insights about how participants become empowered and how player interactions, directly and through the gameplay, helped develop basic computational competences.

Eight gameplay rehearsal sessions were executed, video recording and axially coded for relevant categories, together with individual interviews. Content analysis focused on playful behavior, modes of cooperation, competence development and gender-related aspects. Based on content analysis, we could find evidence of development of competence, collaborative dialogue, and how playfulness aspects of the activity allow to generate opportunities for learning. We were able to identify mechanisms players go through while manipulating the prototype, evidence signaling competence development related to computational thinking, its connections with playful engagement, and how cooperative dialogue might help gameplay resolution. Not only does preliminary evidence shows that players have acquired competences, but it also shows that the player itself has an awareness of that evolution.

The analysis revealed no gender-specific differences in their performance, since all the players completed the game's challenges. Through the individual interviews, we observed that the players did not identify characteristics in terms of aesthetics, theme, and performance that could be attributed to a specific gender.

Future in-depth analysis of collaboration patterns, as well as playfulness and self-efficacy, will be done for further insights. To this end, more rehearsals are required for a more representative sample. Future research will investigate the relationship between these components and the promotion of engagement and curiosity for the STEM areas.

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