Videogames and Innovation: Fostering Innovators' Skills in Online-Learning Environments

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Abstract: Innovation is quite important for economies and entrepreneurs around the world, especially for developing countries such as Colombia, where this study was based. Therefore, education for innovation becomes as important, and newer and innovative educational means must be adjusted for developing skills in innovation and entrepreneurship. Innovator's DNA is a framework of skills that are meant to be developed by innovators. This framework proposes five discovery skills, which are: observing, associating, experimenting, networking, and questioning. This paper studied whether and how videogames can develop innovators' skills in students of entrepreneurship and innovation in online-learning environments, by directly observing the participation of 23 participants during an interaction with a game specifically tailored for fostering these skills. The videogame used is called CAFET, and it consists of a card-based game where players enact coffee industry entrepreneurs in Colombia. A mixed-methods research was carried out by coding each observable action conducted by the participants and interviewing them about their behaviors. Results showed that participants enact actions that may involve and develop innovator's DNA skills, specifically observing, associating, and experimenting. This study analyzed how videogames can develop innovation skills and explains the behaviors observed among other insights.

Keywords: innovation; innovator's DNA; entrepreneurship; game-based learning

1. Introduction

This era is, without a doubt, one of change. Change ranges from the global challenges leading to countries' policies and solutions to the day-to-day of anyone at any place. People experiment the impulse of change and they need to place, adapt, and act according that in order to survive or improve. This is also the current landscape for businesses, and thus there is an ever-increasing necessity for innovation. Innovation can be seen from many perspectives, and it is, indeed, a polysemic term; however, it can be just understood as "the means by which the entrepreneur either creates new wealth-producing resources or endows existing resources with enhanced potential for creating wealth" [1].

Innovation is deemed quite important for people, businesses, and organizations both public and private, and it is also a game-changer for sustainable endeavors in the 21st century [2]. Innovation has become really significant for all of the economies around the world, but perhaps it is imperative for developing countries, due to their need to foster innovation practices and promote innovation policies to adapt to an ever-changing world that advances, nowadays, much faster than traditional economies can barely resist. That is the reason for what in 2005, the World Bank Institute established a conceptual framework for innovation policies to be applied on developing countries [3]. Regarding its

main messages, the study concluded that there is a need to "provide support . . . in the building of a broad climate conducive to innovation which requires a good business environment, an educated population and efficient infrastructure." This is the case of Colombia, the country where the present study is conducted.

Colombia is located at the north-west corner of South America. Colombia's greatest richness comes from being one of the most biodiverse countries in the world, principally because Colombia has various relatively constant temperature zones, climates, and microclimates throughout the year [4]. This characteristic has led Colombia to be a producer of many agricultural commodities, being, for example, one of the main producers of coffee in the world. Nonetheless, this could change in the upcoming years. The coffee industry in Colombia will have at least three core challenges: climate change, a decline in coffee production, and an increasing youth generation which is getting farther from the coffee industry in Colombia [5–7]. This has led to the consideration that it is necessary to train a new generation of coffee entrepreneurs who are leaders and innovators. As concluded in the work by Aubert [3], this needs to include a compromise to create learning environments suitable for training new innovators.

Thus, as training new innovators is important, it becomes of upmost relevance to study ways to educate students in innovation practices, in every discipline, but especially during entrepreneurship programs. As the study by Portuguez, Ross, and Gomez states as a future work, it is required "continue analyzing the role of education for entrepreneurship and innovation . . . " [8]. These authors presented a study where they found how active teaching strategies helped the development of entrepreneurship skills during a course in México, a country with a context like Colombia's.

However, nowadays, many educational processes are conducted under online-learning environments, such as MOOCs (Massive Online Open Courses), virtual learning, and hybrid learning (a mix of virtual and in-person approaches). While a lot of curricular development on the concept of innovation is possible, the development of innovation skills is challenging. Hence, newer digital strategies and tools are needed (see [9,10]). This said, the problem statement for this study is: "There is a difficulty to develop innovation skills on students during online-learning environments".

When the present study started, it needed a framework to define innovation. The Innovator's DNA [11] was chosen, since it simplifies the vision on which are the main behaviors to promote on students. Also, the innovator's DNA counts with a strong foundation on several interviews with the most important innovators (people and organizations) from the world. The innovator's DNA premise is simple: innovators have a "DNA", a set of skills which, similar to genetic DNA, may be changed, and people can foster their DNA becoming more creative and innovative people. The Innovator's DNA framework defines the next five discovery skills, which are employed by most innovators [12]:

- associating is the ability to make connections between things from different areas of expertise, knowledge, or location;
- questioning is the ability to ask thought provoking questions on who, what, when, why, and push this towards being a creative catalyst for the other skills;
- observing is seeing around the world, the people living there, and noticing both what does and does not work in these situations;
- networking is the ability to link ideas and opportunities with others that work and play in the same or different areas of expertise than one's own;
- experimenting is the act of trying out new ideas or processes in search of new data that may lead to an innovative opportunity.

A special emphasis is placed on the observation, questioning, association, and experimentation skills as they are considered very important in the model developed by Mathis, Fila, and Purzer [12], where they observed a sequencing pattern of these skills at analyzing the frequencies and processes followed by a set of innovators.

In the effort to find newer, innovative, and effective strategies for fostering innovators' skills, a brainstorm of educational innovations was conducted to find the one that was suitable for the context and needs of the present study. After this process, a Game-Based Learning (GBL) strategy was chosen since many studies have exposed the great potential of games used for education. GBL activities have been shown to increase the opportunities of students to develop 21st-century skills such as communication, problem-solving, team work, information management, and research and collaboration [13], skills which were deemed to be related to innovators' skills. As a matter of fact, games have been shown to increase motivation and allow activities to be learner-centered, facilitating problem-based learning and independent learning [14–16]. The case studies chosen to be applied are two, a Massive Online Open Course (MOOC) on innovation and a course on entrepreneurship culture and initiative at EAFIT University in Medellin, Colombia. These were meant to be online-learning environments where students aimed to learn about innovation and develop innovators' skills.

After choosing this strategy, this study's driving research question is clear: Are videogames able to foster innovation skills in online-learning environments?

To carry out this study, a systematic mapping of the literature is executed, leading to the discovery that similar efforts to this end have been conducted in the past. For instance, Armstrong and Barsion [17] worked at Harvard Macy Institute by promoting on teachers some strategies involving the development of innovator's DNA skills. Shoop [18], working at WestPoint, developed a strategy involving a framework to increase students' innovator skills following the Innovator Dilemma (a work related to the Innovator's DNA). Songkram's work [10] showed how it is feasible to develop innovation and creativity skills using a Virtual Learning Environment (VLE). Camacho, Sahu and Esteva [19] used a game called "Undertaking" to evidence how students perceive a positive impact of its usage for developing 21st-century skills; while this is not a videogame and it does not aim for Innovator's DNA skills, it certainly points toward a critical understanding of games and their usage for innovation and creativity. A similar approach was used by Vinichenko, Melnichuk, and Makushkin, [20] who used a game by the name "Search for Truth", showing benefits on the development of creativity and innovation. Other works such as [21,22], while not using games, showed how universities should aim for the development of creativity and/or innovation skills in their students, and showed how courses in higher education should advocate for innovation and related skills. Using quantitative methods, Barr [23] showed that playing video games can improve skills such as problem-solving, communication, resourcefulness, and adaptability in adult learners. To support the quantitative study, Barr [24] carried out a second investigation using qualitative data, finding a wide positive perception on the part of the participants about the effect of the video game on the development of their skills. While recent literature agrees on the positive relationship between video games and innovation, as well as the related 21st-century skills and creativity [25–27], to our knowledge, and beyond the evidence presented in this study, there is a scarcity of relevant literature that specifically relates video games and the Innovator's DNA skills. However, according to this summary, there is a huge interest on innovation, and thus, it remains an ongoing interest. Finding how higher education students should be trained and how to foster innovation skills is an open area of study. While a couple of games were found to be used during innovation development courses, as far as it is known, no study has been conducted on the impact of videogames to foster innovation, according to the discovery skills defined by the innovator's DNA.

An opportunity was presented to this study as the University had already created a board game—a card game—specifically designed to foster Innovator's DNA skills. The game is called CAFET, and it is meant to develop innovators' skills through the generation of an environment conducive to the teaching of general skills, emphasizing on entrepreneurship and innovation. In this game, students take the role of an entrepreneur in the Colombian coffee industry, with the objective to teach about the coffee industry to young Colombians, and at the same time to promote the culture and industry related to coffee. A previous study on the board game displayed that participants show motivation and that is linked to the usage of the game. This led to thinking about if this game was not limited to a

physical table, and what if it was designed as a multiplayer interactive digital game meant to be used during entrepreneurship development online-learning environments.

Thus, CAFET was developed in a digital edition and this study proposes the following driving research questions to be conducted on the interactions with the game:

- Is it possible to foster Innovator's DNA skills through the usage of a videogame specifically designed to this end?
- What behaviors leading to the fostering of innovation skills can be observed during an interaction with the game?

Using CAFET in digital edition as a case study, the following research questions will be answered in this paper:

- RQ1: What behaviors leading to the fostering of innovation skills can be observed during the interaction with CAFET?
- RQ2: What reasons do participants interacting with CAFET argue to explain their behaviors observed (behaviors leading to innovation)?

They are shown the results from a mixed-methods observation. The game is installed and run by each participant, recording their screen (it is done this way due to government displacement restrictions, because of 2020's COVID-19 pandemic). Each observable interaction of the participants is codified according to a set of a-priori defined codes. The codes are analyzed, identifying a set of behavioral patterns that suggest that the game helps to foster Innovator's DNA skills (mainly associating, observing, and experimenting). Next, Section 2 shows what methods and resources are used to conduct the observation. Section 3 shows the results obtained and Sections 4 and 5 discuss and conclude on what implications these observations suggest for the development of online-learning environments aiming to foster innovation skills.

2. Materials and Methods

2.1. Participants

A set of 23 participants (age M = 33, SD = 9.99, 57% female, 43% male) was observed directly interacting with the game in a multiplayer online series of sessions. Table 1 summarizes the age, gender, and nationality distribution of the participants. There was a similar distribution between men and women, only exceeding the number of women to men by three. Relating to the origin of the participants, although the highest percentage of participants in the study were Colombians, it is worth mentioning that thanks to the accessibility allowed by the MOOC offered, some of the participants came from different Latin American countries: Panama, Ecuador, and Peru. Although the number of participants was insufficient to describe profiles of innovators depending on their nationality, this highlighted the possibility of using CAFET and MOOC to reach people remotely.

Table 1. Description of study participants.

Age Distribution		Nationality	
Age Range	**Number of Participants**	**Country**	**Number of Participants**
17–23	7	Colombia	20
24–30	1	Ecuador	1
31–37	5	Panama	1
38–44	7	Peru	1
45–51	3	**Gender Distribution**	
Total Participants	23	Male	10
Average Age	33	Female	13
Standard Deviation	9.9508386		

2.2. Instruments

This observation was done using the CAFET videogame. CAFET is a card game where players need to create recipes which give them access to resources, in order to consolidate companies related to the coffee supply chain. It was designed for six people or teams. The minimum required of players/teams is four.

At the beginning of a match, a shuffled deck with all the ingredients is placed in the board for all players to draw from it. Each player has their own shuffled deck of recipe cards and they are given eight ingredient cards and one recipe card. In order to build recipes, a player must play ingredient cards and their intended recipe. Each recipe has a set of required ingredients which must be met entirely during a phase called "Barista". The game is won by the player/team that has gathered the most points by the end of the game.

During a player's turn, they might play one or more ingredient cards of the same type and play one recipe card from their hand. Once they have played their cards, the player must draw ingredients from the ingredient's deck or from their own recipe's deck to have nine cards in their hand again. A turn is completed once the player draws cards from either deck, in which case the turn of the player to their right starts. This mechanic goes on until the ingredients deck is empty, which triggers the Barista phase. Figure 1 shows an example of how the board looks during a player's turn.

Figure 1. Board image of the desktop CAFET videogame.

During the Barista phase, a deck made up of all the cards played by the players is used. One by one, each card is placed on the board in the order they were played. When a recipe card is placed on the board, the Barista checks if it can be made with the ingredient cards placed on the board so far. If it can, the ingredients are removed from the board and the owner receives the recipe, otherwise the player is asked if they have in their hand the ingredients to complete the recipe. Figure 2 shows how the Barista phase looks. Two Barista phases are carried out during a match. The software used can be found on the Supplementary Materials of this paper.
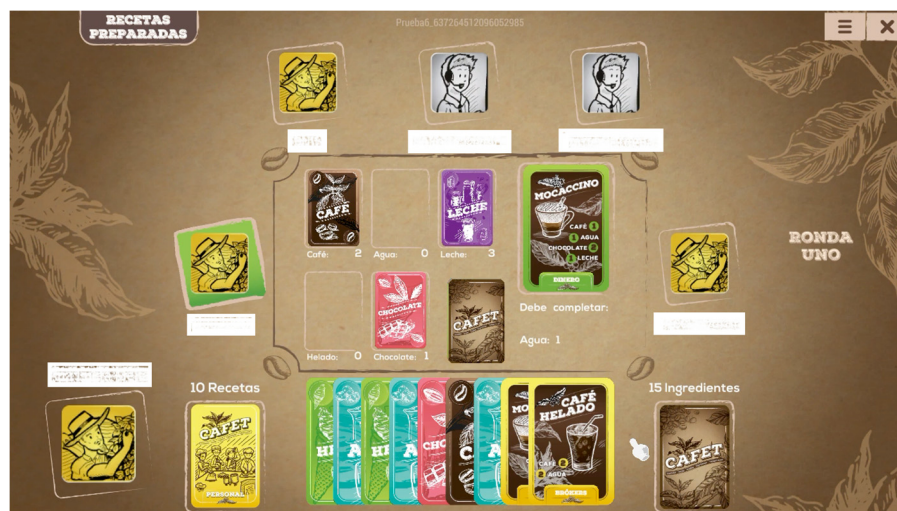
Figure 2. Board image of the desktop CAFET videogame during the Barista phase.

2.3. Experimental Setup

To carry out this research a reduced version of CAFET game was implemented as a desktop videogame. This version only runs until the first Barista phase, so no wildcards, trading, or company consolidation took place.

The game was implemented as an activity during a real MOOC on entrepreneurship and innovation. The purpose of the MOOC was to identify the skills and tools that favor the development of innovative ideas; because of this, the participants belonged to different age ranges and academic training, from senior high school and university students to professionals who are curious, dreamy, and eager for new knowledge.

The course consisted of 24 videos with different activities that sought to reinforce the above-mentioned ideas. In the fourth video, those attending the course conducted a survey to determine where the person had strengths or weaknesses within the innovators' skills. Each thematic unit contained a series of exams and activities aimed at improving these skills; in the same way, case studies were presented showing examples of innovation, and one of these case studies was the CAFET game—students were taught about the justification and context why the game was created and how it is played. The game was also implemented during a course on entrepreneurial initiative and culture as part of the business administration program at EAFIT University; this course had similar characteristics to the MOOC.

In the process of designing both the MOOC and the creation of the digital version of CAFET, several students were asked to play the physical card game. Among the course participants who observed the physical game, a population of 23 attendees was chosen to carry out the study with the digital version of it. An ID was assigned to each participant consisting of the observation number and the participant number (e.g., O1–P3).

2.4. Procedure

Observations were carried out in an uncontrolled environment, given the lockdown policy in place in Colombia due the COVID-19 situation. For this purpose, participants were invited via e-mail to take place in the observations. Once they agreed to participate, another email containing a consent form, instructions on how to install the game, and instructions on how to record their computer screen was sent to the participants along with a citation to a Google Meet video conference session where the observation took place. Before the observation, the researchers attended technical requirements from the participants that had problems following the instructions.

During the gaming sessions, one of the researchers explained the objective of the session, the rules of the game and walked the participants through two unrecorded game matches. After the second match, participants were asked to use a "think aloud" approach during the following match, which was the observation evaluated for the present work. Once the match was over, a discussion session took place asking the participants what their impressions of the game were, and why they thought they ranked as they did in the resulting scoreboard.

To perform the a-priori definition of codes, a set of seven researchers held a brainstorming session to write up which possible interactions could be seen during the observations. When the activities were written in the board, each researcher was allotted a fixed number of votes to cast on the interactions that they thought would be more relevant. When voting was finished, the resulting interactions were transcribed into an observation protocol. The resulting codes can be found in Annex A. This activity took place before subjects were observed.

MaxQDA is software for qualitative data analysis and mixed methods. MaxQDA 20.1.1 was used for this work. The software makes it possible to code text, audio, and video documents to perform different qualitative data analysis. Videos of the participants were added into MaxQDA as documents, along with the previously defined codes. A coding protocol was agreed among four independent researchers. The full list of codes can be found on Appendix A. Researchers reviewed a subset of documents, coding each observable interaction which was defined as any interaction evidenced by the participant's voice or interaction with the User Interface. When no code matched an important interaction according to the researcher, a special code called "observation" was used, along with a comment on why this interaction was relevant. This was also the case for actions that went against innovation, which were coded with the "negative aspect" code. Once all videos were labeled, an intercoder agreement process took place, in which two researchers reviewed a labeled observation and extended the annotation of the video, either by accepting, adding labels, or discussing if a label matched the interaction at hand. Disagreements were discussed and agreed, updating the file accordingly. The videos, codes and other documents can be found on the Supplementary Materials of this paper.

The analysis of the resulting coded documents was conducted following a Grounded Theory approach. Participants' behaviors, answers, and particular "observations" and "negative aspects" were considered as follows: for the proper construction of this study, five driving questions were followed (RQ1–1, RQ1–2, RQ1–3, RQ1–4, and RQ2), which are described below.

RQ1–1: Frequencies of general codes. After obtaining the data, a quantitative observation was conducted on the frequencies of the general codes and the particular codes that recorded the actions carried out by the participants during the game. The codes analyzed were those associated with the five skills of the Innovator's DNA.

RQ1–2: Chronological observation. Referred to observe the behavior of participants through time. In order to carry out this task, a set of organization codes was created to tag different chronological phases on game time.

RQ1–3: Behavior patterns. For this, MaxQDA's document map tool was used to generate a set of clusters grouping the documents by their similarity. The analysis mode chosen was "Frequency of codes", hence documents were compared by the frequency of codes using the squared Euclidean distance as the distance between documents. According to MaxQDA's official documentation, "The clustering of the documents proceeds according to a hierarchical cluster analysis using the positions on the two-dimensional map (not on the distance matrix). Unweighted average linkage is used as the clustering method" [28]. Then, the clusters were analyzed one by one, finding reasons for the clustering and observations within the participants using MaxQDA's codeline [29] tool, which shows the codes of a document along a timeline. With these chronological observations as per a cluster basis, an analysis of the participants was conducted to find behavior patterns. Results show the behavior patterns with examples observed during the participants interaction with the game.

RQ1–4: Negative Aspects and Observations. To answer RQ1-4, MaxQDA's summary grid tool was used to make groups of actions coded in the categories of *Negative Aspect* or *Observation*, then for every participant a summary of their actions was written and saved as a summary table. Finally, the summary explorer tool showed for every participant the summary and the respective codes that can be used as quotes of the observed behavior. Next to that, an analysis of the findings on those particular behaviors on participants was carried out.

With regards to RQ2, during the peer review of observations, the reviewers created a memo document in MaxQDA answering the following three questions: What was the general behavior of the participant? What strategy did they use, if there was one? What happened to the participant that is worth highlighting? These memos were transformed into analyzable documents within the software and were complemented with the transcripts of the participants in the first and last positions of each observation session. One of the researchers creatively labeled each memo document in the following manner: While listening to the observation recording, if the reason was previously registered in the code system, that label was applied within the memo document; otherwise, in cases where the reason had not been previously identified, a new code was created and was assigned to the participant's document.

A limitation of this method is that not all the participants' videos were transcribed. To minimize bias in procedure, the researchers listened to the reasons given by each participant observed and assigned the corresponding labels to the participant's document. In case a new reason was mentioned, the respective transcript was added to the document and the label was added to the code system.

3. Results

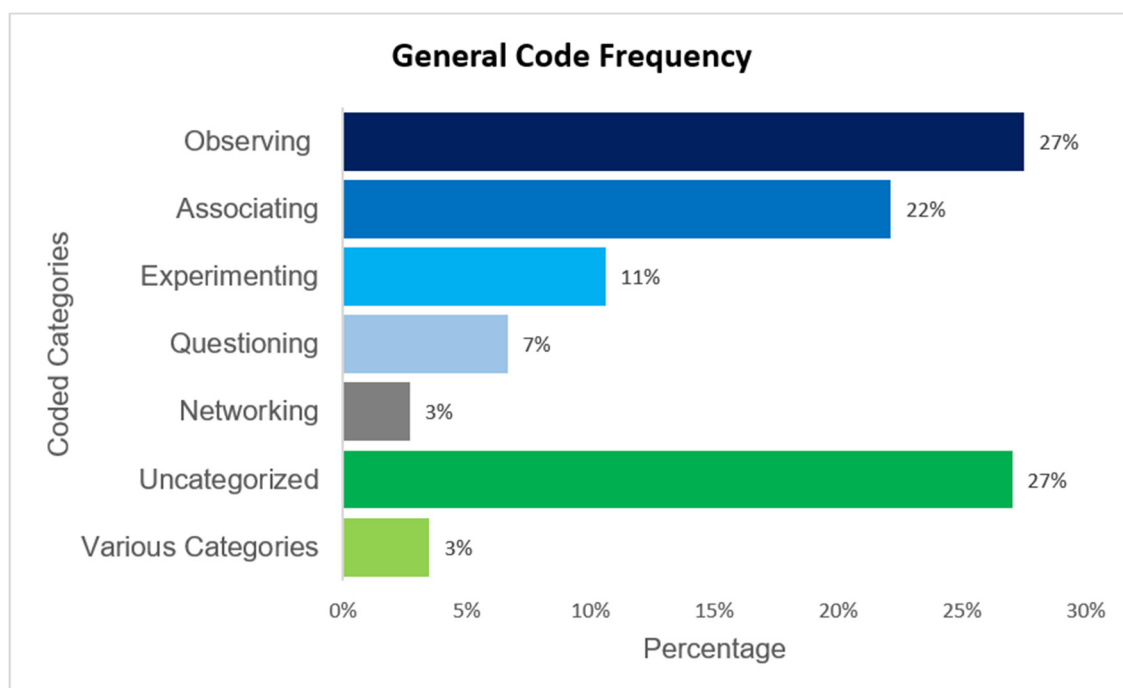### 3.1. RQ1-1 Frequencies of General Codes

Figure 3 shows the percentage of general codes executed as a percentage of the total codes, which correspond to the five skills of the Innovator's DNA and two additional categories that group other types of actions that were evidenced during the CAFET rounds. The most reported skills in the game correspond to observing (27.5%) and associating (22.1%); it is highlighted that the "uncategorized" actions corresponded to 27% of the reported actions. These refer to simple actions such as "take recipe cards" that do not allow a categorization within the Innovator's DNA skills. The experimenting, questioning, and networking skills presented a low participation on the total of the reported actions, equal to or less than 11%.

Taking a closer look at each of the five skills of the Innovator's DNA, and starting with questioning, it was found that the actions with more frequency shown by the participants are related to checking recipes from other players and the player themselves at the end of the round. In fact, summarizing all rounds played across participants, at the end of the game 21.43% of the participants checked the recipes made by the winner player, 21.43% of the participants checked the recipes made by the players who scored lower than them, and 21.43% of the participants checked their own recipes. These codes were frequently accompanied with questions about the reasons on the final score.

From associating, three patterns can be highlighted: (1) play ingredient according to recipe (40.71%); (2) play recipes according to ingredient (32.86); and (3) decide to complete recipe (17.4%). This seems straightforward and systematic, since the game consists of creating coffee drinks using ingredients and recipe cards. Thus, the most common pattern that players showed in this skill was to associate each with another to create as many drinks as they could to earn points. The coded segments of the observing skill that showed the higher frequencies were inspect recipes outside of their turn (45.5%) and inspect what ingredients and recipes they have (20.69%). Experimenting made it possible to have a closer look at the strategic behavior of the participants. The frequency of the coded segments for this skill shows that: (1) 28.36% for the coded segment played recipes to have options after each turn; (2) 17.91% played ingredients to complete their recipes; (3) 17.91% played a recipe and waited for the ingredients to come out later. While the most frequently coded segments for the networking skill

were (1) saying the play out loud (47%); (2) networking (29.41%); and (3) congratulating the opponents (17.65%), not many networking actions were observed.

Figure 3. Frequencies of general codes.

The associating skill (140 codes) presented varied patterns among the participants, reporting from 0 coded actions to 16 coded actions. Associating was one of the categories with the highest frequency between rounds, and due to the structure of the game it was expected that skills of this type would present a high frequency. Something interesting is that three of the four participants who had a code count equal to or greater than 11 belonged to the same observation group (O4). These participants were O4–P1 (16), O4–P3 (14), and O4–P4 (11).

The observing skill (174 codes), which was the category with the most coded segments, had from a moderate to high frequency among the participants, but there were cases where some participants did not report this skill during their round. An interesting case is that of the participant O5-P3, who, despite having the highest amount of interaction with the questioning skill, reported zero codes in observing. However, in general, excluding six cases, the participants reported four or more codes corresponding to the observing skill for their rounds played.

Networking was the category with the fewest coded segments in the different rounds (17 segments). As mentioned above, this is not surprising, since the current version of the game does not implement the networking mechanics on the design.

Experimenting had a total of 67 codes. Among participants, the codes were relatively low, all fewer than five codes, except for participants O4–P1 and O4–P3, who had 13 and 12 codes, respectively. At the sub-code level, the one with the highest frequency was "play recipes to have more options", a quite common pattern.

Figure 4 shows the frequency of the general codes by gender. There was a minimal difference in frequency for each of the Innovator's DNA skills. The largest gap occurred in the observing skill, where the code frequency for women (16%) was only 3 percentage points below the frequency of men (19%). It should be noted that the distribution in the code frequency that is observed in Figure 3 is maintained in Figure 4, with questioning and networking the skills with the lowest frequency.

Exploring RQ1 question, it was found that the highest frequency of the reported codes corresponded to the observing and associating skills. This generates an idea of how CAFET fosters the ability to

connect things—in this specific case, the connection between game cards—as well as the ability to notice what strategies might work during the game. However, there was a low reported frequency of the remaining skills, which can be interpreted as a lack of opportunities in the game to foster a questioning behavior, the ability to generate new ideas, and the opportunity to interact with others and generate ideas together.
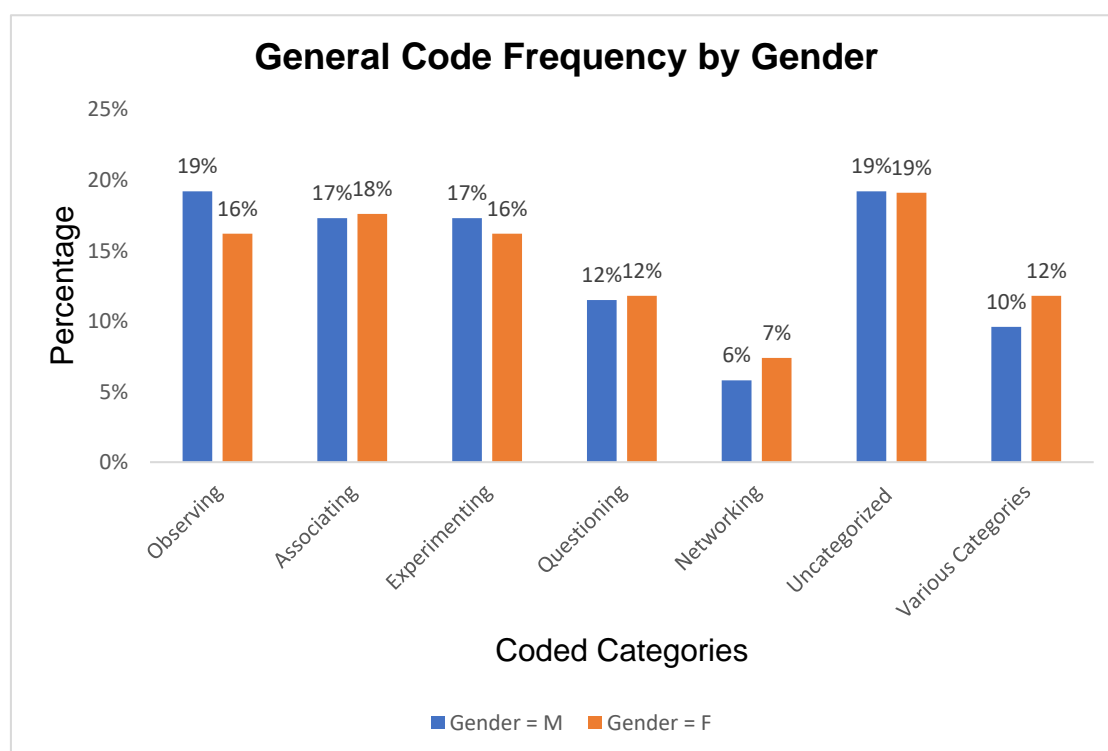

Figure 4. Frequencies of general codes per gender.

3.2. RQ1-2 Chronological Observation

Figure 5 shows a chronological matrix relating the Innovator's DNA codes and the phases of the CAFET game; it includes the instructions, round one (turns), and Barista phases. The matrix shows the frequency of action done in every phase.

Round 1 is divided into different turns; most of the activities coded in round 1 happened between turns 1 and 4, thus as a consequence of how the game works, the higher the number of players the lower the chance of reaching turns 6 to 8. As seen on Table 2 as the different turns increase, the frequency of actions tends to decrease.

Table 2. Code matrix for Round 1.

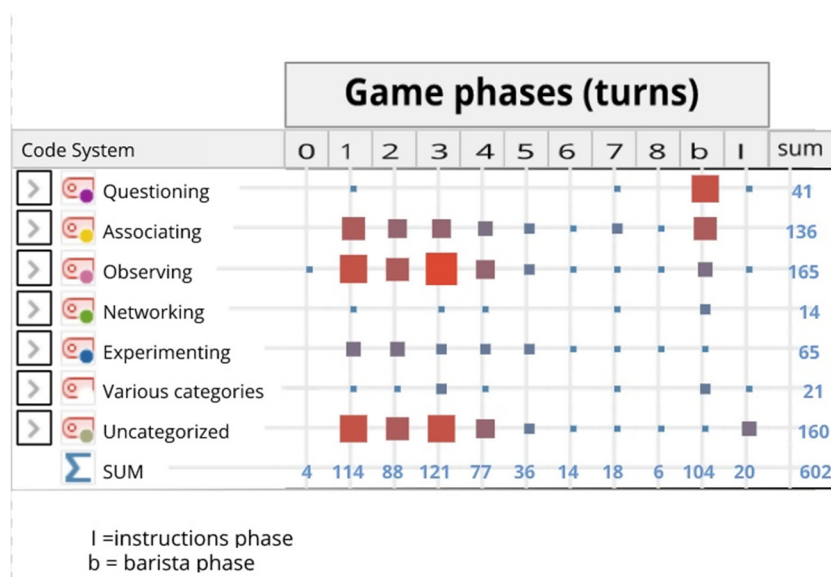|	Turns									
Code System	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Sum**
Questioning	0	1	0	0	0	0	0	1	0	2
Associating	0	27	19	24	18	8	4	6	2	108
Observing	4	34	26	43	25	8	2	3	1	146
Networking	0	1	0	2	1	0	0	1	0	5
Experimenting	0	14	12	10	10	9	4	3	2	64
Various Categories	0	2	3	5	2	0	0	1	0	13
Uncategorized	0	35	28	37	21	11	4	3	1	140
Sum	4	114	88	121	77	36	14	18	6	478

Figure 5. Code matrix between Innovator's DNA skills and game phases.

A description of participants' behavior through the phases was performed. Results are as follows.

3.2.1. Instructions

In this phase, only once did two participants observe the instructions in detail. This is a questioning activity. For the most part, the most observed activity was that the participants quickly passed these and of all of them only "O1–P5 at 0:07:39.4" questioned the other participants about instructions that were not understood.

3.2.2. Round One, Turns 1 to 4

At turn 1, a player should have observed several actions made by other players on turn 0. Coincidently, most of the activities performed on this turn belonged to the *observing* category; the two most performed observing activities were *inspect recipe outside of its turn* and *see what recipe and ingredients it has*, actions necessary to determine which recipes can be created in each play. Generally, on this turn the players preferred to watch what they had, contrary to having experimented with strategies beforehand. This conservative way of playing could be justified in the first turn due to the lack of initial knowledge in order to perform associating activities. However, as long the game progressed these observing activities remained at first place, with turn 3 where they were repeated the most, with a frequency of 27 occurrences, indicating there was tendency in participants to try to perform informed strategies instead of experimenting.

Associating activities were the second most frequent. Moving through all the four turns it was observed that participants preferred to *play an ingredient according a given recipe* more than *play a recipe according its ingredients*. Nevertheless, both were considerably more frequent than the next action, *play ingredients to complete future recipe*; this shows the preference of participants for simple associations where the uncertainty of the future could be avoided.

Compared with the frequency of the Innovator DNA's behaviors, experimenting activities were much less frequent among participants. In this category the most prevalent activity was *collect recipes in order to have more options of playing*, which coincided with the idea of avoiding uncertainty when players performed associating activities. Through turns 1 to 4, the frequency of this action never exceeded six repetitions, which ruled out a strong experimental behavior among participants.

Participants tended to *rearrange cards* frequently, with this the second most common uncategorized activity; however, there was not a prevalent activity of the Innovator's DNA when participants performed this action.

3.2.3. Round One Turns 5 to 8

Those activities that were more common in previous turns were considerably less frequent as the turn progressed; observing activities such as *inspect recipe outside of its turn*, which could reach more than 10 repetitions previously, did not exceed 3 repetitions in these turns, being the more frequent in this category. This frequency reduction was present in associating and experimenting activities as well. As mentioned before, it was unlikely to reach these last turns when they were six players in the game, which made it possible to observe special cases when participants made their strategies thinking on the next phase (Barista). O4–P1 indicated:

"Definitely I need to pick ingredients because there are relatively few ingredients left"

(O4–P1 *0:07:42.6*)

This showed that it was important to save ingredient cards when they were already few, indicating that associating actions came in handy when participants were preparing for the Barista phase. Regarding *various categories* and *uncategorized* activities, these kept the same tendency they had in the first turns, which was already low.

3.2.4. Barista Phase

In this phase, participants tended to carry out questioning above other activities. The least frequent activities were those cataloged as experimenting; this was expected in this phase since the game automatically verifies if recipes can be completed or not. Regarding questioning activities, what the participants did the most was to inspect recipes, whether they were their own, those of the winner, or other players with the highest ranking, because the important thing for the participants was to analyze why the result obtained was reached. Those players who did associating activities mostly sought to complete recipes, only three decided to save ingredients to complete them later. Finally, participants who carried out observing activities tended to review recipes already created. Networking activities were less frequent than those previously mentioned, but they were more frequent than in the turns of round 1.

3.3. RQ1–3 Behavioral Patterns

The clustering process resulted in five clusters which can be seen outlined in the document map shown in Figure 6.

Participants were clustered into five clusters. The colors show the cluster a document belongs to. Each circle represents a participant. Circle sizes represent the relative number of codes on that participant.

The distribution of observable action codes for each cluster is shown below (Figure 7).

The observation of each cluster was followed by the observations of every participant in that cluster. The participants were observed using their respective codeline. Next, a summary of the cluster patterns is discussed, showing the rationale behind the observations and actual quotes of the participants' interactions.
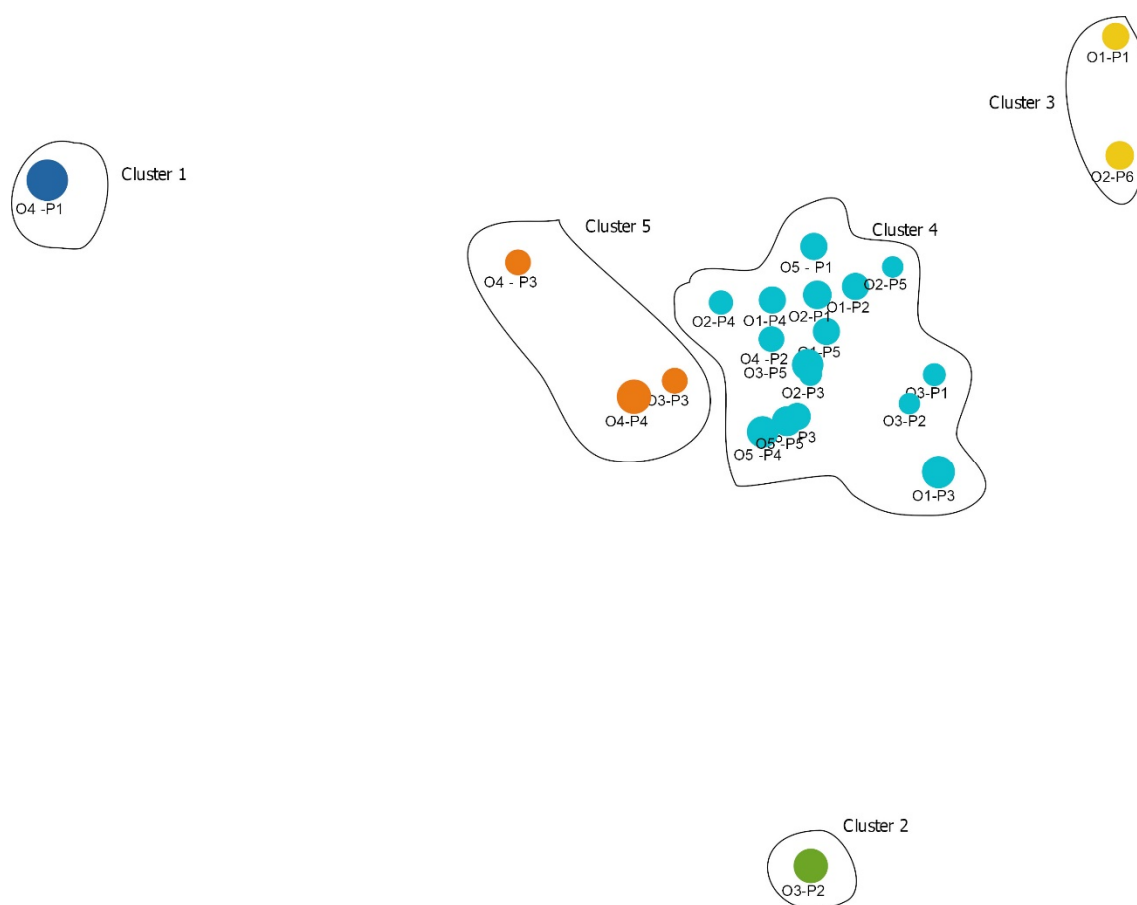
Figure 6. Clustering of the participants.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Observing	25.40%	41.00%	29.30%	26.90%	25.40%
Experimenting	19.40%	2.60%	14.60%	7.30%	16.90%
Questioning	3.00%	12.80%	9.80%	8.20%	0.80%
Networking	3.00%	2.60%	14.60%	1.90%	0.80%
Associating	23.90%	17.90%	2.40%	21.70%	30.50%
Various Categories	1.50%	2.60%	4.90%	4.30%	1.70%
Uncategorized	23.90%	20.50%	24.40%	29.60%	23.70%
N	1	1	2	16	3

Figure 7. This figure shows, for each of the clusters, the percentages of the codes on each category of the five skills of the Innovator's DNA. The cells have been colored regarding the intensity of such percentage and each column's color matches the colors on the document map shown in Figure 6.

3.3.1. Cluster 1: A Participant Showing Many and Varied Interactions

Cluster 1 has only one participant (participant O4–P1), coded with a high frequency in most of the categories (i.e., observing, associating, and experimenting), except for the ones that were low for the whole experiment as abovementioned. O4–P1's codeline is shown in Figure 8.
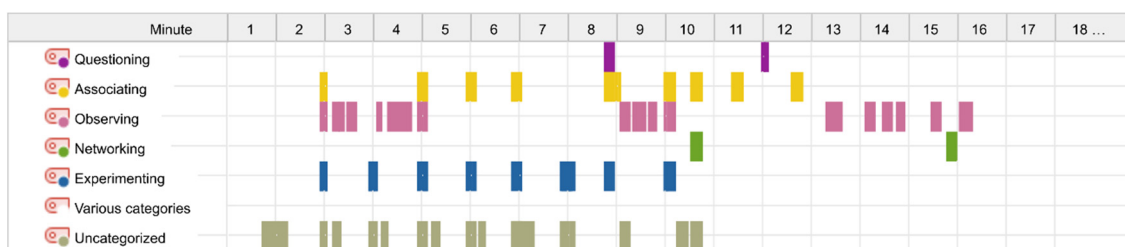
Figure 8. Codeline of the only participant in cluster 1.

During the interaction with the game, the participant showed a behavior where, on each of the turns, they were informed of associating recipes with their ingredients. Also, he was observant, as on each turn he checked on his cards and organized his strategy by rearranging them in his hand. This interaction happened during his first turn:

"I play a card of coffee, since there is plenty of it, I play a corresponding recipe and I take some recipes"

(O4–P1 01:54)

O4–P1 showed how he planned and used many tools of the game. He commented:

"I'm going to play one card of coffee, and I know, I know, I will keep on milk so I can complete the recipe later. I also take some ingredients, and oh look . . . I'm flooding on water (laughter) [He has too many water cards]"

(O4–P1 02:52)

During the game, it was easy to see how O4–P1 played with the same strategy by observing his and his opponents' cards and planning accordingly. Also, he observed, associated, and experimented to take the most-convenient decision:

Since other participant took some ingredient's cards, I see this is going to end . . . so I will place two coffees, because there are plenty and this recipe uses two coffees (who knows If it will be completed) . . . I will take some ingredients to finish this round with many"

(O4–P1 03:53)

Thus, O4–P1 was a participant who varied his actions, and he carried a lot of actions in a short time, which is what made him so different from the others. It is noteworthy that O4–P1 won the match by scoring 54 points.

3.3.2. Cluster 2: A Participant Observing the Most

This cluster has only one participant: participant O3–P2. She had a lot of interactions observing the other participants as shown in Figure 9.
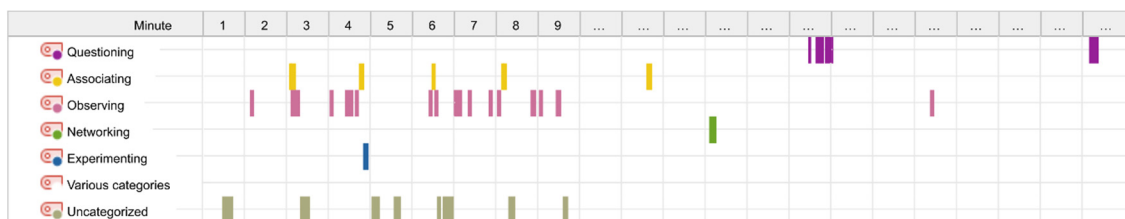

Figure 9. Codeline of the only participant in cluster 2.

O3–P2 was a very observant person. During her turn, she observed the characteristics of each of her cards, relating them (which is why she had lots of associating codes). She said:

> "I'm going to play a card of chocolate and I'm going to play the only recipe I have because it has chocolate, I also know that I can easily get coffee and milk cards later … "
>
> (O3–P2 02:49)

Also, O3–P2 interacted many times with the game's User Interface as she rearranged her cards, she checked her recipes and ingredients and recipes already created. She was also the participant who showed the code "Play recipes because they are easy to complete", and she even justified that was a way to win the game. O3–P2 obtained a high score of 40 points by the end of the match.

3.3.3. Cluster 3: Non-Conclusive Cluster

Cluster 3 has only two participants. However, both O1–P1 and O2–P5 had very scarce codes, since their observable interactions were too few. O1–P1, as shown by the researcher's memo, was not very aware of the rules and this led to her not being very active.

> O1–P1 was very emotional. She did not look like she had understood the rules; however, she tried experimenting to find how to play. She explored and although she made mistakes, she showed she was learning, and she got emotional with whatever she was doing and her results.
>
> (Researcher memorandum)

On the other hand, O2–P6 showed more interaction, he showed a great ability to observe, as he checked his cards and ingredients continuously. He was the only participant who checked the instructions, even though it was not very common in this stage of the game because they had already learned how to play.

Cluster 3 is non-conclusive.

3.3.4. Cluster 4: Observers and Associators

Cluster 4 is the main cluster, as it groups the most participants showing the main behavioral patterns. Participants in cluster 4 showed a similar distribution of observing and associating codes; however, they showed particular behaviors during each of their interactions. Participants showed that they observed and associated cards using their cards, opponents' cards, and cards on the table as well. While some of the interactions were coded as "experimenting", this cluster had fewer experimenting codes. This led to the conclusion that cluster 4 is composed of participants who liked to be "safer" in their moves.

Codelines of the participants in cluster 4 show different distributions of codes along the timeline (Figure 10).

Some behavioral patterns can be identified. For example, O1–P4 showed usage of associating by playing recipes according to ingredients and vice versa, followed by an observation of what was going on their opponents' side and at the central table of the game.

> "Oh, I see that a water card is available [at central table] so I will place two coffee cards and the only recipe I have … iced coffee [which uses two water cards]"
>
> (O1–P4 01:56)

A pattern was observed for O4–P2, O3–P5, and O2–P3. They continuously showed a high tendency to observe their cards and those of their opponents. They played by associating their cards and playing the ones deemed more useful according to the ones on the table. Then, they spent most of their out-of-the-turn time inspecting their own recipe cards, planning for the next turn. This is typically a "safe play". Another example of safe play is that of O2–P4:

"I have too many ingredients but very little recipes, although the recipe I do have is very simple, so I will play a milk card and then I will play the recipe that uses one milk card and one coffee card (a Latte) . . . in any case, I will hold the coffee card in my hand for the Barista"

(O2–P4 02:14)
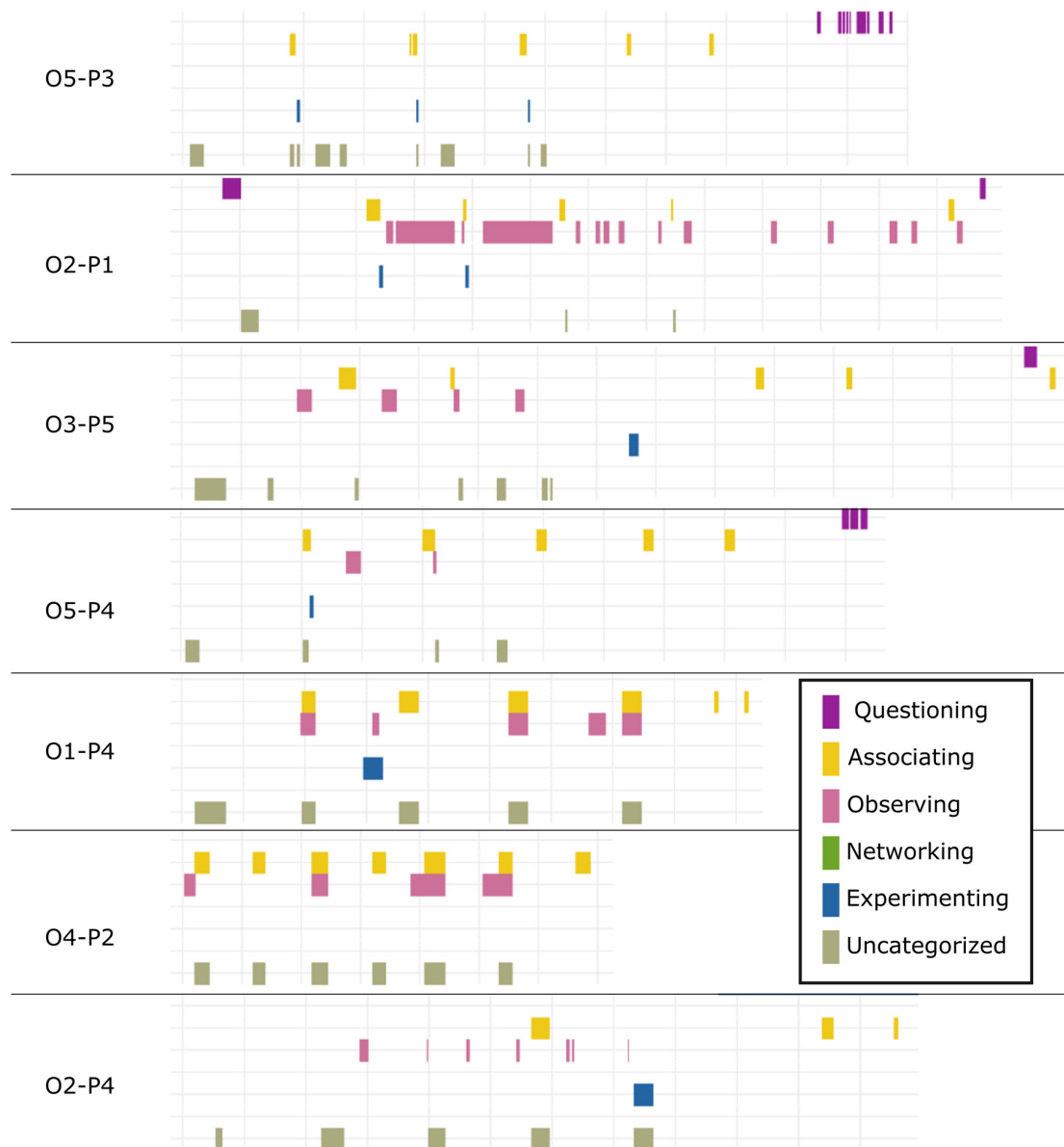
Figure 10. Codelines of participants in cluster 4 who earned the most points in their respective matches.

Another example of this behavior is O5–P3, who decided to play according to the cards that she already had in her hand. She explained her behavior at the end of the match:

"I did the same I had been doing on the previous matches which is observing, organizing the ingredients in my hand, and having a mental account of what other people were throwing . . . Then I put apart the ingredients I would use at the end . . . I played the simplest recipes and I just played the most complicated one when I needed to obtain more ingredients".

(O5–P3 answer in the interview)

Cluster 4 groups the highest number of participants, deemed as the most common behavioral patterns. These results showed that during the interaction with the game, participants could practice and foster their observing and associating skills by willingly combining actions in pro of their final result. Besides this, some of them tried to trust their luck, waiting to maximize their results with what they already had in hand and the probability of getting what they needed.

3.3.5. Cluster 5: Risk-Takers

This cluster groups three participants: O4–P4, O3–P3, and O4–P3. They showed a behavioral pattern like cluster 4, as evidenced in the document map. However, participants in cluster 5 were more prone to experimenting. For example, O4–P3 played like this:

> "I will try to complete this recipe [a Mocha Frappe] so I will place two water cards and I know I have to find two chocolate cards and a milk card, so I will try to get them"
>
> (O4–P3 02:37)

He explained his strategy:

> "So, I was lucky because I got the ingredients such as chocolate and ice cream, but I couldn't find coffee or water, but by using the ones thrown by my opponents, I tried to complete more difficult recipes. . . . So, it was luck and trying to find and use the cards not used by the others"
>
> (O4–P3 answer on the interview)

O4–P3 tended to base his game on luck and randomness, but also using that to experiment with what he was able to see and his available resources. Note that O4-P3 won his match with 54 points. A similar situation happened to the other members of this cluster. As can be seen, participants in cluster 5 trusted their ability to observe their resources and they took risks on that, trying to find what could happen later, which has been coded in the experimenting category.

To summarize, this observation found five behavioral patterns during CAFET interactions, which led to thinking that CAFET can foster the Innovator's DNA skills, especially observing, associating, and experimenting skills. However, networking and questioning were observed less. This could be because the version used did not have a game phase which allows participants to help each other to score points. Nevertheless, it is still interesting that these results show how an interactive game can subtly foster said skills while students have fun.

3.4. RQ1-4 Negative Aspects and Observations

The following are summaries of negative aspects and observations codes. Each observation is justified by quoting the findings done by the researchers.

Negative behavior where players felt frustrated by not understanding certain game mechanics decreased the ability to propose strategies to win the game. Examples in O1–P3's game were:

> "He did not understand that he did not have the ingredients in hand to complete the recipe, he was missing a milk card."
>
> (Negative aspects from participant O1–P3 10: 12)

> "Stated his questions in a negative way, he blamed the game and not his way of playing to justify his poor score"
>
> (Negative aspects from participant O1–P3 10:58)

> "He showed confusion with the point system"
>
> (Observation from participant O1–P3 11:46)

"He expressed dissatisfaction for not putting together a recipe"

(Observation from participant O1–P3 08:08)

"He said he tried to play according to the explanation"

(Observation from participant O1–P3 12:43)

In the case of O3–P2 the observations made by the evaluators were related to negative aspects found and show how the frustration of not understanding the game led him to a bad score. Another reason to commit actions considered negative aspects is failure in networking or questioning. It was seen in O3–P2's observation that:

"She did not ask what she didn't understand during the game or in the test session"

(Negative aspects from participant O3–P2 16:24)

Not only did she not understand the game rules, but also, she did not ask anyone. If she had tried to network with other players, she could have had a better chance of formulating more strategies; it is necessary to inquire about the reasons that lead players to avoid this ability of the innovator, and determine if there is link between these reasons and the game design.

The last reason is the lack of associating and/or experimenting. In O4–P2's game:

"She made a mistake in the amount of chocolate cards needed for her recipe. She played an affogato that only needed a chocolate card, but ended up putting two chocolate cards on the table"

(Negative aspects from participant O4–P2 04:04)

She did not make an invalid play, but in the judgment of the peer, it could just be counterproductive. On the other hand, leaving the "win or lose" scheme and focusing on the innovator's skills, players like O4–P4 stand out. O4–P4 (although she did not achieve a victory) was able to participate in a network with other players discussing their plays. An evidence of this is:

"She made a funny comment about the cards another player had"

(Observation from participant O4–P4 13:15)

"She commented it was difficult to know if it was possible to make the following recipe with the cards on the table"

(Observation from participant O4–P4 13:42)

Next, it is worth mentioning the behavior of O3-P1, who accepted the cause of his failures in the game and decided to help other players (Observation from participant O3–P1 10:32 and O3–P1 11:37). In the same way, there were players with a solid strategy, such as O4–P1. According to the evaluator observation, when he reached the Barista phase it was easy to him create recipes (Observation from participant O4–P111:34).

Finally, it is important to consider that having a solid strategy based on Innovator's DNA behavior does not ensure a victory in the game. O5–P1 apparently had good enough knowledge to create game strategies; he questioned what he could do with his cards:

"My hand seems to be interesting but not very much . . . "

(O5–P1 01:09)

He performed experimenting actions through his game:

"Take ingredients in order to complete their recipes and play an ingredient according to a given recipe"

(O5–P1 03:03)

However, despite the observable strategy he did not achieve a good result and regretted it (O5–P1 10:32).

3.5. RQ2 Reasons Argued by Participants

In total, 15 new labels were created with the reasons given by the participants during the observation. Six of the reasons were unique to the participants, meaning they were only used once. In total these labels were used 43 times. Frequency distribution of reasons is shown in Table 3. The main reasons given by participants were plans for endgame (13.95%), results attributed to luck (13.95%), strategically discarding cards (11.63%), having played with cards from peers (11.63%), and not having understood the rules of the game (9.30%).

Table 3. Frequency distribution of reasons (percentage of occurrences ranked from highest to lowest).

Label	Description	Percentage
results attributed to luck	Participants mentioned how luck affected their result.	13.95%
plans for endgame	Participants mentioned how they planned for the end of the game.	13.95%
having played with cards from peers	Participants mentioned how they used the cards played by others and which patterns they recognized.	11.63%
strategically discarding cards	Participants mentioned their strategy for which cards to discard and why.	11.63%
not having understood the rules of the game	Participants mentioned playing in a way that was erratic or mentioned that they did not understand the game until the end.	9.30%
not having planned during game	Participants mentioned that they did not have a plan during the game.	6.98%
having focused only on their recipes	Participants mentioned that their strategy was focused on a turn-by-turn basis.	6.98%
having played low-cost recipes	Participants mentioned that they played recipes that used the fewest ingredients.	6.98%
not having paid attention	Participants mentioned that they were not paying attention during the game.	4.65%
having played high-cost recipes	Participants mentioned that they played recipes that used the most ingredients.	2.33%
not having played planned recipes	Participants mentioned that they did not plan which recipes they were going to play during the game.	2.33%
having difficulty handling complexity	Participants mentioned the game was too complex to make appropriate decisions.	2.33%
having taken risks	Participants mentioned how important was to take risks in order to gain better chances during the game.	2.33%
having organized the hand	Participants mentioned how ordering their hand helped to create their strategy that led to the result.	2.33%
having memorized cards	Participants mentioned that they remembered which cards other players were playing and how this affected their results.	2.33%

Among the reasons argued by the participants, evidence was found that the game presented the opportunity to practice four out of five of the Innovator's DNA skills. Although it was not explicitly mentioned by the participants, each reason could be associated with one or more skills. Following the line of thinking that "practice makes perfect", using tools like CAFET supports the practice of innovator skills in a way that can be attractive to young learners.

3.5.1. Reason 1: Plans for Endgame

The participants took part in two matches of the game, prior to the recorded observation. During these games, participants that performed better argued that it was vital to separate the most valuable ingredients for the Barista phase. In the words of one of the participants:

> "I separated the ingredients that I knew I would need for the end"
>
> (Memorandum from participant O5–P3)

Gregersen and Christensen define the observing ability as "seeing the world around and the people who live in it and noticing what works and what does not work in these situations" [11]. It seems like players who had no previous experience in the game used this skill in the warm-up matches and prepared their strategy around this situation. For example, another participant explained:

> "If I have ice cream and chocolate cards to be able to complete the most difficult recipes when the Barista arrives, it will be much easier for me to add those ingredients and obtain what I need"
>
> (Memorandum from participant O3–P5)

Getting to the point where one of the participants explicitly mentioned how important it was for him to constantly monitor this game variable:

> "Having monitored when it was close that ingredient cards were ran out to keep only ingredients in my hand … when I saw that there were, as other said, some strategic ingredients … rather stayed with those strategic ingredients to complete my recipes when the time came"
>
> (Memorandum from participant O2–P4)

Given the prevalence across the participants of acknowledging the importance of planning for the endgame, the researchers believe that the game motivates the use of the observing skill, and that the participants agreed that it is one of the factors why they obtained their respective scores.

3.5.2. Reason 2: Results Attributed to Luck

For a game to be interesting, it must always have a luck component. During the observation, many of the participants recognized this situation in different ways. One of the participants noted the following:

> "It depends a lot on the recipe that you get at the beginning"
>
> (Memorandum from participant O3–P3)

Meaning that the strategy chosen throughout the game highly depends on the ingredients cost of the initial recipe that the game provided. Strategically discarding cards is discussed later; however, the two situations are greatly related.

When the players did not get a good position in the results table, they also attributed their results to not having received the cards they were waiting for, for example:

> "So, I'm going to attribute it to my bad luck, I was short of water."
>
> (Memorandum from participant O5–P1)

Likewise, when they won, they recognized the influence of randomness:

> "Well, I was a little lucky with the ingredients that I got."
>
> (Memorandum from participant O4–P3)

> "As people say, 'beginner's luck'"
>
> (Memorandum from participant O3–P5)

Researchers considered randomness in the game as a door to put into practice the experimenting ability, understood as "the act of trying new things, ideas or processes in search of new data that can lead to an innovative opportunity" [11]. None of the participants mentioned it explicitly, but strategically discarding cards can be considered one of the ways in which the participants executed this skill.

3.5.3. Reason 3: Strategically Discarding Cards

Closely related to the previous reason, discarding cards to get better ingredients was the most used strategy in the first position of the observations. Some examples of this were expressed as follows:

"I threw the most complicated recipe I had when I needed to get more ingredients before the last round"

(Memo from participant O5–P3)

"That's why I was giving away water and coffee"

(Memo from participant O2–P4)

The awareness of needing to discard cards for a greater benefit is closely related to experimenting ability. At the same time, making the relationship between the value of the cards and their importance during the course of the games is related to associating ability, understood as "creating connections between things from different areas of expertise, knowledge or location" [11]. This reason stated by the participants indicates that they were putting in action their experimenting and associating skills.

3.5.4. Reason 4: Having Played with Cards from Peers

Networking is "the ability to link ideas and opportunities with other people who work and participate in areas of expertise similar or different to personal ones" [11], this was exemplified during the game according to that expressed by one of the participants:

"Taking advantage of what my classmates discarded, I tried to use that to build complicated recipes . . . a little luck and taking advantage of the fact that others had used a lot of coffee and water"

(Memorandum from participant O4–P3)

To stop thinking about the cards in hand was one of the main factors identified by the participants. It was not a matter of mere observation but being able to use the resources of others that made networking a skill put into practice during the game. As one of the participants explained:

"To be more attentive of what was available, that maybe it was not used in other recipes. Or to be more attentive of the recipes that other people threw to see the ingredients available and that were not going to be completed when the Barista came. Then that is what I looked for. I think"

(Memorandum from participant O3–P3)

Although attention to other players' moves represents a shallow usage of networking skills, combining the game with a real-time communication tool like Google Meets has the potential to explore this skill even further, either by asking people in the session to play an specific ingredient or by simply making the game a little more pleasant through positive comments about other participants' moves.

3.5.5. Reason 5: Not Having Understood the Rules of the Game

Questioning, understood as "the ability to make thought provoking questions about who, what, when and why and guiding these questions towards being a creative catalyst to foster other skills" [11] is perhaps the first innovator skill that was expected to show up during the observations, since none of the participants had played the game before and all of them took an MOOC about innovation. Regarding the game rules, it was observed that players began questioning the game after the observation, and not before or during it.

At the beginning of each match, the rules of the game were briefly presented in the form of slides inside the game, explaining the objective, the types of cards, and asking for confirmation of whether

the player was ready to play. No discussion of strategies was presented at this stage. The game would not start until all the players in the room confirmed that they were ready to play. However, during the reviewing of the recordings, researchers noted that some players did not clearly understand the rules of the game, making comments such as:

> "Participant O2–P1 does not seem to have understood the game because he misses a lot at trying to play ingredients of different types during the same turn. Also, he does not participate much and makes a lot of non-sensical plays."
>
> (Memorandum from participant O2–P1)
>
> "The participant did not understand the rules of the game clearly. He seemed a little frustrated by the result after the Barista phase and during the final discussion."
>
> (Memo from participant O1–P3)

The researchers were hoping that participants would take responsibility in making assertive questions regarding the game, putting in practice the questioning skill. In this regard, participants did not acknowledge the importance of asking questions about what they did not understand, but the frustration during the discussions at the end of the observation indicates that this was indeed necessary. Some of them explicitly mentioned that they only understood the game after the end of the observation, but no further explanation was given.

4. Discussion

The results shown in this paper suggest that actions observed during interactions with a game are related to the Innovator's DNA skills, especially the observing, associating, and experimenting skills. This may be explained as videogames are interactive activities in which a person has an "emotional" commitment to a goal, as mentioned by Gee [30]. In fact, in the classical dissertation by Gee, "Good videogames and good learning" [30], author James Paul Gee mentions 16 traits of good videogames for learning which may explain present observations. For example, observing and associating are closely related to the following game traits: "identity", the ability of a game to make a person identify with its goals and proposed roles; "interaction", the ability of a game to "talk-back"; and "agency", the feeling of a person when their decisions are affecting a system. "Interaction" is at the core of any playful activity, however, in games, it takes a special tint since people playing a game will have a commitment to their role or the goals imposed by the rules. Similarly, "agency" is important for a game to be fun and to develop skills. Related to this is "system thinking", the ability of a game to develop thoughts on variables, actions, mechanics, and the relationships between these. Note that agency and system thinking are not only important for games, but also valuable skills for an innovator. These observations were also conducted comparing men and women and no significant differences were found.

As for the experimenting skill, it is a natural observation because games that include some kind of randomness are a source to train the ability to take risks, which apart from being a desirable skill for innovators, is also a "videogames for learning" trait. The other traits exposed by Gee are also relatable to many of the actions observed and discussed, which suggests that the use of the game suits any gender.

Questioning and networking skill codes were not as observed during the study as the other of the Innovator's DNA skills. The lack of questioning may come from the fact that a game rarely allows a player to question the rules framework, the player's allowed actions, or the possible combinations of in-game resources. While the game in the current version is strong at associating observable resources (cards, players, etc.), it does not provide an opportunity to reorganize or rethink (questioning) the concepts in newer ways. A game intending to promote the questioning skill should allow this. A good videogame with learning purposes, as mentioned by Gee, fosters the ability of players to destabilize an underlying system of rules to accomplish the goals [31]. Good examples of games that allow

players to rethink and recombine are Minecraft and Don't Starve, as they use the "craft" mechanic in which a player is able to use resources in somehow to create others. Note that given the exponential amount of combinations this is rarely accomplished by tailored games such as CAFET. Nevertheless, CAFET allows the players to rethink and question their own strategies, as evidenced in the reasons argued by them.

As for the networking skill, there were too few observations of this trait. One of the limitations of this study was that the phase intended for networking was not fully developed at the time at the observation, and thus it was not covered. However, following the observations presented here, it is argued that for the networking skill fostering, the game ought to have a mechanism for intense interaction between players (even with opponents) where the players need to form alliances and where they are able to take advantage of other players' resources as well as offering their resources for others to use. Also, another limitation of this study was that given that participants were interacting online through a videocall and they were asked to "think aloud", most of them, perhaps to respect the others, tended to not talk outside their turn, which limited the observable actions that could be deemed questioning or networking.

Through the behavioral patterns discussed in Section 3.3, it can be argued that players interacting with the game showed a high commitment to the activity, mixing behaviors such as networking, associating, observing, experimenting, and others. It is arguable that this commitment develops the innovation skills even when the participants do not identify these concepts, or they are not even aware of this fact. This echoes the notion of "Stealth Learning" posed by Sharp [32] that suggests that players are able to learn in online-learning environments without acknowledging it. This notion supports the use of games in online-learning environments to foster innovator skills. Also, note that behavioral patterns in cluster 4 show how free participants were to choose their own learning style while playing. Participants did use the innovator's skills while playing, however they did it in a wide variety of ways.

To gather interesting and deep data and to increase reliability on this study's findings, the actions of the participants were also coded as negative aspects and observations. From this, it can be concluded that there are important aspects to consider when designing and conducting educational processes with games for innovation. Mainly, some participants showed confusion when playing, even when the match recorded was their third opportunity of playing the game. This confusion may come from a scarce relationship with games or the complexity of the rules for certain players. Games aiming to foster innovation skills should consider this, and act to reduce confusion in players. Also, some participants showed discomfort with the game's result. Confusion and discomfort are natural in any game, as they are natural activities in which emotions are involved; besides that, frustration is a part of any gamer's initial steps (see the 'pleasantly frustrating' trait in [30]). However, if these negative aspects are many, they can go against the fostering of innovation skills, thus, they should be considered by designers and teachers.

This study reflects novel findings regarding the use of videogames for fostering innovation. In the past, similar studies have been conducted, promoting the development of innovation skills with the use of novel pedagogical approaches. For example, in the study by Shoop [18] a case was given in favor of new active methods such as the Socratic dialogue for students to discuss innovation and its types; nevertheless, in it an empirical study was not shown. The use of games for innovation is more closely related in the paper by Vinichenko, Melnichuk, and Makushkin [20], where they show the use of a gamified activity to develop soft skills; while this is not innovation, per se, soft skills are closely related to innovation and an active, participatory, and playful activity shows benefits in the learning and practicing of these skills. In a general sense, the present study is in line with the studies [10] and [9], as they show how their respective pedagogical and active strategies benefit the development of innovativeness and creativity. Lastly, perhaps the most similar previous study was conducted by Bellotti et al. [33,34]. These authors conducted a project in which they used Commercial-Off-The-Shelf (COTS) games in order to develop skills related to entrepreneurship; while this is not innovation,

this shows how games are able to foster skills, and in this sense our study continues this idea by using a game (although a tailored one, not a COTS) for fostering innovation skills.

It is important to note some of this study's limitations. The game was conducted in an already established course on entrepreneurship and innovation; thus, participants could be aware that they were being trained on these skills (although this was not explicitly made except in the agreements signed by them). Also, this study was not able to be conducted on an offline environment, thus observable actions in this kind of context may vary. In this regard, coding was conducted with codes defined by a multidisciplinary team, but they were defined a priori based on pilot observations and the team owned experience with the game. Due to lack of taxonomy of innovation in game actions, the team resorted to this strategy.

With all of this, it is valid to argue that CAFET does benefit the fostering of innovators' skills in online-learning environments. However, changes ought to be made to its design to promote questioning and networking skills. Not only this, but the interaction with the game was a way for the teachers to argue in favor of the coffee industry in Colombia and its relationship with innovation and entrepreneurship.

5. Conclusions

In this paper a broad question regarding the use of videogames to foster innovator's DNA skills was researched: are videogames able to foster innovation skills in online-learning environments? For this, two driving research questions were established. A mixed-methods study which included the development of a game called CAFET to foster innovators' skills was conducted. A set of observations was made over the interactions of participants who were students of courses related to entrepreneurship and innovation.

For RQ1 (what behaviors leading to the fostering of innovation skills can be observed during the interaction with CAFET?) multiple observations were conducted from several points of view: a quantitative analysis of coded actions, a set of chronological observations, and a set of behavioral patterns which included particular observations and negative aspects for the fostering of the innovators' skills. From this it was concluded that participants in a game like CAFET show several actions that lead to foster the Innovator's DNA skills, in particular observing, associating, and experimenting. The skills of questioning and networking were not as observed as the abovementioned. Participants acted in several manners showing many ways to foster these skills while interacting with the game.

As for RQ2 (what reasons do participants interacting with CAFET argue to explain their behaviors observed (behaviors leading to innovation)?) answers from participants interviewed show different strategies which suggest that the fostering of skills using videogames is mediated by a strategic approach and a sense of keen observations on the resources that players have at hand.

In this sense, it is argued that the use of videogames in online-learning environments related to innovation and entrepreneurship has some potential to foster innovators' skills.

As for implications for practice and research, the findings presented in this research provide universities with an effective tool to have students gain interest in the coffee industry, while fostering their innovator skills. The CAFET videogame can propose an activity to students in which skills such as experimenting, observing, and associating can be practiced and developed. Games specifically made for the purpose of developing innovator skills can start a new subgenre of learning games. The considerations presented here will allow game designers to make informed decisions in their work regarding practicing the skills of the innovator. In that sense, this work can be extended by observing and exploring what game development best practices should be used in games that foster innovation and creating frameworks to theoretically observe the development of innovator skills in any game.

Still, this study was based on a set of limited observations during short periods of time. This leaves pending work to study what would happen in a longitudinal observation where students are able to participate in several sessions with tailored games. Regarding this, future work could study the long-term implications of using commercial videogames of several genres to foster innovators' skills.

This effort was conducted in a case study related to the fostering of innovators' skills in Colombia, attempting to increase the interest in an important industry of this country: the coffee industry. It is expected to have shone light on the promotion of the use of new interactive media in higher education for entrepreneurship and innovation.

Appendix A Innovator's DNA Codes Used in MaxQDA Software

Color	Code Name
•	**Negative aspect**
•	**Observation**
•	**Questioning**
•	Questioning\Review recipes from players whose score is lower than his
•	Questioning\Review his own recipes
•	Questioning\Review winner's recipes
•	Question\Review recipes from players whose score is higher than his
•	Questioning\Drag a card of the center of the table, but don't play it
•	Questioning\Ask something related with the rules of the game
•	Questioning\Review each instruction in detail
•	**Associating**
•	Associating\Save ingredients to complete future recipes
•	Associating\Decide to complete recipes
•	Associating\Play a recipe according his interests
•	Associating\Play a recipe according his ingredients
•	Associating\Play an ingredient according a given recipe
•	**Observing**
•	Observing\See recipes already created
•	Observing\Inspect instructions
•	Observing\Inspect a recipe card
•	Observing\Check the recipes that he owns
•	Observing\Avoid playing cards that may favor other players
•	Observing\Inspect recipe out of his turn
•	Observing\See what recipe and ingredients it has
•	Observing\Check if he is running out of recipes or ingredients in his hand
•	Observing\Play recipes with lower points due its simplicity
•	**Networking**
•	Networking\Congratulate his opponents
•	Networking\Ask other players about the cards in their hands
•	Networking\Comment positively on a play outside his playing time
•	Networking\Say out loud his plays
•	Networking\Play the most valuable recipes in his hand
•	**Experimenting**

Color	Code Name
●	Experimenting\Ask to play again
●	Experimenting\Play an ingredient and a recipe that doesn't contain that ingredient
●	Experimenting\Take recipes in order to accomplish companies
●	Experimenting\Take recipes in order to have more options
●	Experimenting\Explore game functionalities out of his playing time
●	Experimenting\Take ingredients in order to complete his recipes
●	Experimenting\Play a recipe because it gives more points than other recipes
●	Experimenting\Put lots of an ingredient card to complete a recipe
●	Experimenting\Comment his recipes before his playing time
●	Experimenting\Play a recipe card hoping the ingredients will come later
●	**Various categories**
●	Various categories\Discuss the reasons of his score (O, A)
●	Various categories\Play a recipe using other players cards (A, N)
●	Various categories\Ask about a movement out of his playing time (N, Q)
●	Various categories\Observe what type of cards other players play (O, N)
●	Various categories\Inspect several times the same recipe (Q, O)
●	Various categories\Ask other players something not understood in the instructions
●	Various categories\Memorize the type of cards needed (Q, O)
●	**Uncategorized**
●	Uncategorized\Rearrange cards
●	Uncategorized\Time's out
●	Uncategorized\Get excited when he can complete a recipe
●	Uncategorized\Play two or more ingredients
●	Uncategorized\Take recipes
●	Uncategorized\Take ingredients
●	Uncategorized\Pass the instructions quickly

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