TRUE

Transparency of Learning Outcomes

IO3 Serious game "Market Island"

Manual v3

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1. Introduction and game objectives

1.1 Benefits of serious gaming methodology

Blockchain Technology and distributed ledgers are known as complicated and very technical subject. Creating a serious game as part of the TRUE Project (the project website: https://trueproject.eu/) enables us to break this first filter. Playing games offers physiological benefits associated with the stimulation of the brain and it delays naturel aging.

Teaching such a technical subject to students via gaming will drive their decision-making skills and break the ice between the most reluctant ones and this technology. The interactive environment makes it possible to apply the basics of blockchains to different real-world application. Serious games for training incorporate systems that permit constant monitoring. Thus, those responsible for the implementation of training can study the learning process in depth, as well as its effectiveness on the achievement of objectives. Furthermore, soft skills (decision making, critical thinking, broad thinking) can be tested with a collaborative training.

1.2. Learning objectives

During the serious game, the following points are highlighted in order to let the participants understand the mechanisms needed to put a digital trust in real life trustless environment:

- **The ledger:** understanding that Blockchains are a new kind of data bases.
- **The decentralized topology**: how are we going to have access to the same information at the same time?
- **Consensus mechanisms:** how do we agree on the data added on our ledger?
- **Encryption/Hushing:** do we need our information to be stored in an encrypted way or not? How do we add this in a trustless environment?

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1.3. General rules

The serious game is based on the following general rules:

- Each player is an economic actor. He/she sells and purchases products in the Island. He/she makes transactions.
- Each player is a validator. He/she participates in the validation of the transaction.
- Each player is a Ledger keeper. He/she keeps a copy of all the transactions made in the island.
- Each player starts the game with the same amount of virtual money (*Istoken*).
- All players participate in creating the encrypted transaction blockchain.

All details regarding the game mechanics are explained in the next sections.

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2. Storyline: This is how it all began...

The players have survived a shipwreck and are on a deserted island. They decide to use a blockchain economy system for their transactions as an alternative to coins/money.

A group of intrepid strangers, united by their desire for adventure, embarked on a ship called Destiny. They wanted to cross the ocean and reach a new world full of opportunities. But little did they know that this voyage would change the course of their lives and in what way.

The day they would never forget seemed calm. A blazing sun and calm sea did not foreshadow what was about to happen. Suddenly, as if it was nightfall in a matter of seconds, a violent storm darkened everything. Torrential rain, gale-force winds, and gigantic waves tossed the ship around until it could no longer hold on. The Destiny could not hold on and broke in half.

The adventurers, as if their lives depended on it, grabbed what they could. The end of the mainmast, a large wooden boot, and even the rudder was used by these passengers to hold on and stay afloat while the Destiny sank in no time.

The storm swept them along for endless hours with no fixed course until the calm returned and they found themselves exhausted in the middle of the ocean. Hopelessly, after days that seemed like weeks, the squawk of a seagull broke the monotony of those endless days. The bird flew over the group suspiciously and, by surprise, ended up landing on the large boot. Joy returned to the group; they were close to dry land! One of the castaways raised his head and managed to spot an island on the horizon. Without a second thought, they began to swim with the last of their strength and managed to reach the beach, albeit completely exhausted.

After resting, the group of castaways organised themselves and began to explore the area around the beach. After walking several kilometres, they realised that they were completely alone on a small island they did not

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recognise and with limited resources. Their excitement at finding themselves on the mainland turned to disappointment and sadness.

But the discouragement only lasted a few days. The new inhabitants of the island began planning their new life on the island and soon became a team. Without cooperating and collaborating with each other, survival would be much more difficult. Each of the castaways took on a series of tasks that would be easier for them to perform because of their previous skills and knowledge.

Days became weeks, and weeks became months. The organisation of the different activities and the specialisation of each of the castaways made living together and life on the island more and more comfortable. They built shelters, managed to build fires, found food, and fresh water and fishing became their main activity.

But the island held more surprises in store for them. The nearby waters were inhabited by dangerous jellyfish which made fishing a risky sport. Their stings would put the castaways out of action for hours. Also, during the night they had to stand guard to avoid the attacks of the vermin that lived on the island and came to steal their food. And as if this were not enough, a strange entity accompanied them and could even possess them, they called him "The Spirit of the Island".

They soon realised that, as was the case in all advanced societies, for their system to be sustainable and fair they needed a model for equitably exchanging their products and knowledge. The classic barter of the more rudimentary communities did not seem to them to be a fair way to complete their transactions.

On the night of the summer solstice, the shortest night of the year, the castaways sat around the campfire and decided not to get up until they found a formula, they could all agree on. After hours and hours of deliberation, they agreed on a monetary system based on tiger mussel shells. These were not very abundant on the island's beaches, but there were enough of them to become their currency. They collected all the tiger mussel shells they could

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find, divided them equally among the inhabitants and kept a good portion for the community to pay for certain services to be done for everyone. They seemed to have devised a fool proof system.

Each member of the group used their shells according to their tastes or needs. This allowed them to specialise in certain jobs and concentrate on what they did best to share fairly and efficiently. The shell system took hold in the community and transformed life on the island. It fostered innovation, specialisation and allowed them to continue to grow within their small ecosystem. They had succeeded in creating a sustainable and enduring model.

Life continued on the island with this monetary model, but the Spirit of the Island had a new surprise for them. One night, this spirit caused one of the biggest storms the castaways ever experienced. That's not all, at dawn, the group approached the beach to begin their daily chores and saw how it was covered by a blanket of tiger mussel shells. Thousands, millions of shells. The storm had washed them onto the sand during the night. At first, the islanders did not realise the magnitude of the problem and began to fill sacks and sacks of their currency. But they soon realised that their monetary system had failed, their currency, faced with millions of tiger mussel shells, was now worthless.

The castaways gathered again around the campfire and discussed different systems. They considered returning to the barter system, finding a new object that could function as currency, and other crazy possibilities, but none of them convinced everyone on the island. Until they thought of using a system similar to blockchain.

The new system consisted of implementing a decentralised and secure registry to record and verify all transactions that took place on the island. To record all transactions, they created a physical "ledger" where each exchange would be recorded. This register serves as a record for every transaction as accurately as possible and cannot be edited. This ledger would always be accessible to all castaways and would be updated with each new exchange.

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Every night, the inhabitants of the island would gather by the fire to record each new transaction. Each castaway had to agree to each new record.

This decentralised system helped to foster transparency and trust within the group while ensuring that each exchange was fair and equitable.

As the years passed, life on the island with its new monetary system became more and more comfortable. While it controlled the exchanges, it encouraged collaboration and cooperation among the survivors. This culture of transparency helps them to resolve conflicts through dialogue and compromise.

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3. Material for the game

The game can be played between 2 to 6 players. To play the game we need:

Printable material:

- 1 Board: 4 A3 pages to be assembled together to create the board;
- The square of the number of players of Scoreboards (that is, 4 scoreboards are needed for 2 players, 9 scoreboards for 3 players, 16 for 4 players, 25 for 5 players, 36 for 6 players);
- 26 income cards;
- 26 expense cards;
- 54 action cards.

If possible, print using higher grammage (thicker) paper, that is instead of using the normal 80g/m2 paper use e.g. 160 g/m2 paper.

Additional material:

1 standard 52-card deck of playing cards
→ Check out for more details on standard 52-card deck: here

1 dice

Pawns: one colour per players: to be used on the board.

Pins/markers: twice the number of markers (or pins) as the number of scoreboards: 2 markers are needed per scoreboard (one for counting the units and one for counting the multiples of ten).

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4. Game mechanics

4.1. Start of the game

1. Each player chooses a colour and takes the corresponding 2 pawns, takes also as many scoreboards as the total number of players, and twice that number of pins (or markers)
2. The 52-card deck of playing cards is shuffled and placed face down on the board.
3. Each player starts the game with 50 Istoken, an alternative to conventional money. All the scoreboards of all players should be marked with that starting amount (**50** = **5** x 10 + **0),** put one marker (or a pin) in the left **5** (representing 50) and one marker or a pin in the units of each scoreboard (representing **0**).
4. Place face down on the board:
    - The set of **Income Transaction cards** above the gold coins treasure chest.
    - The set of **Expense Transaction cards** above the hands exchanging coins.
    - The set of **Action cards** above the question mark.

4.2. Game rounds

Phase 0. Start

0.1 The players agree on which is the maximum game duration time and activate a timer (countdown clock) in their mobile phones. We suggest 30 to 45 minutes playing time for 2 players and 1 hour to 1 hour and a half playing time for 3 to 6 players.
0.2 All players put one of their pawns on the starting point (the box with the flags), the pawns will move on the board clockwise.
0.3 The player who starts the game is selected by rolling the dice: whoever has the highest number of points wins. Then the players will participate in turn, in clockwise order.

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0.4 If it is the first round, then there is no previous Winning Card. Therefore, the first player takes the top card from the standard deck of cards and puts it face up on the table, near the board. In the following turns, that card will be replaced with the Winning Card.

The game starts, each game turn has 2 phases:

Phase 1. Moving on the board

All players in the established order roll the dice and advance to the square they touch as indicated by the dice. Depending on the square each player lands there are different options:

- If the square is action (question mark) the player takes an action card;
- If the square is expense (hands exchanging coins), the player takes an expense transaction card (E card);
- If the square is income (treasure chest with coins), the player takes an income transaction card (I card).

Notice: the players **are not yet supposed to execute** what is said in the card, they just take the card and do not show it to the other players, whatever is said in the card will be executed at the end of Phase 2.

There are 4 special boxes → see point 4.5. for more information.

Phase 2. Mining the block and executing the transactions

2.1 The players put the cards that they have drawn (one income, expense or action card per player) next to each other face down and with the second pawn of each player next to it[1]. The previous Winning Card is also placed there, on the left of the other cards[2].

[1] Blockchain concept: these cards represent the block of transactions that are going to be mined.
[2] Blockchain concept: this represents linking with the previous block (thus creating a block chain).

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2.2 Each player, in the same order, takes the top card from the 52-card deck. Now the player has to decide whether to participate in the validation of the transactions (mining operation[3]). If he/she decides not to participate, then the player places the card at the bottom of the deck and the game proceeds to the next player. Otherwise, the player places the card face down next to him/her and reduces his/her score[4] by 1 monetary unit (Istoken). In deciding whether to participate in the validation of the transactions, the player knows (1) the denomination and suit of the previous Winning card (everyone can see that), (2) his/her still secret income/expense/action card (its denomination and suit) and (3) his/her standard card (its denomination and suit) and knows how the score is evaluated.

2.3 There are three special cases to consider:

- If a player got an action card that forbids the participation in the transaction validation operation (*stung by a jellyfish*) then that player in the next turn will be excluded from drawing a card.
- If a player is permanently excluded from the mining round (*possessed by the spirits of the island*) then that player from the next turn on no longer is able to draw a card.
- If a player got the *on guard all night* action card, then that player in this turn can draw two cards instead of just one. After looking at the two cards the player either returns both to the bottom of the standard card deck and in that case has not to pay anything, or keeps one of those two cards while returning the other to the bottom of the standard card deck and reduces his/her score by 1 monetary unit (Istoken).

2.4 All cards (the expense/income/action card) of each player and the standard cards of those players that paid to participate in the mining rounds, are turned over so that everyone is able to see them. The score of each player that participated in the mining round can then be evaluated and the player with more points wins[5]. Notice that the points are always counted taking into consideration n+2 cards, where n is the number of players: one previous

[3] Blockchain concept: this represents the fact that mining is an optional operation that not all the participants in the blockchain are required to do.

[4] Blockchain concept: this represents the fact that mining is expensive (e.g. paying the electricity bill of the computer that is trying to solve the mathematical challenge).

[5] Blockchain concept: this represents the encrypted transaction block process and the miner that won the race to validate the transactions stored in the block.

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Winning card, one income/expense/action card per player, and the player's standard card. The counting is made as follows (see also the examples provided in **Section 4.7**):

- Count one point per match of the standard player card with each of the other cards (e.g. a *nine* matches with a *nine* of any suit)
- Count one point per player card that is of the same suit as one of the other cards

If two or more players have the same number of points then the player with the highest standard card wins, if there is still more than one winner then each winner throws a dice[6] to figure out which one will win (the one with the highest score).

2.5 The player who won the hand gets 5 monetary units (Istokens) as a prize for mining the block[7]. At this moment, in turn, the transactions represented in the income/expense/action card of each player are executed[8] and the scoreboard is adjusted accordingly (each player has a copy of the score of all players[9]).

2.6 The Winning Card[10] (the standard card played by the winner) is kept on the board and will be considered for the next turn.

2.7 All the income, expense and standard cards used in this turn are collected and placed under the corresponding card piles.

2.8 Players that in this round got the *stung by a jellyfish* action card have to put it face up next to his/her scoreboard to represent the fact that they are not allowed to mine in the next turn. If on the other hand the turn where they were not allowed to participate has just finished, then those cards are also returned to the bottom of the Action deck.

2.9 Players that got the *spirit of the island* action card have to put it face up next to his/her scoreboard and that card will remain there until the end of the game.

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[6] Blockchain concept: solving the mathematical challenge depends on computational power and luck.

[7] Blockchain concept: transaction fee.

[8] Blockchain concept: this represents the fact that once validated the transactions are executed.

[9] Blockchain concept: this represents the distributed ledger.

[10] Blockchain concept: this represents the hash of the previous block that is used to link the blocks in the blockchain so that any attempt to change the blockchain can be detected.

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2.10 The remaining Action cards are collected and placed at the bottom of the Action deck.

A new turn begins by going back to Phase 1.

4.3. End of the game

If a player reaches a negative number of Istokens then that player is disqualified and stops playing.
The game is over if any of these 3 conditions occurs:

- only one player remains in the game;
- in a given turn no one is allowed to participate in the mining (transaction validation) operation;
- the agreed upon duration time is reached, at that time the current turn is finished and the game stops.

After the end of the game the player who has more Istokens wins. If two or more players have the same amount of Istokens then it is a draw between those players.

4.4. Cards

4.4.1. Transaction cards

There are two types of Transaction cards. When the cards are printed on the back put E in the case of the expense cards and I in the case of the income cards. Examples:

- **I=income "You receive 4 Istokens from the player on your left"**
- **E=expense "You pay -5 Istokens to the player on your left"**

4.4.2. Action cards

There are 4 types of action cards:

- Jellyfish → "You have been stung by a jellyfish while you were fishing and you will spend 1 turn without participating in the mining of the block."

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- Fire → "On a rainy night, you managed to make a fire to heat the camp. As a reward each player gives you 1 Istokens."
- Totem → "During the ritual, the spirit from the island has possessed you and has clouded your mind. You cannot participate in the mining round."
- Axe → "You have been on guard all night to defend the camp from wild animals. As a reward you can take out 2 cards in the mining turn."

4.5. Special boxes/square

There are 4 special boxes on the corners of the board and a rule for crossing the starting point:

- Starting box → Every time a player crosses the starting point, he/she receives 4 monetary units (Istoken), if the player lands in the starting box then the player takes an action card.
- Jellyfish → If the player lands on a square with jellyfish, the player takes 1 expense card and pays 1 extra Istoken (to be deduced from the player's scoreboard).
- Fire → If the player lands on a square with the fire, the player takes 1 income card and is awarded with 1 extra Istoken.
- Totem → If the player lands on a square with totem the player takes 1 action card, and he/she is not allowed to participate in the mining of the block in this round.

4.6. Scoreboard (The Ledger)

The scoreboard is an abacus that reflects the distributed ledger of the blockchain. Everyone can see the player scoreboard at the same time. All players' scoreboards are updated at the same time[11] during the game rounds. Changes to transactions on the scoreboard are applied for all to see. One scoreboard per player records the status of his/her wallet giving the value of the current cash. If it reaches a negative value, then that player is out of the game.

[11] Blockchain concept: each scoreboard is an abacus that is also replicated by the other players to reflect the distributed ledger nature of the blockchain.

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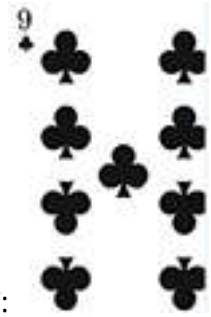
4.7. Examples of how to score

In the examples below, the Winning card (from the previous round) is always on the left, followed by the Income/Expense/Action card of each player, below is the card played by each player (P1, P2, P3). One point is counted for each matching rank and one point is counted for each matching suit.

4.7.1 Examples of scoring in 2-player games

Example 1 (2-player game):

- On the table the Winning card (WC) is *9 of clubs,* Player 1 transaction card is *9 of hearts*, Player 2 transaction card is *King of hearts*

WC:  P1: 

P2: 

- Player 1 (P1) plays *9 of diamonds* and Player 2 (P2) plays *Ace of clubs*, it is each of those 2 cards that need to be compared with the 3 cards above:

P1:  P2: 

- Score of Player 1 (P1): playing *9 of diamonds* he/she gets 2 points: 1 point by matching the nine of *9 of diamonds* with the *9 of clubs*; 1 point by matching the nine of the *9 of diamonds* with the *9 of hearts*
- Score of Player 2 (P2): playing *Ace of clubs* means he/she gets 1 point: same suit (clubs) for *Ace of clubs* and *9 of clubs*
- Therefore Player 1 wins and the Winning card of the next round will be *9 of diamonds*

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Example 2 (2-player game):

- On the table the Winning card (WC) is *9 of clubs,* Player 1 transaction card is *9 of hearts*, Player 2 transaction card is *King of hearts*

WC:  P1: 

P2: 

- Player 1 (P1) plays *9 of hearts* and Player 2 (P2) plays *Ace of clubs*, it is each of those 2 cards that need to be compared with the 3 cards above:

P1:  P2: 

- Score of Player 1 (P1): playing *9 of hearts* he/she gets 4 points: 1 point by matching the nine of *9 of hearts* with the *9 of clubs*; 1 point by matching the nine of the *9 of hearts* with the *9 of hearts* (notice that the same card can appear more than once), 1 point by matching the same suit (hearts) for the *9 of hearts* and the *9 of hearts*, 1 point by matching the same suit (hearts) for the *9 of hearts* and the *king of hearts*
- Score of Player 2 (P2): playing *Ace of clubs* means he/she gets 1 point: same suit (clubs) for *Ace of clubs* and *9 of clubs*
- Therefore Player 1 wins and the Winning card for the next round will be *9 of hearts*

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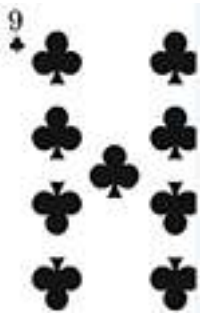
4.7.2 Examples of scoring in 3-player games

Example 1 (3-player game):

- On the table the Winning card (WC): is *9 of clubs*, Player 1 transaction card is *9 of hearts*, Player 2 transaction card is *King of hearts*, Player 3 transaction card is *9 of diamonds*

WC:  P1: 

P2: 

P3: 

- Player 1 (P1) plays *9 of hearts*, Player 2 (P2) plays *Ace of clubs*, and Player 3 (P3) plays *King of hearts*, it is each of those 3 cards that need to be compared with the 4 cards above:

P1:  P2:  P3: 

- Score of Player 1 (P1): playing *9 of hearts* he/she gets 5 points: 1 point by matching the nine of *9 of hearts* with *9 of clubs*; 1 point by matching the nine of *9 of hearts* with *9 of hearts* (notice that the same card can appear more than once), 1 point by matching the nine of the *9 of hearts* with the *9 of diamonds*, 1 point by matching the same suit (hearts) for the *9 of hearts* and the *9 of hearts*, 1 point by matching the same suit (hearts) for the *9 of hearts* and *King of hearts*
- Score of Player 2 (P2): playing *Ace of clubs* means he/she gets 1 point: same suit (clubs) for *Ace of clubs* and *9 of clubs*
- Score of Player 3 (P3): playing *King of hearts* means he/she gets 3 points: 1 point for matching king of the *King of hearts* with the *King of hearts* (notice that the same card can appear more than once), 1 point for matching same suit (hearts) for *King of hearts* with the *9 of hearts*, 1 point for matching the same suit (hearts) for the *King of hearts* with the *King of hearts*
- Therefore Player 1 wins and the Winning card for the next round will be 9 of hearts

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Example 2 (3-player game):

- On the table the Winning card (WC): is *9 of clubs*, Player 1 transaction card is *King of hearts*, Player 2 transaction card is (again) *King of hearts*, Player 3 transaction card is *9 of diamonds*

WC:  P1:  P2:  P3: 

- Player 1 (P1) plays *9 of hearts*, Player 2 (P2) plays *Ace of clubs*, and Player 3 (P3) plays *King of hearts*, it is each of those 3 cards that need to be compared with the 4 cards above:

P1:  P2:  P3: 

- Score of Player 1 (P1): playing *Ace of clubs* means he/she gets 1 point: same suit (clubs) for *Ace of clubs* and *9 of clubs*
- Score of Player 2 (P3): playing *King of hearts* means he/she gets 4 points: 1 point for matching king of the *King of hearts* with the first *King of hearts* (notice that the same card can appear more than once), 1 point for matching king of the *King of hearts* with the second *King of hearts*, 1 point for matching the same suit (hearts) for the *King of hearts* with the first *King of hearts,* 1 point for matching the same suit (hearts) for the *King of hearts* with the second *King of hearts*
- Score of Player 3 (P3): playing *9 of hearts* he/she gets 4 points: 1 point by matching the nine of *9 of hearts* with *9 of clubs*; 1 point by matching the nine of *9 of hearts* with *9 of diamonds*, 1 point by matching the same suit (hearts) for the *9 of hearts* and the first *King of hearts*, 1 point by matching the same suit (hearts) for the *9 of hearts* and the second *King of hearts*
- Player 2 and Player 3 have the same number of points thus they need to throw a dice to decide who is the winner:
- P2:  , P3:  , therefore Player 2 (P2) wins and the Winning card for the next round will be *King of hearts.*

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5. Snapshots of a 2-players game

5.1 Start of the Market Island serious game, the initial score was not yet initialized, the randomly selected Winning Card is *7 of diamonds*.

5.2 All players start with a score of 50.

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5.3 First player throwing a dice to figure out where to move on the board.

5.4 First player moving the pawn on the board.

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5.5 Second player throwing a dice to figure out where to move on the board.

5.6 Second player moving the pawn on the board.

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5.7 After each player took the Action / Expense / Income card according to the square where the pawn landed, it is time for the first player to draw a standard card.

5.8 Second player got a *7 of hearts* during the mining operation (at this time, contrarily to what the picture seems to indicate, that card should not be shown to the other players).

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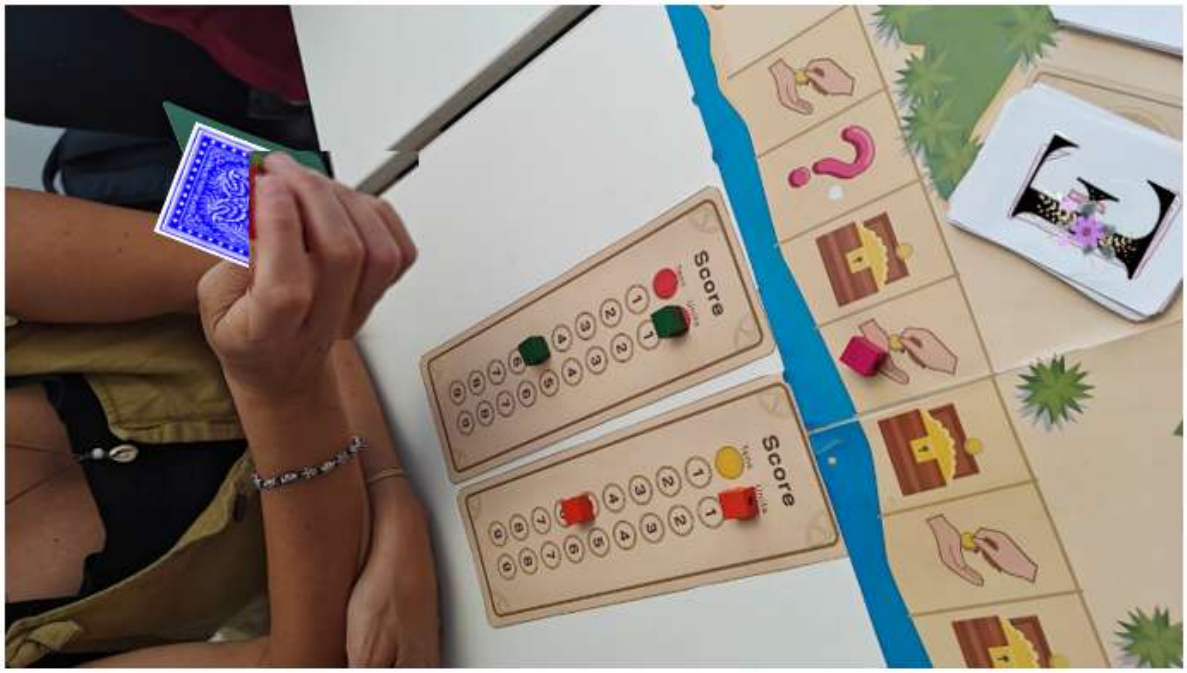
5.9 Second player drawing the card that represents the mining operation.

5.10 Second player with the standard card that represents the mining operation.



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5.11 Assuming that both players decided to execute the mining operation the cards are shown. The first player got a *7 of hearts* and the second player a *Jack of spades* as the mining card, in this case the second player gets 1 point, and the first player wins with 2 points thus the new Winning card will be *7 of hearts.*

5.12 The winner of the block mining gets his/her reward.

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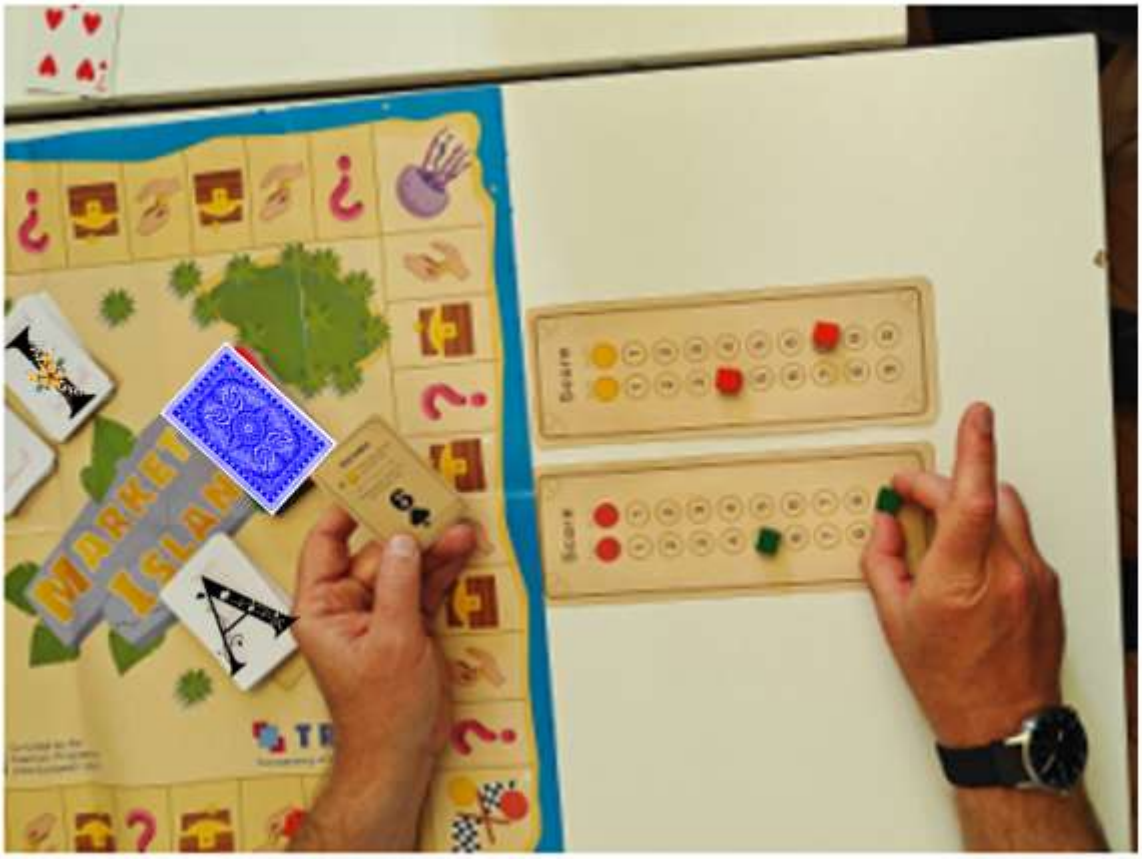
5.13 The two players, in order, start applying the transactions and updating the score cards. Here we have the first player updating his scorecard.



5.14 Here we have the second player updating the scorecard of the first player.

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5.15 Here we have the first player updating the scorecard of the second player.

5.16 Here we have the second player updating the scorecard of the second player.

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5.17 Once the transactions are applied all players have an identical copy of the scorecards.

5.18 The turn is almost completed and ready for the next round using the new player positions, the old Winning card (*7 of diamonds*) still needs to be replaced.

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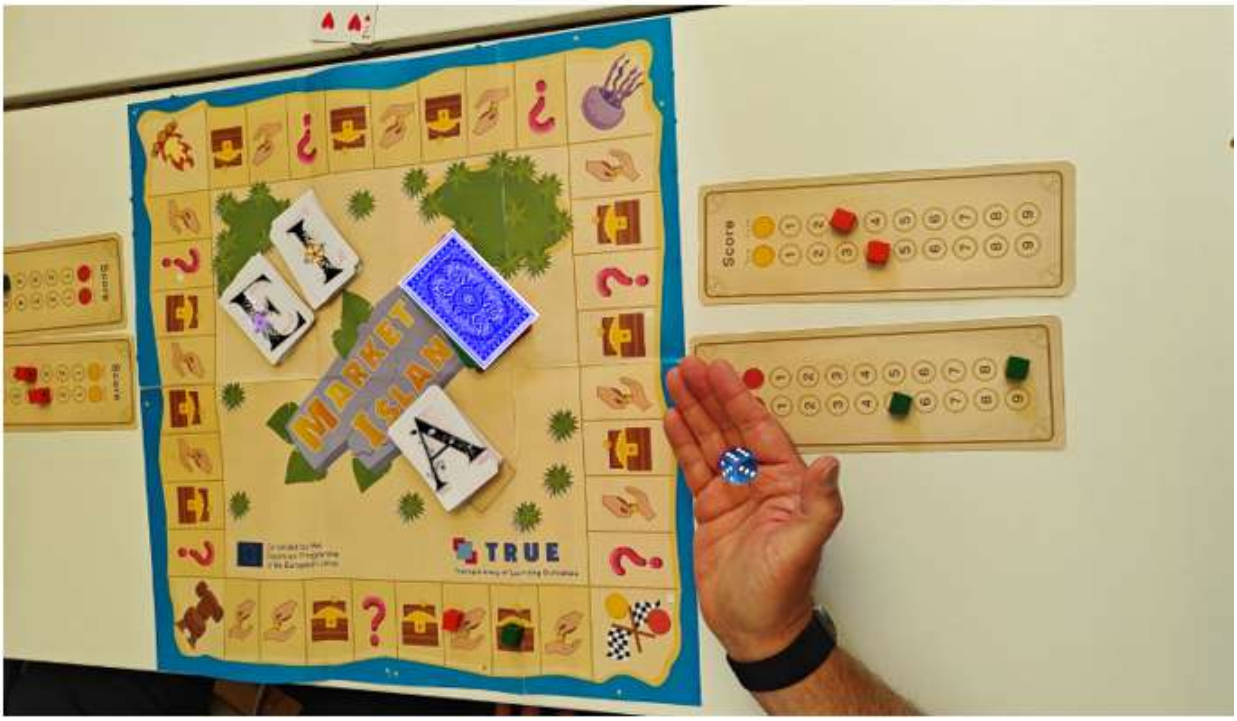
5.19 The new Winning card (*7 of hearts*) is placed on the board and the second round starts with a new toss of the dice.



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