Baziyo: Development of a cryptogame with Unity on an Ethereum Blockchain Test Network

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Abstract. *The importance of developing software that keeps pace with Web3 technologies is crucial in fostering discussions about their utilization in the current scientific landscape. Within this context, this research aims to present the development of a "criptogame" that utilizes blockchain technology to incorporate NFTs (Non-Fungible Tokens) into its mechanics. The text addresses fundamental concepts of Web3, making references to relevant literature. Subsequently, the development process is described, including specific methodologies and models. The obtained results consist of a puzzle game that incorporates NFTs as playable characters and enables the transfer of these assets between digital wallets.*

1. Introduction

In the last decade, a new form of payment known as cryptocurrency has emerged [Mattos et al., 2020]. The main characteristic of this asset is decentralization, which means there is no need to involve third parties in transactions, making national and international financial operations more efficient in terms of time and cost compared to the model used in the traditional banking sector [Abramova and Böhme, 2016]. Although the term cryptocurrency is often used synonymously with Bitcoin (BTC), the first cryptocurrency to be launched, there are currently various cryptocurrencies that extend beyond BTC.

Exploring the possibilities of Web 3 in the digital gaming market, Maris & Fantini (2022) state that blockchain has established itself as one of the most promising technologies today and can provide new perspectives for the digital gaming market. Among the expectations created for blockchain in games, the authors claim that there is the possibility of conferring property rights to digital assets within the game, making them non-fungible, exchangeable, and independent of development. This game mode is called "play-to-earn" [Giles et al., 2021; Maris and Fantini, 2022].

One of the concepts that guide the digital gaming market is Web 3. According to the company Metamask (2022), Web 3.0 is characterized as an internet that incorporates identity, money, and an additional social layer. This vision of an internet is built on open protocols that value transparency and innovation and seek to decentralize the power of large corporations, putting control of data in the hands of users [Oliveira et al., 2018; Voshmgir, 2021]. Thus, blockchain technology plays a fundamental role in this context, offering secure and transparent solutions for the digital gaming market [Giles et al., 2021].

Using qualitative and bibliographic research methodology, this article sought to present the development of a "cryptogame" a digital game that incorporates blockchain technology using the Unity engine as a case study. The aim was to understand the process

of integrating this technology in a gamified context, leveraging the concepts of Web 3.0 mentioned earlier, such as decentralization, transparency, and the ability to confer property rights to digital assets. To achieve this, we will use a test network (testnet), exploring the benefits and challenges of applying blockchain in this scenario.

2. Theoretical Framework

2.1. Blockchain Concept

According to [Belotti et al., 2019], blockchain is a technology that brings the concept of shared record to distributed systems for a range of application domains, from cryptocurrency to potentially any industrial system that requires a decentralized, robust, reliable system and automated decision-making in a multi-stakeholder situation.

A typical example of a blockchain is illustrated in Figure 1. A blockchain consists of sets of data that are composed of a chain of data packets (blocks) where each block comprises multiple transactions. The chain of blocks is extended by each additional block and thus represents a complete record of transaction history [Nofer et al., 2017].

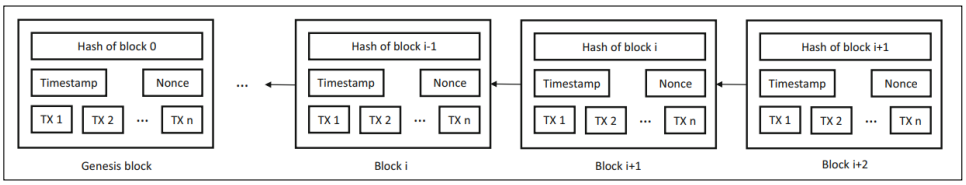

Figure 1. Blockchain and its blocks according to Nofer et al. (2017).

The network stores the information of a group of transactions in blocks, marking each block with a timestamp and date record. At regular intervals (10 minutes in the blockchain), a new block of transactions is formed, which is linked to the previous block.

The blocks are interdependent and form a chain of blocks (hence the name: blockchain). This makes the technology perfect for recording information that requires trust, such as in the case of a bitcoin and other crypto transactions [Fantini, 2020; Maris and Fantini, 2022; Nofer et al., 2017]. According to the authors, the blockchain network is formed by miners who verify and record transactions in the block. In order for this to be possible, miners lend computational power to the network. As an incentive to continue collaborating and make the network sustainable and more secure, they receive a reward in digital coins [Zyskind et al., 2015].

When developing a virtual machine program on the Ethereum blockchain, it is necessary to pay gas to set up and use the said program. This gas on the Ethereum network is considered a transaction fee. Testnets, or test networks, are highly useful tools for Ethereum virtual machine development, making Ethereum software testing easier and providing developers with a secure layer to test their programs before running them on the main network. Testnets are similar to the main network in almost every aspect, except that Ether on these networks has no value. Public TestNets are accessible to anyone connected to the internet and can be accessed through wallets like Metamask [Coutinho et al., 2020; Shaker et al., 2021].

2.2. The concept of NFT

A Non-Fungible Token (NFT) is a type of cryptocurrency [Fairfield, 2022] derived from Ethereum smart contracts [Wood, 2014]. NFT was initially proposed as an improvement of Ethereum ERC-721 [William et al., 2018] and later developed into ERC-1155 [Witek et al., 2018]. NFT differs from classic cryptocurrencies [Shirole et al., 2020] such as Bitcoin in its intrinsic characteristics [Nakamoto, 2019]. According to InfoMoney website (2020), Bitcoin (BTC) and Ethereum (ETH) paved the way for the emergence of new formats of digital assets that attracted thousands of investors and moved billions of dollars.

Between January and September 2021, according to data from the analytics website DappRadar (2021), the sales volume of these tokens reached $13.2 billion, a value larger than the Gross Domestic Product (GDP) of Acre, Amapá, and Roraima combined. Thus, a token in the cryptocurrency universe is the digital representation of an asset, such as money, property, or a registered artwork on a blockchain.

2.3. Blockchain Games

Blockchain games, or cryptogames, are digital games that utilize blockchain network technology for their creation and implementation. These games allow for micro transactions within the game environment, carried out through smart contracts [Min & Cai, 2019]. Being a digital technology, its application in the context of games is a natural choice [Fantini, 2020]. According to Min et al. (2019), cryptogames operate differently from traditional digital games. Before starting a gaming session, players need to register an address on the corresponding blockchain platform. This address, accessed through a digital wallet, functions as a unique identity and is the location where all of the player's virtual assets are stored.

3. Development of the Baziyo cryptogame

In this section, we will present the entire development process of the Baziyo cryptogame, as well as the research process conducted for the implementation of blockchain technology within the scope of the game.

For the Baziyo project, we chose to use the agile Scrum method as the development framework. This choice is due to its iterative and collaborative approach, which allows us to deliver functional increments of the game over time [Sutherland, 2014]. The game development team adopted sprints, daily meetings, and other agile practices to optimize the development process.

The flow of research and game development execution followed the following stages:

3.1. Creation of NFTs

This stage was crucial in the development of the cryptogame, as it involved the creation of the necessary artwork for implementation in the game. It was necessary to define the dimensions and aesthetic patterns of the artwork that would be transformed into NFTs. In the case of the Baziyo game, the art creation process was carried out in Adobe Photoshop version 2022.

The playable characters in the game, has unique characteristics in terms of colors and shapes. However, all the characters follow the rectangular size of 32x32 pixels, as defined in the aesthetics and asset art documents.

Figure 2. Images of the characters created for the game.

Next, all the images were exported in the .PNG format to be subsequently transformed into NFTs.

3.2. Storage of Images

The second step was to store the created images in a decentralized network. Among the available free options, the most accessible ones are IPFS (InterPlanetary File System) and Pinata Cloud. These storage platforms stand out from others due to their ability to store files without size limits and share them through a peer-to-peer (P2P) connection [Daniel & Tschorsch, 2022].

For the Baziyo game, Pinata Cloud was selected for storing the assets to be used in the game. This application utilizes IPFS but adds a layer of user control over the uploaded files. After the images were inserted into the decentralized platform, a HASH code was generated, which was used in the minting process, adding the NFT to the blockchain.

3.3. Creation of the Smart Contract

According to Samir Kerbage, CTO of Hashdex, smart contracts are the digital expression of commitments established between two or more parties, representing a mutual agreement. These contracts are encoded in a programming language and automatically executed once the predefined terms and conditions are met, eliminating the need for an intermediary to ensure execution [Martin, 2022]. To create a Smart Contract, it was necessary to understand the standardizations within the blockchain universe. The models used are ERC721 and ERC1155.

In the Baziyo game, the ERC-721 standard was adopted, which is used to standardize NFT tokens on the Ethereum blockchain. Below is the code of the smart contract used in the project. As this is a case study, this contract is limited to defining the currency used for the NFTs (characters) and the process of creation (minting). Other functionalities, such as assigning value to transactions, were not implemented in this context.

```
contract newNFT is NFTokenMetadata, Ownable {

  constructor() {
    nftName = "Baziyo";
    nftSymbol = "BZY";
  }
  function mint(address _to, uint256 _tokenId, string calldata
_uri) external onlyOwner {
    super._mint(_to, _tokenId);
    super._setTokenUri(_tokenId, _uri);
  }
```

Figure 3. Base of the Smart Contract used in the Baziyo game.

Later, the contract was transferred to a dedicated IDE for the Ethereum network, known as REMIX. This IDE was used to "compile" the contract code and execute its functions. One of the most commonly used functions is mint, which is responsible for adding the NFT to the Ethereum blockchain. After this process, the first NFT of the Baziyo game was created and added to a test network, the Goerli TestNet.

3.4. Attributes in NFTs

Depending on the scope of the game, it may be necessary to add attributes to the NFT, such as maximum power, life, attack speed, among others. The metadata of the NFT should be included in the JSON file of the used image. These metadata typically include the following items:

- Name: The name of the NFT.
- Description: A brief description or summary of the NFT.
- Image: The URL or file path of the image associated with the NFT.

In the game Baziyo, the characters have the following attributes: name, description, multiplier, and maximum energy. These attributes are used to classify a character as common, uncommon, or rare, according to the specifications of the game designer. Each NFT has its own JSON code, which was stored in a specific folder on Pinata Cloud.

3.5. Unity and blockchain integration

To perform token transactions and establish the game's connection with the blockchain, it was necessary to integrate the ChainSafe package into the Unity engine. ChainSafe (2023) is a company dedicated to research and development of blockchain-connected applications. For the game development, this package was chosen to provide classes and methods that allowed for a direct connection to the Ethereum network or a test network such as Goerli.

3.6. Performing Wallet Login

When it comes to game development with NFTs, many games require user validation to retrieve the assets belonging to that player. Therefore, a login screen is necessary to connect the game with the user's wallet and retrieve their NFTs. The term "wallet" refers

to a virtual purse or wallet where we can manage our cryptocurrency assets. It is software or hardware designed exclusively to store and manage the public and private keys of our cryptocurrencies [Kaushal et al., 2017].

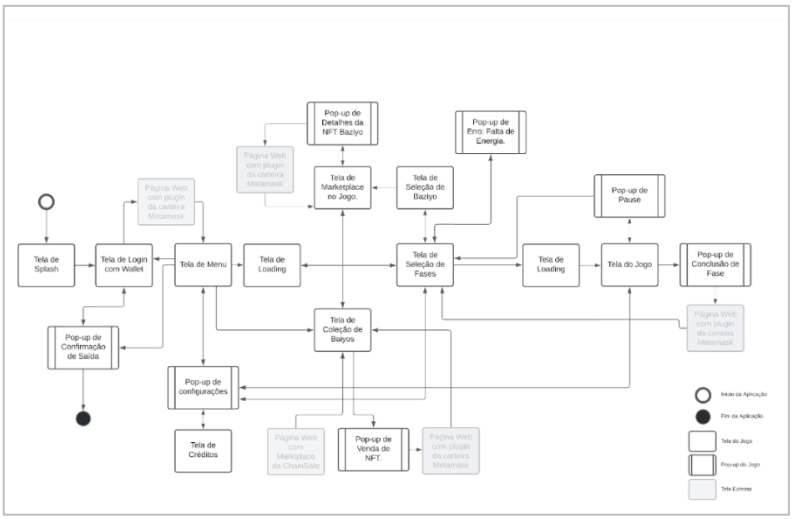

Figure 4. Screen Flow of the Baziyo Cryptogame.

In the game, it was necessary to obtain the number of Baziyos that the user owned and their respective images in order to start the game. For this purpose, the Metamask wallet was used, which allows communication with the Goerli TestNet, where fees could be paid with TestNet faucets (test coins).

By using the functions provided by the Chainsafe library, it was possible to implement the login mechanism with the user's Metamask wallet. After this implementation, some handling was required, such as verifying the smart contract signature in the Metamask wallet.

3.7. Character Selection

One of the objectives of the Baziyo cryptogame is the use of NFTs within games. As a result of this demand, these digital assets were used as characters in the game. Through Chainsafe, the game system makes requests to the blockchain and retrieves the NFTs present in the contract. The NFTs are displayed on the character selection screen and within the gameplay scene.

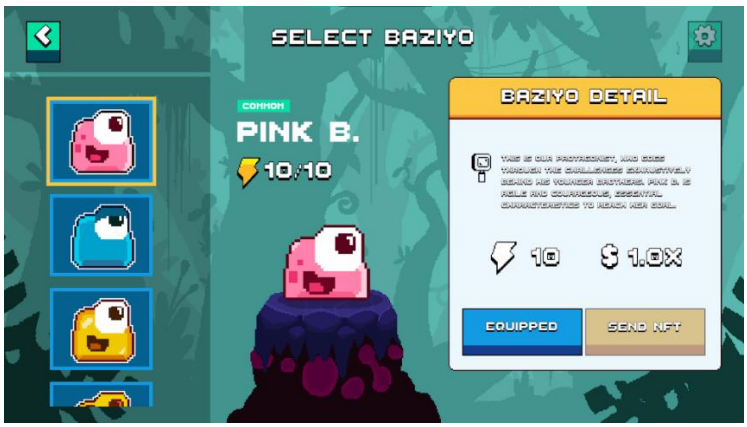

Figure 5. NFT Character Selection Screen.

3.8. User Testing

As a final step in the development of the cryptogame, two playtest sessions were conducted, which involved playing the product in development with the aim of discovering if it delivers the desired experience [Schell, 2011]. There are six types of playtests according to Fullerton (2014): one-on-one testing, group testing, survey, interview, open discussion, and data hooks, which can be combined and tailored to different types of developers. For the playtest of the Baziyo game, a one-on-one testing approach was conducted with 13 participants, where a facilitator guided the player through activities while observing and collecting data on their performance.

Figure 6. Playtest Session.

At the end of each match, a Likert-scale-based form was filled out to understand the player's perception regarding the game mechanics: ease of understanding the game controls, overall gameplay, difficulty, and aesthetics. In addition, the manipulation of NFTs was evaluated: equipping an NFT in the selection screen, transferring and receiving an NFT. The data was analyzed and can be viewed in the images below.

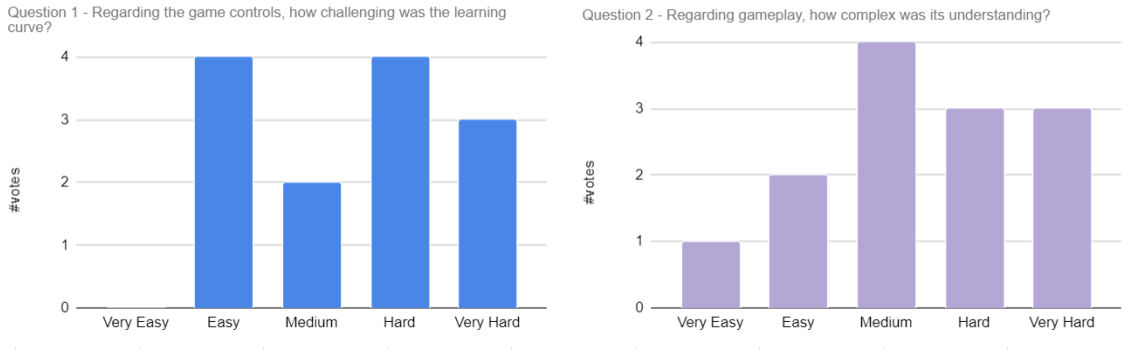

Figure 7. Graphs on game controls and overall gameplay.

Regarding controls, players expressed difficulties in understanding the commands independently, requiring multiple attempts and assistance until the gameplay mechanics

were grasped. In terms of gameplay, players expressed satisfaction and enjoyment upon completing the levels. This statement is supported by the graph shown in Figure 8.

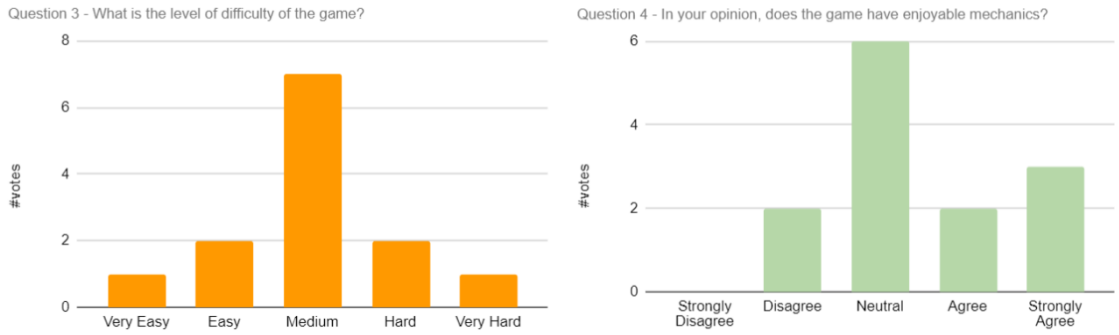

Figure 8. Difficulty and Enjoyment Graphs of Baziyo Game

It is worth noting that the version used in the playtests was not balanced, presenting a high level of difficulty for some users. Regarding the manipulation of NFTs, players were invited to perform the action of selecting an NFT and transferring it to another participant, as well as receiving an NFT. All participants successfully carried out these actions.

4. Conclusions and Future Work

When we talk about games and NFTs, we are dealing with two rapidly expanding markets. However, despite the great potential of this combination, there are few developers who invest in this idea compared to other genres of game development. Additionally, there is a scarcity of learning resources available for those interested in entering this new technological world.

With this in mind, the creation of the cryptogame Baziyo was proposed as a means of learning the key theoretical and technical concepts necessary for NFT game development. The project not only served as a rich learning tool but also served as a foundation for teaching and training other developers.

During the production of the game, research was conducted and put into practice on topics such as what an NFT is and its relationship with the blockchain, the definition of wallets, as well as the numerous options available on the internet, the creation and deployment of smart contracts, NFT minting, the connection of a Unity project with NFT assets, wallet connection functions, recovery of NFTs within a smart contract, and transfer of NFTs between different users (different wallets), which serves as an introduction to developing the entire business logic for NFT sales within a game.

Baziyo was successfully completed as a functional NFT game (cryptogame), even though it is still in a TestNet. By establishing the connection between Unity and the blockchain, Baziyo successfully utilized blockchain technology to enhance gameplay mechanics and provide players with a unique and immersive gaming experience. There are several other functionalities that can be addressed within its scope, such as multiplayer mechanics, and it can also provide momentum for future research on the use of NFTs in gaming. However, the main goal of its well-documented development process was to introduce others to the vast concept of Web3.0.

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