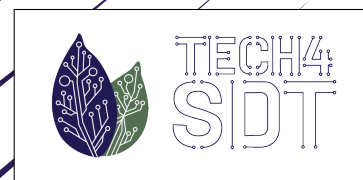




# Digital Card Game Platforms for Digitalising Design Games

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# Chapter 1

## Introduction

This report concerns the development of the design card game PluriCards, developed at the [Centre for Sustainable and Digital Transformation \(TECH4SDT\)](#). PluriCards is a card game which encourages players to take part in discussions on achieving a sustainable future. As part of digitalizing PluriCards we aimed to digitalise the game, to gain the possibility for both rapid prototyping as well as remote testing and playing.

We investigated 12 digital platforms, which support developing card games. The contents and features of these platforms were investigated by reading documentation, social media posts, as well as developing and playing games using digital platforms. For every platform, we noted down aspects relevant to the contents and features. We elaborated upon our notes into a larger analysis characterizing the platforms. In this report, we structure these analytical points covering the following areas:

**Features** Which features do the platform offer its users?

**Privacy** How does the platform collect data, and what types?

**Technology** Which technologies does the platform use for games?

**Community** What characterizes the community surrounding the platform, and how do you access it?

**Pricing** What role does price play in the platform, and what are relevant prices?

**Support** What options are there for users experiencing issues during game development?

We have organized the 12 digital platforms into the categories "Virtual Tabletops" and "Game Engines and Tools" based on their contents and features. Every platform is associated with a short abstract describing the overall results of the investigation related to this platform. Our results and associated abstracts may be relevant for those wishing to digitalise card games in a way that attends to organisational contexts.



## Chapter 2

# Digital Card Game Platforms

## 2.1 Virtual Tabletops

The category of "Virtual Tabletops" refers to those digital card game platforms, which aim to provide game creators with a virtual table, upon which card and board games can be played. They enable game development primarily by letting users drag and drop graphical elements and may implement programming as a feature, though not the primary offering.

Platforms in this category provide the technical infrastructure for playing games, which also means games have to be accessed by users via this infrastructure. This is most often supported with an online portal which game developers cannot edit.

### 2.1.1 Dulst

#### ABSTRACT

Dulst is a feature-rich platform for developing and playing card games in the browser. The platform provides features for novice and advanced card game developers, and games can be developed with advanced logic and styling options, partly through code in CSS and a JSON-like language. Dulst can be used without payment, and games can be fully developed without payment, though support for non-paying developers is limited.

Dulst is a platform built specifically for developing card games to be played in the browser. It is found at <https://dulst.com/>.

**Features** The set of features on Dulst is quite extensive. There are editors to change the physical map of a game, AI players, achievements, and a marketplace for games, among others. Many of these seem to be focused on games which are supposed to be distributed to gain a player base independent from the developers, for example with AI players to support single-player experiences. There is a very refined and sleek-looking user interface. Many features are also relevant for card games specifically, like features for different types of cards. It is worth noting that the way rules are used to enforce game logic is not something which one can "just do", as there are many rule cards which are interdependent, and their implementation is not always clear. Rule cards help control the game's logic, which is useful if the developed game should

itself manage the flow of gameplay and (il)legal moves. Importantly, Dulst manages all multi-player work automatically using either a peer-to-peer connection (single computers connecting to each other with equal responsibility, available in the "Free" tier) or with dedicated servers (a single computer managing connections between users, available in the "Pro" and "Enterprise" tiers).

**Privacy** In their privacy policy, it can be read that Dulst collects personal information from their users, as well as tracking actions on their site. They use cookies to enable things like automatic sign-in. It is worth noting, that Dulst has the right to publish non-private data, though data from games marked private in administrative settings will not be published. Finally, Dulst does not knowingly collect personal information from children under 13, and they aim to delete data from children under 13, should they become aware of these users.

**Technology** Dulst works by hosting developed games in HTML5, which is a markup language for web content, which is supported by all major browsers, as well as in select few older browsers. This means, that there should be no concern about users having the technology to play games, as they neither need to install nor download any items or use a specific browser. To theme the games, Dulst uses the visual styling language CSS, which is further supported by the Stylus preprocessor language. Stylus gives us access to a little programming (variables, functions, etc.) in CSS, as well as simplifying the syntax. The implementation of rule cards (which control the logic of games) is a little confusing. It is achieved with a no-code implementation where fields are filled in, though also with a form of code which looks like JSON (a format for data), although not quite. This is worth considering, as non-standard programming languages and frameworks affect how well the game can be maintained in the future.

**Community** Dulst seems to be built primarily for quickly creating card games and sharing these with others. Currently (February 2023), the most popular game has approximately 11,000 players, which, while not insignificant, is not that many. Furthermore, Dulst has forum features, where people can post regarding bugs, issues, and questions, although these are in our experience not often used. Lastly, it should be noted that many games which can be found on Dulst are based on popular media franchises (e.g., Minecraft and Star Wars), which is relevant for first-time users who may gain a specific understanding of the platform based on this.

**Pricing** Regarding pricing, Dulst has multiple pricing tiers. The "Free" tier costs nothing and provides basic functionality, with the "Pro" tier costing 49 dollars per month, but providing further features like Git-backed revisions, micro-transactions as well as direct chat support. In the "Enterprise" tier, costing 499 dollars per month, you get everything from the previous tiers, with additions of things like match history, premium support, and the ability to use external scripts. As such, it is not necessary to spend money on Dulst, as all features for creating and playing card games exist in the "Free" tier.

**Support** For support, the "Free" tier of Dulst does not give users access to direct support at Dulst, though there are public emails for the overall team behind the platform. The platform has a broad wiki, which documents the many things you can do in Dulst, from changing cards and



themes to managing effects. There is also a thorough tutorial for those starting to develop their first game with Dulst. This tutorial is based on an already existing game (with a very specific Hearthstone-inspired ruleset), and there is seemingly no tutorial for creating a game completely from scratch. The forum features can be used for technical support.

### 2.1.2 Card Game Simulator

#### ABSTRACT

Card Game Simulator lets users develop and play card games, with a simple feature set to support this development. It is possible to use the platform on both mobile and desktop devices, and the platform does not have a large community. It is completely free to use Card Game Simulator, and they only collect information during email correspondence and platform crashes, and no information about users is collected under other circumstances.

Card Game Simulator is a platform for developing, sharing, and playing card games on multiple platforms. It is found at <https://www.cardgamesimulator.com/>.

**Features** On features, Card Game Simulator is quite sparse, with features primarily for developing a card game and then updating it. There are features for game management, where especially the ability to import custom card games from a web URL is nice. This means you can just upload your files to a web server. Further, the deck editor is a simple visual way to create and edit decks. It is worth noting, that Card Game Simulator does not quite have the level of refinement of other platforms, for example with a somewhat crude user interface. Generally, at the time of writing, it is a lightweight service which has very few features that are not necessary.

**Privacy** Card Game Simulator collects no information from visitors of the site, nor do they use cookies. Furthermore, they do not have Google AdSense or third-party behavioral tracking. They describe that they only collect information as part of email correspondence or when an exception/crash happens in the app.

**Technology** Regarding technology, Card Game Simulator uses a number of technologies. The platform itself is built with Unity, a cross-platform game engine. The platform can be used on a computer, via either the Steam service (a platform for buying and playing games), Mac App Store or an experimental build on GitHub Pages for web browser access. It is also possible to download Card Game Simulator on the Google Play and iOS App Stores to play games on the phone. Card Game Simulator is also hosted on GitHub (a platform for managing versions of digital platforms' code), where it is possible to see the code. The roadmap for the platform is also available, where it is possible to see the many technologies, which the developers want to implement. The AutoUpdate feature uses a URL to point to a JSON file, which is used to generate a folder — game developers can create their own JSON and validate them against schema (a specific structure of a JSON file) available on the website.

**Community** The community aspect of Card Game Simulator is visible on the social medias Discord (which facilitates chat between community members), Reddit, and Twitter. The Discord

channel currently (February 2023) has 90 members, which is not many. As such, interacting with the community and gaining access to this will be challenging, when so few members are available. It is possible to engage with the community by contributing to the project, presumably through the public GitHub repository.

**Pricing** Card Game Simulator is completely free, and the roadmap does not suggest any changes to this.

**Support** To get support for the platform, there is a wiki for the platform hosted with the associated GitHub repository. Furthermore, there is specific documentation for those wanting to develop custom games with the platform. Bugs (technical issues with the platform) can be reported on the Discord channel (and probably other social media platforms).

### 2.1.3 Tabletop Simulator

#### ABSTRACT

The platform Tabletop Simulator provides an environment for developing full-fledged tabletop games. Development and play happen in a desktop application, and many multiplayer features are available here. There are also physics simulation features to let users interact with board pieces and cards similarly to real life. The community of Tabletop Simulator is situated on the game distribution service Steam, where the platform costs 19.99 euros to buy — both players and developers have to buy the game.

Tabletop Simulator is a platform for developing tabletop games with a standalone desktop application. It is located at <https://www.tabletopsimulator.com>.

**Features** The features of Tabletop Simulator are reflected in its name, as these are provided to do more than just card games. One feature of tabletops is that of colliding and interacting objects through physics, for example with the game pieces. This is further implemented with gestures, for example in shaking and throwing dice rather than just clicking. Multiplayer features are also heavily prioritised, with up to 10 players at a table and hotseat modes for playing locally on one computer.

**Privacy** Tabletop Simulator has a detailed privacy policy. They collect information provided through social networks (for example Facebook and LinkedIn), both from directly provided information, as well as information through social networks based on privacy settings on these networks. Information based on the use of services provided by Tabletop Simulator is also collected, including device information (hardware model, operating system, etc.), personal information (though only email is necessary), and log information (navigation paths, search queries, etc.). They use aggregated and demographic information to support advertising, though third parties do not have access to personally identifiable information without consent. They do not actively collect data on children under 13. Data is stored and processed in the United States.

**Technology** The platform can be used through Steam on the operating systems Windows, macOS, Linux, as well as SteamOS. It also supports Steam Workshop integration, so you can both create, upload, and download community-made assets for a tabletop game, as well as import 3D models. The platform also supports scripting with the Lua programming language (accessible with an in-game Lua editor), which has been used to customise and modify existing platforms. Further, virtual reality support is under development, with the Vive and Rift headsets currently supported. There is also the possibility of creating user interface elements with XML, which is a popular markup language (for example used by the Android development framework).

**Community** The community aspects of Tabletop Simulator seem quite prominent, with a total of over 57,000 reviews (as of February 2023) on Steam — this seems to signify a large base of people invested in the platform. It is possible to leave feedback for the developers with a feature on the website, as well as creating discussions on the game's Steam page. Further, there is a Discord channel with over 78,000 members (February 2023, further cementing the popularity of the platform. The platform includes a global chat connecting everybody playing Tabletop Simulator at a given time, which is governed by a set of global chat rules.

**Pricing** The price of Tabletop Simulator is 19.99 euros on the game distribution service Steam for the basic game for one person, with the 4-pack option with 4 licenses for the platform costing 54.99 euros — thus, you need to buy the program to play games built on the platform. Further, it is possible to buy downloadable content (DLC) to further expand the game on Steam, with different board games being accessible by buying specific packages of DLC.

**Support** Support for Tabletop Simulator can be found in the extensive knowledge base, which contains guides for a lot of things to do using the platform. There are also video tutorials published by the developers.

#### 2.1.4 Tabletopia

##### ABSTRACT

Tabletopia provides users the ability to create and play board games, including licensed board games, on a website. Game development requires an account with the platform, and implements a number of features for automation (like turn tracking) as well as pre-made game pieces. Tabletopia is cross-platform, and can be used with Steam, a web browser, as well as iOS and Google Play app stores. For support, there is a number of video tutorials, as well as articles covering best practices of game development.

Tabletopia is a multi-platform environment for playing board games, also licensed ones. It can be found at <https://tabletopia.com/>.

**Features** Tabletopia's features are focused on the tabletop experience. Specifically, there are lots of automated features like turn and phase tracking, as well as custom camera controls. It is possible to play games both solo, as well as multiplayer, with multiplayer being enabled through both online and hotseat multiplayer. To create a game, you have to create an account, and

some games require you to have a premium account. There are many objects already existing (dice, chess pieces, etc.) which can be used for games. An interesting feature is that of different modes for determining the winner, which might be relevant for our game, seeing as it has different game modes. Different platforms also offer different features, with Steam offering DLC and the premium plan.

**Privacy** Regarding privacy, Tabletopia collects some personally identifiable information in accordance with the European Union's General Data Protection Regulation (GDPR), but also usage data, such as traffic data or in-game activity. The platform uses cookies for Google Analytics, cookies from Twitter, Facebook, and YouTube, as well as cookies for authentication. Non-personally identifiable information may be provided to third parties. Tabletopia does not allow third-party behavioural tracking. They have a specific page for how they manage GDPR, describing how they act as a data controller.

**Technology** The Tabletopia team lets you use their widget module to show games on external websites. This widget is inserted into the HTML of a website. You can play games in the web browser, with Steam, iOS App Store or Google Play, making it cross-platform.

**Community** Tabletopia's community seems pretty, active with "Secret Hitler" having the most collective playtime (as of February 2023) on the platform with 169,000 hours playtime. This is further reflected in the fact that many of the platform's games are large licensed games, like "Secret Hitler", "Wingspan", and the Danish game "Det Dårige Selskab".

**Pricing** The pricing of Tabletopia depends on the groups of players and designers. Players have the tiers "Bronze", which is free and provides 2 simultaneous game sessions; "Silver" costs 5 dollars per month and provides 10 simultaneous sessions and premium games; "Gold" costs 19 dollars per month, providing 10 simultaneous game sessions, premium games, and guests in premium games. For designers "Workshop BASIC" is free, but limits both media used in games and amount of games created; "Workshop ADVANCED" costs 10 dollars per month and gives access to more games and multimedia features; "Workshop PRO" costs 20 dollars per month and provides all multimedia features as well as many more games and setups. It costs 300 dollars to get the Tabletopia team to fully import a game, rather than doing it yourself.

**Support** Tabletopia's support has multiple video tutorials for creating games. Uniquely, they have a number of articles related to how to create games and user experiences on the platforms, which include topics like usability guides and game promotion. Furthermore, their knowledge base covers creating games, playing games, Tabletopia partnerships, and account settings.

### 2.1.5 Screentop

#### ABSTRACT

Screentop provides an online platform for creating and playing board games, which is still quite small in terms of game selection and number of players. The platform is completely free, but track some personal and usage data. When developing games, developers retain all rights to the Screentop-game, and development is focused on dragging and dropping different types of objects. There are few premade elements, and instead the platform provides broad categories like “tiles” for developers to utilise and implement themselves, for example using “tiles” as cards. Further, the gameplay is fully sandbox-style, meaning players themselves have to enforce the rules.

Screentop is an online platform for creating board games, which is found on <https://screentop.gg/>.

**Features** Screentop has features for creating different types of components, as well as linking these together in different ways. Relevant to note is that the concepts for creating components and placing them in the room are “broad”, as in they can manage both cards, dice, mats, etc. Another relevant feature is that of assets, where images are placed in a sheet of rows and columns (divided evenly), which is important for our game, so that you do not have to create individual cards, but instead can just upload all cards as a sheet to be divided up. You can create rooms for playing games, where they will expire after two days — for longer play sessions, one can “star” rooms. There is also features for revisions of games. It is possible to share a game with other users and give them specific permissions, specifically designers, testers, and players. Games can also be both private and public. It is also possible to create games collaboratively. There seems to be no automation of any kind, meaning any rules and flows need to be maintained by the players themselves.

**Privacy** For privacy, Screentop collects personal data (like email and name), usage data (like IP address or browser version) and tracking and cookies data. They use third party companies, specifically Google Analytics to monitor the use of Screentop. As creator, you retain the rights to your Screentop-game fully and can delete them at any time.

**Technology** Technologically, it is possible to use Markdown, a language for formatting text, for creating the page for a game. When editing games, it is possible to write JavaScript (a core programming language used on the internet) to build update entities in a game. Entities are represented using the notation format JSON.

**Community** The community aspect of Tabletopia is seen with 621 members of a Discord channel and 208 Twitter followers (as of February 2023 for both). Thus, it is not that large of a community. The game list also does not seem that large (with 41 games in February 2023). Some games are commercial games, like “Earth Rising”, though none immediately recognisable.

**Pricing** Regarding pricing, Screentop is completely free to use, both for playing and creating games (as of February 2023). However, there are plans to add premium plans as a support for ongoing development efforts.

**Support** For support, Screenshot has a "Learn" section. There is a number of tutorials, with a beginner tutorial for creating a card game from the beginning — this one is very relevant for our card game.

### 2.1.6 Boardgame Lab

#### ABSTRACT

The platform Boardgame Lab is a platform still in development, which supports prototyping and playtesting tabletop games. It requires no coding to develop games, and it is possible to use spreadsheets to quickly create and prototype components in a game. Developers can use Boardgame Lab in a sandbox-mode or with full rules enforcement, and bots provide an easy way to test, and a visual editor lets developers create games. To use the platform, an email address is necessary to sign up for a preview.

Boardgame Lab is an in-development platform for prototyping and playtesting games on tabletops. It can be seen at <https://boardgamelab.app/>.

**Features** Features of Boardgame Lab are not the most extensive, since the game is still in development — as such, you can only access a preview. There is the possibility of using bots that can play the game automatically. Games can be played in sandbox-style (meaning players can freely act on the tabletop) with no enforced rules or with rules enforced fully by the platform. It is possible to give players different roles with different rules. The user interface is very sleek and minimal. There is a visual editor for creating the board of a game, as well as a visual editor for different rules. There is a feature for wiping the data.

**Privacy** The privacy aspect of Boardgame Lab concerns their collection of personal information, which is not shared publicly or with third parties.

**Technology** Regarding technology, the preview of Boardgame Lab saves game data in the LocalStorage of the user's browser, where data is stored in the browser with no expiration date. The implemented version will use cloud storage, where data is stored by a third party. There is a debug console in the game creation mode.

**Community** Regarding community, there are 414 Twitter followers and 399 Discord channel members (both from February 2023). This seems to imply a somewhat small community.

**Pricing** The price of Boardgame Lab is currently free by providing an email address, so that one can be signed up for a preview and a mailing list.

**Support** For support, there are tutorials for prototyping and playtesting. Further, there are guides for the many different aspects of creating a guide, also with a short reference guide for containers and cards/tiles. Bugs and feature requests are supposed to be posted in the Discord channel.

### 2.1.7 Enterprise Game Stack

#### ABSTRACT

Enterprise Game Stack provides access to a set of two games which support organisational processes. The platform is relatively new (founded in 2021), and can be primarily read about in blog posts. They provide either a role-playing game or a card sorting game, both of which can be customised by the platform's customers to suit their organisation's needs. The enterprise nature of the platform entails a steep price, with the cheapest option of a one-time event being 2,500 dollars.

Enterprise Game Stack is a service concerned with developing games to support processes inside of organisations. It is found at <https://www.enterprisegamestack.com/>.

**Features** The features of the platform are centered around two different game types. Their role-play game focuses on communication, and users are provided a number of templates for role-playing games (as well as card templates), with the added functionality of creating cards from scratch. Card content can be managed via Excel sheets. They also have a card sorting game, which also has templates for games. They are describing a number of AI features as “coming soon”, including analytics tagging and generating game scenarios based on answers to questions. All games are created for remote use with the platform.

**Privacy** With regards to privacy, it is difficult to read anything about it, as they have a line about it on the website without any text or links.

**Technology** Enterprise Game Stack's technology is not really clear, apart from their website using HTML, CSS, and JavaScript (which does not really say a lot considering they are implemented in nearly everything used on the internet).

**Community** The community aspect of Enterprise Game Stack can be seen with the platform's use of blogs, where different aspects of games of learning and development are written about. They have four Twitter followers and 121 LinkedIn followers (as of February 2023) — while this seems to imply a small company with a small following, the company (according to LinkedIn) was also founded in 2021.

**Pricing** Pricing-wise, the platform is one focused on delivering enterprise solutions, which is reflected in the pricings. A “One-Time Game Event” costs 2,500 dollars per event, a “6-Month Access Pass” is 12,000 dollars for 6 months, and an “Annual Access Pass” requires personal contact to get a price. These different options provide different levels of assistance and numbers of players, though these are much higher than small platforms — for a “One-Time Game Event”, 1,000 players can be involved. This pricing also means that it is not really feasible to demo the game before really using it.

**Support** On support, the platform provides the opportunity to schedule demos to understand if the game is relevant. There is also assistance for game creation, though the amounts of this varies depending on the chosen pricing plan.

### 2.1.8 PlayingCards.io

#### ABSTRACT

PlayingCards.io is a virtual tabletop platform, where users can develop and play tabletop games, providing live synchronisation for multiplayer games. It further uses sandbox-style play with no rules, and there is no chat feature in the game. However, there are features for automating certain tasks. PlayingCards.io is cross-platform for both desktop and mobile devices, though text can be hard to read on smartphones. The platform seems specifically optimised for traditional 52-card games, and many of the example games adhere to this.

PlayingCards.io is a digital platform on the web to facilitate playing online card games. It is located at <https://playingcards.io/>.

**Features** Regarding features, the platform primarily focuses on providing a visual interface with which to play online card games with. The virtual tabletop has live synchronisation between players, meaning all movements should be seen at the same time by all players. The platform does not implement rules, and thus requires players to enforce rules themselves — further, there is no chat feature of any kind. It is possible to import games from “.pcio”-files. The platform also provides a number of default card games like “Go Fish”. They have a neat feature with “Automation Buttons”, which allow users to use a graphical element of a button to do repetitive actions in a game, for example shuffling cards. Decks can be filled using CSV-files. There is also a visual editor of cards on the platform, so creating custom cards can be done inside PlayingCards.io. Rooms can be created, so private games can be joined via a room code entered on the platform — rooms created without an account are deleted after 2 weeks of inactivity, while those with an account are deleted after a month of inactivity. They do not have the feature of turning cards sideways, and they describe this as an example of special movements that cannot be done on the platform. This might signify that the platform is optimised specifically for traditional 52-card games.

**Privacy** PlayingCards.io’s privacy policy is very detailed, describing what information they collect and how they manage it. They automatically collect some data like IP address and device characteristics, as well as log and usage data related to interactions when using PlayingCards.io. They share data with the categories of ad networks, data analytics services, and payment processors. Their privacy policy regarding minors differs from others cited in this report, as they specifically cite not collecting data from minors under 18 (rather than the usual 13) years of age.

**Technology** The platform uses a good amount of open-source technology, for example IBM’s Design Icons. Further, they provide access to their entire file of licenses (which for some, like MIT, is already mandatory), so it is possible to see where different parts of the platform are sourced from. They employ the file extension “.pcio”, which seems to be a proprietary format for storing games created on the platform. The platform is only available in a web browser, and while it can then be played on both computer, tablet, and phone, they describe the text as possibly hard to read on phone screens.



**Community** The community surrounding PlayingCards.io does not seem that extensive. On Facebook, they have 105 likes, while their Twitter has 2,059 followers (as of February 2023). As of writing this, the latest posts on both platforms are from April 2022, signifying that the community aspects of the platform might not be heavily prioritised.

**Pricing** For pricing, they describe a monthly description with features like non-expiring rooms and admin controls. Even though it was supposed to be implemented in 2022, it does not seem to be available, even after logging an and looking at your account.

**Support** Regarding support, the platform provides both guides, as well as documentation relevant for customising creating, customising, and playing games. It is also possible to email the platform — the email cited seems like a personal email, which could mean there is not a large team to handle support.

## 2.2 Game Engines and Tools

In the category "Game Engines and Tools", the reviewed platforms focus on giving users the ability to write code for game development. Specifically, they do not provide the ready-made tabletops and game objects like that of the "Virtual Tabletops" platforms, instead requiring users to define much of this themselves.

These platforms further do not provide the technical infrastructure to let players access developed games. For example, by developing a game with a game engine, it may be necessary for developers to already maintain a website in which the game can be embedded, to support online access.

### 2.2.1 Boardgame.io

#### ABSTRACT

The game engine Boardgame.io provides game developers with the ability to write code for all parts of a boardgame. It is feature-rich, providing the ability to program bots, multiplayer, game logs, move simulation, and much more. The engine requires writing JavaScript, both the plain variety and the popular library React. It is a free, open-source engine, and there seems no signs that this will change. There are also a number of tutorials and guides freely available.

Boardgame.io is an open-source game engine for turn-based games, which can be found at <https://boardgame.io/>.

**Features** Features in the platform are very extensive. There is multiplayer, AI bots, lobbying features, move simulation for prototyping, and game logs for viewing a game board at earlier states. An interesting feature is that of the Debug Panel — the engine will render this panel even without a user interface implemented, which means it is still possible to play the board game developed.

**Privacy** Regarding privacy, it is not clear which privacy policy either the game engine or the website employs.

**Technology** Technologically, the game engine uses the MIT license, which is very permissive for use and distribution of projects using Boardgame.io. The engine uses NodeJs to handle server-side work in web applications. It is possible to implement the game engine and user interfaces using both plain JavaScript as well as the library React. This means the engine can be implemented with very popular and (probably) stable languages, though it also means we are dependent on a good amount of programming knowledge.

**Community** The community surrounding Boardgame.io consists of 8 individuals which have donated to the development of Boardgame.io (as of February 2023). There are a number of projects developed using the platform, which can be seen online, which include both other games and clients for using Boardgame.io in other frameworks.

**Pricing** For pricing, all payments seem to be completely optional, i.e., through donations. The open-source nature of the game engine supports this, and so the acquisition of the game engine should be a very cheap endeavor.

**Support** Regarding support, there are extensive guides and several tutorials. These cover both creating games, adding features, and the more foundational stuff like setting up a development environment. The tutorials also provide examples (when applicable) for implementing the game engine using both plain JavaScript and React. There is a GitHub which can serve as insights into the code, and which also shows that the engine is being updated quite frequently.

### 2.2.2 nanDECK

#### ABSTRACT

nanDECK is a software, which aids game developers by providing an application for developing decks of cards. It is possible to edit cards visually, but all cards are transformed into lines of code, which can be manipulated. The platform provides features for printing and testing cards, as well as automated features like a wizard for quickly creating decks. The software requires no installation, and it is completely free for use. The website uses Wordpress, which would entail that it uses their privacy policies.

nanDECK is a piece of software for supporting the process of developing decks of cards. It uses the website <https://www.nandeck.com/>.

**Features** nanDECK's features are found in its desktop software. There is a visual editor for adding card elements, and the possibility to edit cards as code — the visual editor will create cards as code, so both possibilities are combined. Many file formats are supported, including the classic .jpg-format for pictures, but also the possibility to read data from Excel-files. Further, there are virtual tables for playtesting, as well as options for creating dice that can be rolled. It is possible to use scripts to help with automatically updating multiple cards at once. The platform's

deck wizard helps create decks from the bottom-up based on a number of predefined features like size and contents. The user interface could be difficult to get used to, as there are a lot of options, and some of them quite technical for non-technical users.

**Privacy** The privacy policy of nanDECK is not made clear on the website for the platform. It is also not shown in the desktop program. It would be relevant to assume that the site assumes the same privacy policies as other sites made with WordPress. This entails automatic collection of data with cookies, non-personally identifying information in the browser (like language preferences or browser type), as well as some personally identifying information like IP address.

**Technology** The platform's website uses WordPress as its content management system, while the actual software is a program that runs on a computer desktop. The software runs on Windows without any further installation, but to run it on OSX or Linux, one needs to install WINE, which can let Windows applications run on non-Windows computers. Scripts are used for updating multiple cards at once.

**Community** The community of nanDECK can be found on Discord, where (as of February 2023) there are 143 members, and a Facebook page with 50 likes (also February 2023). They also have a guild (i.e. discussion group) on the BoardGameGeek website with 809 members, where there is some discussion — for example, 11 posts between 15th of February and 1st of March.

**Pricing** The platform costs nothing to use, and there are no limitations on the free use of the platform. It is possible to support the platform with Patreon and Paypal donations.

**Support** As for support, it seems the Discord server and BoardGameGeek guild are often used for getting questions answered, as well with people posting the code for different things. There is no clear way to get in touch with the developer(s) of nanDECK.

### 2.2.3 Tabloro

#### ABSTRACT

Tabloro is software that enables developers to create board and card games to be played in the browser, using different programming frameworks and libraries, and thus requiring users to program. The platform is free, and can be downloaded from GitHub, though the support through GitHub for things like reports of issues with the platform seems limited. Tabloro can run on PCs, Macs, tablets, and smartphones, and they provide video and audio chat features. Board game tiles can also be scanned and uploaded to the platform.

Tabloro is a piece of open-source software for playing online board games in the browser, and it is found at <https://github.com/fyyyyy/tabloro>.

**Features** Tabloro's features are plentiful, for example with the ability to run Tabloro on Macs, PCs, tablets, and smartphones. There is in-built video and audio chat, and it is possible to scan and upload your own board game tiles, so you can play these with others.

**Privacy** Regarding privacy, the requirement of downloading the code's repository to your own device seems to imply that little data is collected.

**Technology** Technologically, Tabloro several different frameworks and libraries to deliver the right functionality for the code written with it. These include NodeJS and Express (to get requests from users to deliver information and deliver that information), MongoDB (to save information), Phaser (to support features for developing games), and PeerJS (to create video and audio chat between players). The platform uses the MIT license, which permits use, modification, and sharing (among others) of the platform. Tabloro also primary uses JavaScript, so it requires some knowledge of how to program and use JavaScript. It has not been possible to locate the website of Tabloro.

**Community** The community surrounding Tabloro is not that large. The Facebook page has 206 likes (as of March 2023), but the last post is from October 2015. The GitHub has 15 contributors (of March 2023). This seems to signify quite a small community around Tabloro, with the last commit of code to the GitHub repository (of March 2023) being 17th of November 2022, which is somewhat recent. The use of peer-to-peer video and audio chat means that users do not chat using a server, and that seems to imply that information shared on these chats will be kept private and secure.

**Pricing** For pricing, the platform is completely free, and seems to require only forking the GitHub repository of code (i.e. downloading the code to your own computer) to start development.

**Support** Regarding support, it is not clear whether any support is available. It is possible to open issues that need to be resolved on the project's GitHub page, but there are 6 open issues (as of March 2023), so it is not clear how seriously these issues are used. Due to the little activity on the platform's Facebook page it does not seem like that is a relevant avenue for support.

## 2.2.4 GameMaker

### ABSTRACT

GameMaker is a popular platform for developing all sorts of games, including card games. It is a desktop application for developing games using code (similar to JavaScript) and/or visual programming, with intricate setups possible. The platform provides a means for both developing and publishing games, with further options for publishing expanded with paid subscriptions. GameMaker's large community provides much support, and the publicity of GameMaker is seen from the many popular games developed using the platform.

GameMaker is a development tool for making 2D games. The website for GameMaker is <https://gamemaker.io/>.

**Features** GameMaker provides users a large number of features, which are focused on all aspects of game development. The programming language GML (see below) can be used both as writing traditional code, but also using the visual implementation of GML Visual, where flowcharts are used to visually script, rather than type code. The marketplace on GameMaker also provides the possibility to download (and buy) extensions and resources for games. There is a visual editor for objects being developed and used in a specific game, and there are also certain visual effects that can be applied, for example blur. When developing games there is a feature for debugging and finding issues with the code, as well as a feature to run games directly in the development environment. There is a very large number of possible actions to program in games (too many to describe here), and they cover both programming-specific things like data structures, audiovisual things like playing sounds, as well as control features like mouse movements — in short, everything relevant for developing a game. Users can publish games directly to the online GX.games platform inside of the development environment.

**Privacy** GameMaker's privacy policy describes that they collect potentially personally identifiable information like names, home addresses and email addresses. They also collect information about devices used for accessing GameMaker services, as well as data related to usage of the service. They collect information through cookies, of which they provide an extensive overview of used cookies on their website. They may use cookies from third parties, for example regarding data collection for Google Analytics. They may share their collected with third parties.

**Technology** GameMaker uses multiple technologies, most notably GML (short for GameMaker Language), which is the programming language used for developing games with GameMaker. Writing GML code uses a similar syntax like the very popular JavaScript, which means the language should be easy to pick up. The platform uses a desktop application as the development environment, which requires installation. The development environment is written in C# and C++, both very popular programming languages. It is possible to use the GX.games platform for publishing games, which is the only option for users on the "Free" tier.

**Community** A large community has formed around GameMaker. They have 256,000 likes on Facebook and 90,800 followers on Twitter (both as of March 2023), a large community compared to many other platforms described in this report. There is also a forum hosted by the GameMaker platform itself, where it is possible to get support, as well as discuss the many aspects of GameMaker.

**Pricing** Regarding pricing, the platform provides 4 tiers of pricing. The "Free" tier provides the GameMaker software, as well as the opportunity to export created games to the online platform GX.games. "Creator" costs 31.5 DKK a month and adds to the functionality of the "Free" tier with the option to publish games to desktop as well, meaning no website is necessary to play games, also adding monthly asset bundles and beta release functions. The "Indie" option costs 62.99 DKK per month and adds web exports and mobile exports of games as features. Finally, the

"Enterprise" tier is 499.99 DKK a month and provides console exports of games for PlayStation 4 and 5, Xbox One and Series X, as well as Nintendo Switch. An important thing to note is that no matter the tier, there is always unlimited access to the GameMaker environment.

**Support** For support, the forum of GameMaker is relevant for help with GameMaker and associated issues. They have an extensive collection of guides and tutorials in their help center and manuals, and they cover both development and release of games, as well as more general use of the platform. Tutorials are also sorted into different difficulty levels of "Beginner", "Intermediate", and "Advanced". It is possible to contact the team behind GameMaker and report bugs, request features and more. Furthermore, they have a roadmap which shows the things that are being developed for the platform.

## Chapter 3

# Reflections on Choosing a Digital Card Game Platform

After the investigation presented in chapter 2, as well as many discussions, we tested game development in the platforms Screenshot, Dulst, GameMaker, and Tabletopia, as we deemed these to be a likely subset of the 12 platforms to be used. We ended up choosing Screenshot as our digital card game platform.

In this section, we detail some of the aspects we considered when having to choose the final digital card game platform, which we could use to implement a digital version of Pluri-Cards. These considerations can serve as inspiration for other designers aiming to digitalise card games.

### 3.1 Scaling with Changing Employment

Throughout this investigation, it became clear that a number of the identified platforms required extensive experience with games and digital technologies. For example, platforms providing advanced rule enforcement and physics may require coding in several programming languages, some proprietary.

We researchers leading the digitalisation (Jacob Lindholm Nørgaard and Victor Vadmand Jensen) have a large amount of experience with both physical and digital games, digital platforms, as well as programming. Due to the nature of our contracts as research assistant and student assistant respectively, our positions in the project were set to end summer 2023. Thus, we were aware that the future use of the digital platform and further digital development would have to be undertaken by someone else than us. This led us to consider how we could ensure that future employment would not be severely restricted, e.g., hiring software engineers with experience in JavaScript.

Specifically, Dulst and GameMaker were platforms that made us concerned about this. The many features for games on these platforms are implemented using different programming languages and constructs. Thus, it would be reasonable to assume that future game development with these platforms would require training with these specific platforms without the support of the original developers. This is even more apparent with Boardgame.io and Tabloro which require programming web applications. Therefore, we wanted to prioritize platforms that did

not require experience with things like programming, so that the development could scale with changing employment at TECH4SDT.

### 3.2 Fidelity of the Platform

In investigating the presented digital card game platforms, we encountered many ways to present and play card games. Some were very visually polished, for example regarding well-established platforms like GameMaker, while others were not as visually appealing, for example the less known Tabletopia. Other platforms, for example Boardgame Lab, were still early in development at the time of investigation.

Thus, it became clear to us that the concept of “fidelity” of the chosen digital card game platform was central, with platforms exhibiting both conceptual and physical fidelity (terms used by David Benyon about system design in “Designing Interactive Systems”). Conceptual fidelity concerns how established the fundamental concept of a platform is, i.e. is the core functionality of the platform established? Physical fidelity concerns how visually streamlined the platform’s user interface is, i.e. does the platform have a visually appealing user interface with a coherent visual structure? The digital card game platforms were to be used both for digitalising the card game but also for playing by persons not affiliated with TECH4SDT. Thus, we wanted a digital card game platform with both high conceptual and physical fidelity, meaning the final platform should not change drastically in concept, and it should be visually appealing and streamlined.

In light of these considerations on platform fidelity, a number of platforms could be disregarded. One example regarding limited conceptual fidelity is that of Boardgame Lab. At the time of investigation, the platform was early in development, providing only a preview of the platform. Thus, it was not clear what features the platform would provide in the end, and we were concerned that this might deviate from our ambitions with the card game digitalisation. Physical fidelity was a concerning aspect for other platforms, for example with Tabletopia’s quite informal and flashy user interface. In the other end of the spectrum, nanDECK’s user interface provides a great many options that all look very similar, with a style visually reminiscent of operating system interfaces like on Windows. Therefore, we wanted to prioritize platforms that could provide high levels of both conceptual and physical fidelity.

### 3.3 Choosing a Platform During Game Design

When we began this investigation of digital card game platforms, the purpose of the game was shifting. When PluriCards was first conceptualized, it was meant just as much as a design tool as a competitive card game. However, this focus shifted, meaning the relevant digital card game platforms would shift as well.

As such, we realized that any given platform had to be flexible enough to accommodate the conceptual changes in PluriCards. This would ensure that we would not have to change digital card game platform every time there was a shift in the card game concept. Furthermore, such flexibility could aid us in prototyping the game, as a flexible platform could in quickly trying out name ideas and mechanics.

For example, a platform like GameMaker would be very relevant for the game-focused digitalised version of the card game but might lock us into developing game mechanics for the game



while these were uncertain. Similarly, Enterprise Game Stack only provides two game formats – if we were to change the game format (which became relevant), it would thus be problematic to be locked into Enterprise Game Stack. Instead, platforms like Screentop and PlayingCards.io provided sandbox-style environments which were appropriate for experimentation.

### 3.4 Technical Conditions for Design Cards

Due to the described gradual shift in game focus, we ended up with an card game closely aligned to design card sets like the [AI Ideation Card Deck](#) or the [Tiles IoT Inventor Toolkit](#), rather than a purely educational card game as originally planned. As such, it became more of an ideation and design tool for the players, rather than a game for education alone. The game's role as a TECH4SDT tool then also became that of enabling discussions of not just what sustainability entails between center members, but also of finding appropriate, interdisciplinary approaches for sustainability.

With this in mind, we had to consider what the technical conditions for design cards are. Design cards and similar tools are intended to be open-ended and provide users with the ability to discuss and debate. Traditional card games entail a set of rules to be enforced and a set of mechanics not to be deviated from. While design cards do have mechanics and rules, these are often much less strictly enforced, and mostly used to the extent that they provide the space for discussion and reflection. Further, fully-fledged games entail a polished visual presentation, which can appeal to casual and dedicated players alike. While the aforementioned design games do provide high visual fidelity, this is often not a primary goal of design card development.

As such, we were aware that it would probably not be necessary to choose a digital card game platform with features relevant for developing fully fledged production-grade card games. The strict rule enforcement of platforms like Dulst would simply not be necessary, and it might perhaps be detrimental for us to have to adhere to this due to the nature of the game. Further, the guided nature of design cards became apparent when we implemented a facilitator in the game, and they could thus manage rule enforcement. However, this also entailed that a sandbox-style environment like that of Tabletop Simulator or Screentop would be a relevant feature in the platform, as this could support the more open-ended nature of design cards.

### 3.5 Providing Player Access

An important ambition in digitalising Pluricards was to provide players the opportunity to play and collaborate remotely. This aspect though required us to facilitate access to the digital card game platform. This is seemingly obvious for a physical card game — if we want to get players to use it, we will have to bring it to the players. However, for a digital platform, it is possible to provide the digital card game without giving players the resources to access it. Therefore, we wanted to ensure that players had easy access to play the game and collaborate without us researchers intervening.

Firstly, this made us focus on platforms, which did not require users to pay to play games with the platform. For example, while games on Tabletop Simulator may be played without payment, the program itself has to be paid for. Thus, we would either come to exclude players who did not have access to Tabletop Simulator (or resources to gain access), or we would have to

provide this access ourselves. The former would exclude possible players and primarily enable us to engage with well-off players, while the latter would require investments from TECH4SDT in buying the platform. Secondly, we also wanted to ensure that players did not have to install software unknown to them.

This prompted us to aim for primarily the web-based platforms available in our list of digital card game platforms. As such, the platform Tabletop Simulator was excluded. Furthermore, the free distribution option for GameMaker (which distributes games via the online platform GX.games) requires users to install Opera GX, a browser for games. As such, we could also exclude this platform. We were inclined to focus on platforms like PlayingCards.io or Screenshot, as they run a game totally in-browser, while letting players use room codes as their way of accessing a game.