
care, judgment, dexterity

# *CRAEFT*

# Toys and games for informal craft education

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# Executive summary

The education sector is continually seeking innovative methods to engage learners and effectively impart knowledge. One promising approach is utilizing games—both digital and physical—to teach traditional crafts. These crafts, representing a vast array of skills and knowledge handed down through generations, are vital to cultural heritage. Games can play a crucial role in preserving and promoting these crafts by leveraging their interactive and engaging nature.

Digital games for traditional crafts fall into two main categories: craft simulators and simpler web-based games. Craft simulators offer a virtual environment where players can practice traditional craft techniques without needing physical materials, providing an immersive learning experience. Simpler web-based games, such as quizzes and 2D puzzles, test and reinforce players' knowledge of traditional crafts through engaging challenges.

Physical games add another layer of interaction by using downloadable and 3D-printable designs. These games offer hands-on experiences, allowing learners to engage with materials and tools akin to those used in traditional crafts, thereby enhancing their understanding and skills through tangible interaction.

Hybrid games combine digital and physical elements to create a comprehensive learning experience. These games might feature a digital tutorial paired with physical materials printed on a 3D printer, merging virtual learning with real-world application. This approach offers a multifaceted way to educate individuals about traditional crafts, making the learning process both engaging and effective.

This deliverable aims to investigate the potential of digital, physical, and hybrid games in teaching traditional crafts. By examining the background of serious games and analyzing Craeft's methods of integrating traditional crafts into educational games, we provide insights into the design and implementation of these innovative learning tools. This deliverable highlights how technology can be effectively utilized to preserve and promote cultural heritage through engaging educational games.

Three directions are explored in this deliverable the first regards the implementation of digital craft-inspired games. The second regards the creation of educational content that can assist the implementation of such games. The third regards research on existing internet-based resources that can be exploited for the implementation of such games.

The rest of the deliverable is structured as follows:

In Section 2, we established a comprehensive understanding of serious games, highlighting their evolution and the multifaceted educational advantages they offer. By categorizing serious games into digital, physical, and hybrid types, we demonstrated the diverse approaches available for traditional crafts education, each with unique strengths in fostering hands-on skills and cognitive development.

In Section 3, we present Craeft's approach, a systematic methodology, which emphasizes generating valuable knowledge and data about crafts, simplifying complex techniques, and translating them into engaging game formats. This approach not only facilitates the learning process but also ensures the accurate transmission of traditional craft knowledge to new generations.

In Section 4, we present digital games such as "The Pottery Workshop" and "The Jewellery Box" illustrating the immersive and interactive potential of digital platforms. These games offer learners an opportunity to engage deeply with craft techniques in a virtual environment, making traditional skills more accessible and appealing.

In Section 5, 3D-printed physical games are presented to highlight the innovative use of modern technology to create tangible educational tools. Detailed instructions on finding, printing, and assembling 3D-printed loom designs and pottery accessories provide a practical guide for educators and learners alike. The inclusion of various loom types and pottery tools emphasizes the versatility and adaptability of 3D printing in supporting diverse educational activities.

In Section 6, hands-on learning experiences are presented, focusing on improvised loom techniques using everyday materials such as chairs, cardboard, and plastic plates. These activities demonstrate that effective craft education does not necessarily require sophisticated tools, and creativity can thrive with simple, readily available resources.

The deliverable closes with a Section on conclusions (7).

# Document history

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# Abbreviations

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| **2D** | Two dimensional |
| **3D** | Three dimensional |
| **ABS** | Acrylonitrile Butadiene Styrene |
| **AR** | Augmented Reality |
| **CH** | Cultural Heritage |
| **PLA** | Polylactic Acid |
| **STL** | Standard Triangle Language |
| **VR** | Virtual Reality |

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# 1. Introduction

In the rapidly evolving landscape of education, innovative methods are continuously being explored to engage learners and impart knowledge effectively. One such promising approach is the use of games—both digital and physical—to educate individuals about traditional crafts. Traditional crafts, which encompass a wide range of skills and knowledge passed down through generations, are an integral part of our cultural heritage. However, in today's digital age, these crafts face the risk of being forgotten. By leveraging the engaging and interactive nature of games, we can preserve and promote traditional crafts, ensuring they remain a living part of our culture.

Digital games, in this context, refer to two main types: simulators of crafting activities and simpler web-based games such as quizzes and 2D puzzles. Craft simulators provide a virtual environment where players can engage in crafting activities, allowing them to experience and learn the techniques involved in traditional crafts without the need for physical materials. Simpler web-based games, on the other hand, can include quizzes that test knowledge about traditional crafts or 2D puzzles that require players to solve problems related to these crafts, thereby reinforcing their learning through engaging challenges.

Physical games are another innovative approach, where games are designed to be downloaded and printed using a 3D printer. These games provide a tangible, hands-on experience, allowing learners to physically engage with materials and tools similar to those used in traditional crafts. This direct interaction can enhance the learning experience by providing a more realistic and immersive way to understand and practice these crafts.

Hybrid games combine the best of both digital and physical worlds. These games feature components that are both digital and physical, creating a more comprehensive and immersive learning experience. For instance, a hybrid game might involve a digital guide or tutorial paired with physical crafting materials printed on a 3D printer. This integration can help bridge the gap between virtual learning and real-world application, offering a multifaceted approach to educating about traditional crafts.

The purpose of this deliverable is to explore the potential of these different types of games—digital, physical, and hybrid—in educating individuals about traditional crafts. We will delve into the background of serious games, examine Craeft's approach to integrating traditional crafts into educational games, and provide insights into the design and implementation of these games. By doing so, we aim to highlight the innovative ways in which technology can be harnessed to preserve and promote our rich cultural heritage.

# 2. Background on serious games

## 2.1 Definition and History

Serious games are designed with the primary purpose of achieving objectives beyond pure entertainment. These objectives can range from education and training [1] to health improvement [2] and social change [3]. The concept of serious games dates back to the early 1970s when the first educational games began to emerge. Initially, these games were simple and often limited in scope, but they laid the foundation for the development of more sophisticated and effective educational tools.

Over the years, the field of serious games has grown significantly, incorporating advancements in technology and educational theory. Today, serious games are used across various industries, including education [4], healthcare [5], military training [6], and corporate training. They leverage the engaging and interactive nature of games to create immersive learning experiences that can effectively convey complex information and skills.

## 2.2 Educational Benefits

The educational potential of serious games is vast, offering numerous benefits that can enhance the learning experience:

**Engagement [7]:** Games naturally captivate users' attention and motivate them to continue learning. This engagement is crucial for maintaining interest and encouraging sustained educational efforts.

**Interactivity [8]:** Serious games require players to actively participate in the learning process. This interactivity can lead to improved retention and understanding, as learners are more likely to remember information they have actively engaged with.

**Experiential Learning [9]:** Many serious games simulate real-world situations, allowing learners to practice skills and make decisions in a safe and controlled environment. This experiential learning approach helps learners apply theoretical knowledge in practical scenarios.

**Immediate Feedback [10]:** Games provide instant feedback on players' actions, helping them learn from mistakes and improve their performance. This immediate feedback loop is essential for reinforcing learning and correcting errors in real-time.

## 2.3 Types of Serious Games for Traditional Crafts Education

When educating about traditional crafts, serious games can be categorized into three main types: digital games [11], physical games, and hybrid games [12]. Each type offers unique advantages and can be tailored to different learning objectives and contexts.

### 2.3.1 Digital Games

Digital games encompass a range of formats, from complex simulators to simpler web-based games such as quizzes and 2D puzzles.

**Craft Simulators:** These games provide virtual environments where players can engage in crafting activities. For example, a weaving simulator might allow players to practice different weaving techniques on a virtual loom [13]. These simulators offer a high degree of realism and interactivity, making them effective for teaching complex skills. By replicating the tools and processes used in traditional crafts, simulators can provide an immersive learning experience without the need for physical materials.

**Web-Based Games:** Simpler digital games, such as quizzes and 2D puzzles, can also be valuable educational tools [14, 15]. Quizzes can test players' knowledge about traditional crafts, reinforcing learning through repetition and feedback. For instance, a quiz game might challenge players to identify different types of weaving patterns or pottery styles. 2D puzzles might involve solving problems related to crafting processes and helping players understand the steps and skills involved. These games are often accessible and easy to use, making them ideal for a broad audience.

## 2.3.2 Physical Games

Physical games provide a hands-on learning experience through tangible components that can be downloaded and printed using a 3D printer.

3D Printed Games offer physical components that players can interact with [16], such as replicas of traditional crafting tools or materials. For example, a game might include 3D-printed pieces that replicate the tools used in pottery or weaving. By physically handling these components, learners can gain a better understanding of the tools and techniques used in traditional crafts. This tactile interaction can enhance the learning experience by providing a more realistic and immersive way to understand and practice these crafts.

Board and Card Games can also be adapted to teach about traditional crafts. These games might include elements that mimic crafting processes or require players to apply knowledge about crafts to progress in the game. For instance, a board game might involve collecting resources and using them to create various craft items, simulating the steps involved in traditional crafting.

## 2.3.3 Hybrid Games

Hybrid games combine digital and physical elements, providing a comprehensive and immersive learning experience.

A hybrid game might involve a digital tutorial or guide paired with physical crafting materials. For example, a game could include a digital app that walks players through the steps of a craft project, while they use 3D-printed tools and materials to complete the project in the real world. This combination helps learners bridge the gap between virtual instruction and hands-on practice, offering a multifaceted approach to educating about traditional crafts.

AR technology can enhance hybrid games by overlaying digital information onto the physical world [17, 18]. For instance, an AR game might display virtual crafting instructions or tips overlaid on the physical

workspace, helping learners follow along and understand the process more clearly. This integration of digital and physical elements can create a seamless learning experience that leverages the strengths of both formats.

## 2.4 Conclusion

Serious games offer a powerful and versatile approach to education, particularly in the context of traditional crafts. By harnessing the strengths of digital, physical, and hybrid games, educators can create engaging, interactive, and effective learning experiences. These games not only help preserve and promote traditional crafts but also ensure that these important cultural practices continue to thrive in the modern world. In the following sections, we will explore Craeft's approach to integrating traditional crafts into educational games and provide insights into the design and implementation of these games.

# 3. Craeft's approach

## 3.1 Systematic Understanding of Crafts

Our approach to educating about traditional crafts is grounded in a comprehensive and systematic understanding of these practices. This understanding is achieved through a multi-faceted process that includes documentation, video elicitation, ethnography, simulation of craft actions, and digitization of craft materials and products.

Documentation involves capturing detailed records of traditional crafts, including the tools, materials, techniques, and processes used by practitioners. This can take the form of written descriptions, photographs, and technical drawings, all of which contribute to a thorough archive of craft knowledge.

Video Elicitation is employed to document and analyse the actions of craftsmen. By recording practitioners at work, we capture the nuances of their techniques and the subtleties of their skills. These videos serve as valuable resources for both preserving and teaching traditional crafts.

Ethnography allows us to delve deeper into the cultural and social contexts of crafts. Through immersive fieldwork, we gain insights into the traditions, values, and communities that sustain these practices. This holistic understanding enriches our educational content, ensuring it is not only technically accurate but also culturally resonant.

Simulation of Craft Actions involves creating virtual models that replicate the movements and techniques of craftsmen. For instance, a pottery simulator is designed to mimic the effects of a practitioner's actions on clay, providing users with a realistic and interactive experience of pottery making. These simulations are powerful tools for preserving the intricate skills of craftsmen and making them accessible to a wider audience.

Digitization of Craft Materials and Products entails creating high-resolution digital representations of crafted items. This includes detailed 3D models and textures that capture the essence of materials like silver, clay, and textiles. These digital assets are crucial for creating accurate and engaging educational games.

## 3.2 Generating Knowledge and Data

The systematic documentation and digitization processes generate a wealth of knowledge and data about traditional crafts. This data includes detailed descriptions, visual records, and interactive simulations of crafting activities. These resources form the foundation of our educational games, ensuring they are based on authentic and meticulously researched information.

## 3.3 Simplification and Game Development

Our approach to creating educational games involves simplifying complex and detailed research outcomes into accessible and engaging formats suitable for children. By distilling the essence of traditional crafts

into game mechanics, we aim to introduce young learners to these practices in a way that is both fun and educational.

For example, the pottery simulator we developed is a mass-preserving simulator capable of mimicking the results of practitioner actions on clay. By using this simulator, children can learn about the basic techniques of pottery making in an interactive and immersive manner. The simulator simplifies the complex actions of a skilled potter into manageable steps that children can follow and understand.

Similarly, our jewellery box immersion game uses ultra-high-resolution digitization to create a virtual environment where users can explore and appreciate the intricate details of a silver bracelet. The game simplifies the concept of jewellery making into an exploratory adventure, allowing children to learn about the craft through visual and interactive engagement.

The potholder loom game exemplifies how physical games can introduce children to weaving simply and tangibly. By using a 3D-printed loom and elastic loops, children can learn the basics of weaving while engaging in a hands-on activity.

## 3.4 Educational Impact

The ultimate goal of our approach is to make traditional crafts accessible and engaging for a younger audience. By leveraging modern technologies such as 3D printing, high-resolution digitization, and interactive simulations, we bridge the gap between ancient practices and contemporary learning methods. Our games not only teach children the technical aspects of crafts but also instil an appreciation for the cultural and historical significance of these practices.

Through this innovative approach, we aim to ensure that the knowledge and skills associated with traditional crafts are preserved and passed on to future generations. By introducing children to these crafts through simplified and engaging games, we foster a new generation of learners who value and continue the rich traditions of craftsmanship.

In conclusion, our approach combines thorough research, advanced technology, and creative simplification to create educational games that effectively teach traditional crafts. By systematically understanding and documenting crafts, generating detailed data and simulations, and transforming this information into accessible games, we provide a unique and impactful educational experience.

# 4. Digital games

Currently, the following digital experiences/games have been explored in the context of this work. The first regards the implementation of a pottery workshop game where the players can master their pottery skills through simple experimentation. The second regards an educational gaming experience where the user is immersed in a jewellery box to witness the delicacy of details and the craftmanship for the creation of a silver bracelet

## 4.1. The pottery workshop

One of the digital games we have developed focuses on the traditional craft of pottery making. This game immerses users in a virtual 3D traditional craft workshop, providing an environment where they can explore and interact with various elements of pottery crafting. The workshop is meticulously designed to replicate the atmosphere and tools of a real pottery studio. Users can navigate through the workshop, observing different tools, materials, and pottery pieces at various stages of completion. This immersive environment helps users feel as though they are genuinely part of a traditional craft setting, enhancing the overall educational experience.

At the heart of the workshop is the pottery wheel simulation. In the first version of the game, users interact with the pottery wheel using their mouse to control the "tool." This simulation allows users to engage in the intricate process of shaping clay, providing a realistic experience of crafting a pottery piece from start to finish. The mouse control system is designed to be intuitive, enabling users to manipulate the clay with precision. By moving the mouse, users can apply different pressures and movements to shape the clay, simulating the tactile feedback experienced in real pottery making. The game incorporates realistic feedback mechanisms, such as changes in the shape and texture of the clay based on user input. This feedback helps users understand the impact of their actions, making the learning experience more authentic.

To assist beginners, the game includes step-by-step instructions and visual guides. These guides walk users through the fundamental techniques of pottery making, such as centring the clay, opening it up, and pulling up the walls to form the desired shape. Users have the freedom to experiment with different shapes and designs, allowing them to express their creativity. The game also offers various tools and brushes that can be used to add intricate details and patterns to the pottery.

The primary educational objective of this digital game is to teach users the basic techniques and principles of pottery making. By providing a hands-on, interactive experience, the game aims to enhance users' understanding of the pottery-making process, from preparing the clay to finishing the final piece. The simulation helps users develop their motor skills and hand-eye coordination, which are essential for real-world pottery making. Moreover, the game encourages users to explore different techniques and styles, fostering a sense of creativity and innovation.

User feedback has been instrumental in refining the game and enhancing its educational value. Players have appreciated the realistic feel of the simulation and the ability to experiment with different techniques. Based on this feedback, future versions of the game will include more advanced control options, such as touch-screen interfaces and VR support, to provide a more immersive experience. Additionally, more detailed tutorials and tips for advanced techniques will be added to cater to users with

varying levels of expertise. Enhancements to the graphics and physics engine will make the simulation even more lifelike, including the addition of texture variations and more detailed clay behaviour.

In conclusion, the digital pottery-making workshop is an innovative educational tool that combines the engaging nature of gaming with the rich tradition of pottery-making. By offering a realistic and interactive experience, this game not only preserves the craft but also makes it accessible to a broader audience, ensuring that the art of pottery continues to thrive in the digital age.

**Figure 1. The pottery workshop mini-game**

# 4.2. The jewellery box

The second digital game we have developed is a unique and immersive experience based on the concept of a user being transported into a jewellery box. This game leverages cutting-edge research in ultra-high-resolution digitization of shiny materials to create a visually stunning and educational environment. At the core of this experience is the digitization of a silver bracelet, captured in extreme detail to showcase the delicate binding of silver strings and the exquisite workmanship of the jeweller.

The game situates the digitized bracelet within a virtual jewellery box, where the user assumes the role of a first-person adventurer exploring this intricate environment. The ultra-high-resolution digitization allows users to experience the fine details of the bracelet up close, appreciating the craftsmanship and intricate designs that are often difficult to observe with the naked eye.

As the user navigates through the jewellery box, they can walk on the bracelet itself, providing an unprecedented perspective on the artistry involved in its creation. The virtual environment is designed to be highly interactive, with various vantage points and areas for the user to stand on. These elevated spots

offer panoramic views of the bracelet, allowing users to gain a comprehensive understanding of its structure and design.

The game's environment is crafted to enhance the user's sense of immersion. As the adventurer walks through the jewellery box and across the bracelet, they can inspect the intricacies of the silver strings, observe the fine details of the patterns, and appreciate the jeweller's meticulous work. The lighting within the virtual box is carefully designed to highlight the reflective qualities of the silver, enhancing the visual appeal and realism of the experience.

Educationally, this game aims to provide users with a deeper appreciation of traditional jewellery-making techniques. By offering an interactive and detailed exploration of a high-quality piece of jewellery, the game helps users understand the level of skill and precision required in this craft. It also emphasizes the beauty and value of traditional craftsmanship, encouraging users to appreciate and preserve these artisanal skills.

User feedback has played a crucial role in shaping this game. Players have expressed awe at the level of detail and realism achieved through the ultra-high-resolution digitization. The ability to explore the bracelet from a first-person perspective and view it from various angles has been particularly well-received. Future iterations of the game will aim to expand the variety of digitized jewellery pieces, offering users the opportunity to explore different styles and techniques from various cultures and historical periods. Additional features such as interactive tutorials and historical context about the jewellery pieces will further enrich the educational experience.

In conclusion, the jewellery box immersion experience is an innovative digital game that combines advanced digitization technology with interactive learning. By allowing users to explore a meticulously crafted piece of jewellery in a virtual environment, the game not only highlights the artistry of traditional jewellery making but also makes this heritage accessible to a broader audience. This immersive approach ensures that the appreciation for such intricate craftsmanship continues to thrive in the digital age.

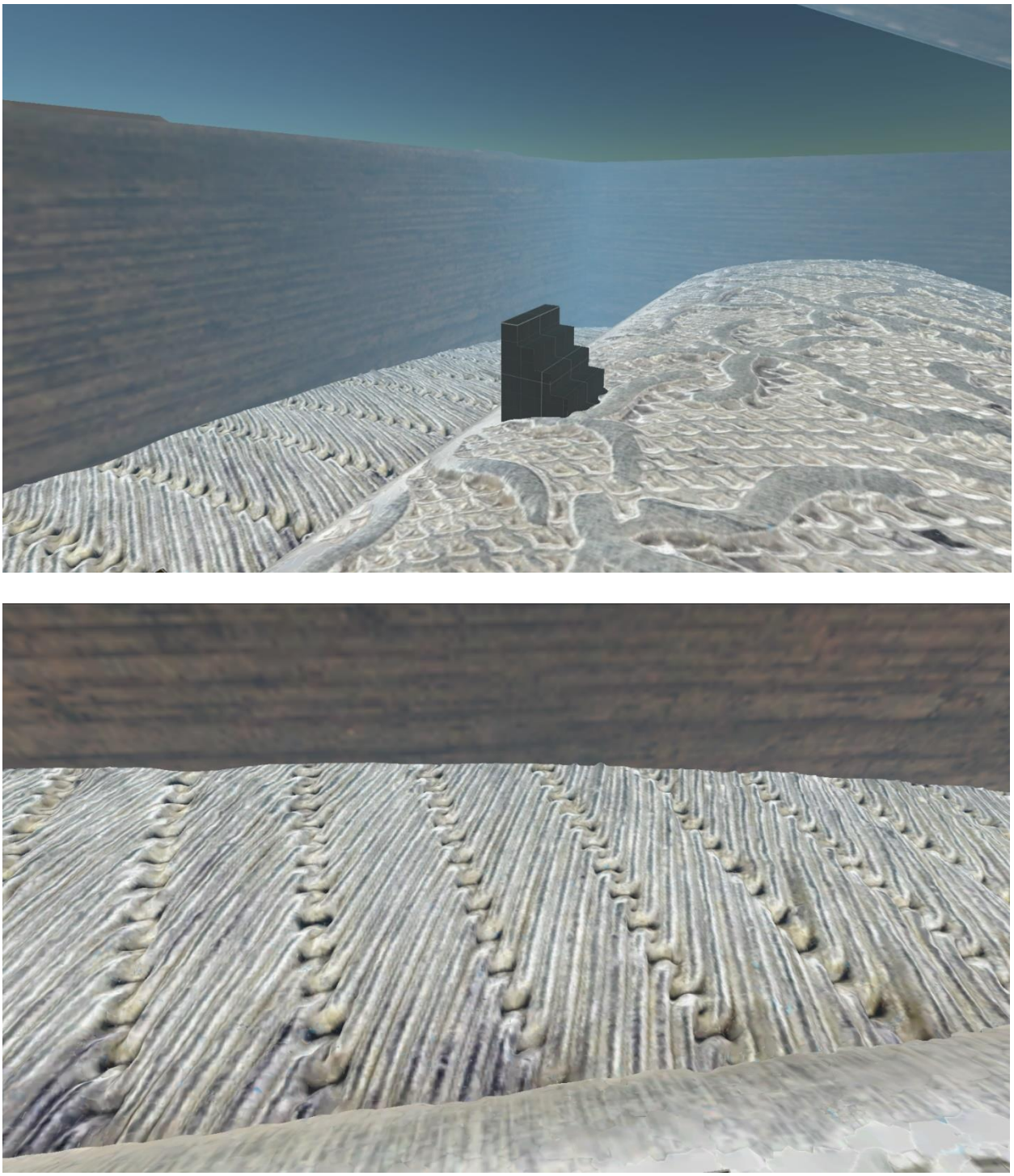

**Figure 2. The jewellery box mini-game – different views of the silver bracelet**

# 5. 3D-printed Physical games

Physical games introduce the concept of a craft more simply and abstractly, making traditional skills accessible and engaging for learners of all ages. One such example that we have tested is the potholder loom, a straightforward yet effective tool for teaching the basics of weaving.

## 5.1. Communities of 3D printable designs

Communities like Thingiverse, MyMiniFactory, and Cults3D have become central hubs for the global 3D printing community. These platforms facilitate the sharing, discovery, and customization of 3D printable designs, catering to a wide range of interests and skill levels.

**Thingiverse** is one of the largest and most well-known repositories for 3D printable models. Created by MakerBot, it offers a vast collection of user-generated designs that are freely available for personal use. The platform encourages collaboration and innovation, allowing users to upload their creations, share modifications, and provide feedback on designs.

**MyMiniFactory** focuses on ensuring high-quality, curated content. It collaborates with designers to provide a marketplace for premium designs while also offering a substantial number of free models. MyMiniFactory supports a variety of creative projects, from hobbyist endeavors to professional product development, emphasizing the importance of quality and reliability.

**Cults3D** is another prominent platform that blends free and paid 3D printable models. It is known for its vibrant community of designers who showcase their work and monetize their creations. Cults3D supports a diverse range of categories, making it a valuable resource for enthusiasts and professionals alike.

These communities not only provide access to a wealth of 3D printable designs but also foster a sense of collaboration and learning. They enable users to explore new ideas, share knowledge, and connect with other enthusiasts, driving the growth and evolution of the 3D printing ecosystem.

### 5.1.1 Using the communities to locate physical loom games

Specifically regarding printable loom design some generic guidelines on how to access 3D printable models follow:

- **Thingiverse**:
  - Go to Thingiverse.
  - In the search bar, type "mini loom" or "weaving loom." or “potholder loom” or any other loom type you wish to search for
  - Browse through the results and select a design that suits your needs.
  - Download the STL file and print it using a 3D printer.
- **MyMiniFactory**:
  - Visit MyMiniFactory.
  - Use the search function to look for "mini loom" or "small weaving loom." or any other loom type you wish to search for

    - Explore the available designs, choose one, and download the STL file.
- **Cults3D**:
    - Go to Cults3D.
    - Enter "mini loom" or "weaving loom" or any other loom type you wish to search for in the search bar.
    - Check out the designs, both free and paid, and download the desired file.
- **PrusaPrinters**:
    - Visit PrusaPrinters.
    - Use the search feature to find "mini loom" or "weaving loom." or any other loom type you wish to search for
    - Select a design, download the STL file, and print it.

### 5.1.2 Printing and Assembly

Creating a physical 3D printed loom device should be easy for users with prior knowledge to 3D printing. Typical steps in this process involve:

- **Download the STL File**: From the chosen platform, download the STL file of the mini loom design.
- **Prepare the 3D Printer**: Load the STL file into your 3D printer's slicing software (such as Cura or PrusaSlicer). Adjust the print settings as necessary.
- **Print the Parts**: Print the loom parts. Depending on the design, you may need to print multiple pieces.
- **Assemble the Loom**: Once the parts are printed, assemble the loom according to the design instructions. This usually involves snapping or gluing parts together.
- **Start Weaving**: Set up your warp threads and begin weaving using the shuttle and heddle bar.

## 5.2. 3D prinateble looms

### 5.1.1 Loom type - Mini weaving loom

A 3D printable mini loom is a small, handheld device designed for weaving small pieces of fabric, perfect for hobbyists and educational purposes. This loom is compact and portable, making it easy to use anywhere. The key advantage of a 3D printable loom is its accessibility and customizability, allowing users to create their own loom using a 3D printer and tailor it to their specific needs.

The loom consists of a frame, which is the main structure that holds everything together. This frame is rectangular and features pegs or slots along the top and bottom edges. These pegs or slots are evenly spaced and are used to hold the warp threads in place, which are the threads that run vertically on the loom. When printed, the frame is typically made from durable plastic materials like PLA or ABS, ensuring stability and longevity.

Central to the loom's functionality is the heddle bar, a movable bar with slots or holes that allow the warp threads to be separated into two sets. This separation is crucial as it makes it easier to pass the weft thread (the horizontal thread) through the warp threads, simplifying the weaving process. The heddle bar can be printed to fit perfectly within the frame, ensuring smooth operation.

The shuttle is another essential part of the loom. It is a small, flat piece used to hold and guide the weft thread through the warp threads. By wrapping the weft thread around the shuttle, users can easily pass it back and forth through the warp threads to create the woven fabric. A 3D printable shuttle can be customized in terms of size and shape to suit different weaving projects.

Lastly, the beater is a tool used to push the weft thread tightly against the woven fabric, ensuring a neat and compact weave. The beater helps maintain the tension and alignment of the threads, resulting in a uniform and professional-looking piece of fabric. The design of the beater can be adjusted and printed to match the user's specific weaving requirements.

The 3D printable concept allows users to download and print all the components of the mini loom from various online repositories, such as Thingiverse, MyMiniFactory, Cults3D, and PrusaPrinters. These platforms offer a variety of loom designs that can be freely downloaded and customized. Once the STL files are downloaded, they can be loaded into a 3D printer's slicing software, adjusted for print settings, and printed. The printed parts can then be easily assembled to form a complete loom.

In addition to providing a cost-effective and customizable solution for weaving, a 3D printable mini loom also promotes creativity and innovation. Users can modify the design files to create unique loom configurations, add additional features, or improve existing ones. This flexibility makes 3D printable looms a valuable tool for both beginners and experienced weavers, offering endless possibilities for weaving small pieces of fabric.

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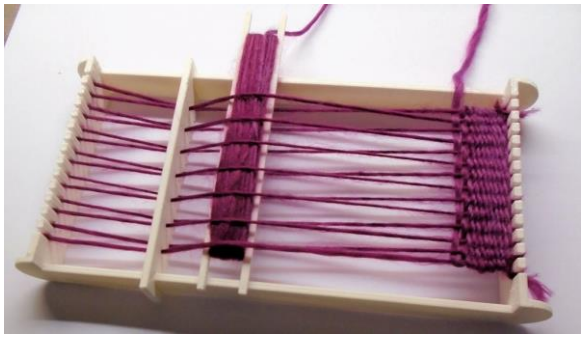
|  |  |
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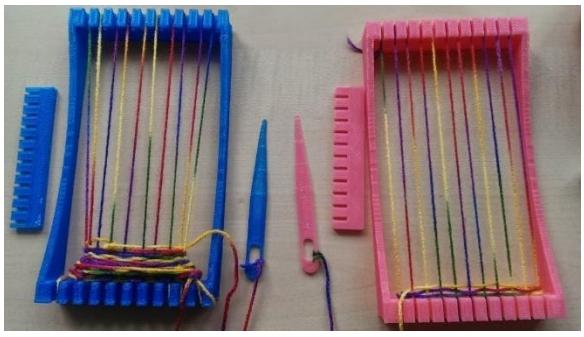
|  |  |

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**Figure 3. Mini weaving looms examples**

## 5.1.2 Loom type - Potholder loom

A potholder loom is a simple device that allows users to create potholders by placing elastic loops on the loom and weaving them together. The design for this game was sourced online, and we utilized a 3D printer to bring it to life. The process began by downloading a digital design for the loom, which was then printed using a 3D printer. The printed loom components were subsequently secured onto a wooden panel to provide stability and ease of use.

The resulting toy is not only functional but also serves as an educational tool. To demonstrate its use, we created a detailed demonstration video and step-by-step instructions. The video guides users through the entire process of setting up the loom, placing the elastic loops, and weaving them to create a finished potholder. These resources are designed to be easily accessible and user-friendly, ensuring that learners can follow along and replicate the process independently.

Educationally, the potholder loom game introduces the fundamental concepts of weaving in a hands-on and engaging manner. By interacting with the loom, users can understand the basic principles of tension, pattern creation, and the interlacing of threads, which are essential skills in traditional weaving crafts. The tactile experience of manipulating the elastic loops and seeing the potholder take shape provides a deeper understanding of the craft compared to purely theoretical learning.

The use of a 3D printer in creating the loom adds an innovative dimension to the project, demonstrating how modern technology can be harnessed to revive and teach traditional crafts. The combination of digital design and physical assembly bridges the gap between contemporary technology and age-old crafting techniques, highlighting the versatility and potential of integrating these fields.

Feedback from users has been overwhelmingly positive. Participants appreciated the simplicity and clarity of the instructions, as well as the satisfaction of creating a functional item with their own hands. The physicality of the loom, combined with the educational resources, provides an enriching learning experience that goes beyond mere observation.

Looking forward, we aim to expand this concept by exploring other simple weaving devices and crafts that can be similarly designed, 3D printed and demonstrated. By creating a series of such physical games, we can build a comprehensive educational toolkit that covers various aspects of traditional crafts, each with its instructional video and printed materials.

In conclusion, the potholder loom project exemplifies how physical games can simplify and abstract the concepts of traditional crafts, making them accessible to a wider audience. By combining 3D printing technology with hands-on crafting, this game offers a tangible and interactive way to learn about weaving. The success of this project encourages further exploration and development of similar educational tools, ensuring that the knowledge and appreciation of traditional crafts continue to thrive in modern times.

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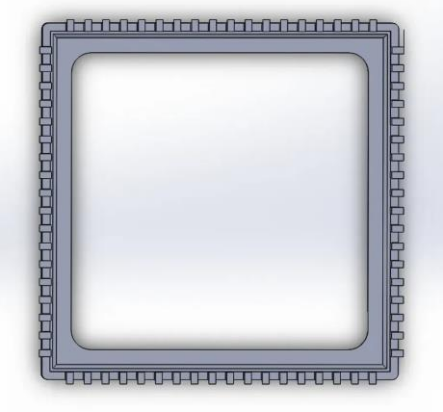
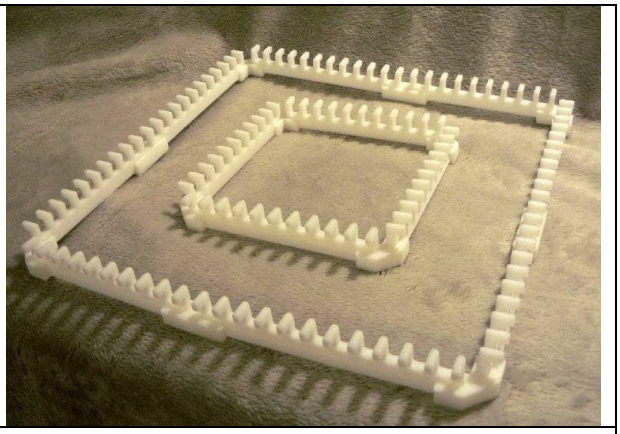
|  |  |
| https://www.printables.com/model/150671-potholder-loom | https://www.thingiverse.com/thing:104503 |

**Figure 4. Potholder loom example**

### Exemplar of using a potholder loom design

For experimentation purposes and for creating educational material for the specific weaving variation we have implemented one of the aforementioned designs. During the validation phase, we understood that specific printing parameters and materials would benefit the application of the specific design. This practically means that for inexperienced with 3D printing users these designs will have to be accompanied by specific instructions. Another drawback was the stability of the structure which cannot support very strong in terms of tension loops. To address this issue, we have mounted the loom on a piece of wood to enhance its stability and reduce the structure wrapping effect. Finally, we encountered the issue of broken pins when exercising pressure. In this case, we had to reprint the loom with greater infill. After these adjustments in the process, we were able to proceed with the design and create our first potholder. The entire process was recorded to be converted to educational material. Figure 5 provides an overview of the adapted design and the first potholder weaved using this device.

**Figure 5. Example of the application of the potholder design**

## 5.1.3 Loom type - Rubber band bracelet looms

A 3D printable rubber band bracelet loom is an innovative tool that allows users to create intricate and colorful bracelets using small rubber bands. Designed to be compact, portable, and easy to use, these looms are perfect for children and hobbyists alike.

The loom consists of a rectangular base that forms the foundation, which may be designed as a single piece or as multiple pieces that can be connected together. The base is typically made from a sturdy plastic like PLA or ABS to ensure durability and is usually small enough to be handheld or fit comfortably on a desk.

Pegs or pins are evenly spaced along the base and can be arranged in various patterns, such as a single row, double row, or staggered configuration, depending on the complexity of the bracelet designs. These pegs act as anchors for the rubber bands, allowing users to stretch and loop the bands in different configurations. Pegs are generally cylindrical with a slight taper to hold the rubber bands securely, and some designs include grooves or notches to prevent slipping.

A key component of the loom is the hook tool, a small handheld implement with a hooked end, used to manipulate the rubber bands during the weaving process. The hook tool is often made from plastic, though it can also be made from metal for added strength. It allows users to lift and loop rubber bands over the pegs, creating the interwoven patterns that form the bracelet.

Some loom designs include additional connector pieces to link multiple bases together, enabling the creation of larger or more complex bracelets. These connectors are usually simple clips or snap-fit parts that join the loom sections securely without the need for additional tools.

Customization options are often available, with advanced designs featuring movable pegs that can be rearranged to create different patterns. Extensions and additional modules can be printed and attached to the main loom to expand its capabilities. Users can also print the loom and its components in different colours to make the process more visually intuitive and enjoyable.

Using a rubber band bracelet loom provides both educational and creative benefits. It helps improve fine motor skills, hand-eye coordination, and spatial awareness, making it a great educational tool for children. The loom also encourages creativity and experimentation, allowing users to design unique patterns and colour combinations for their bracelets.

Designed to be user-friendly, the loom is straightforward to use, with clear instructions often provided by the designer. Beginners can quickly learn to make basic bracelets, and the compact size makes it easy to carry around, so users can take their crafting projects on the go.

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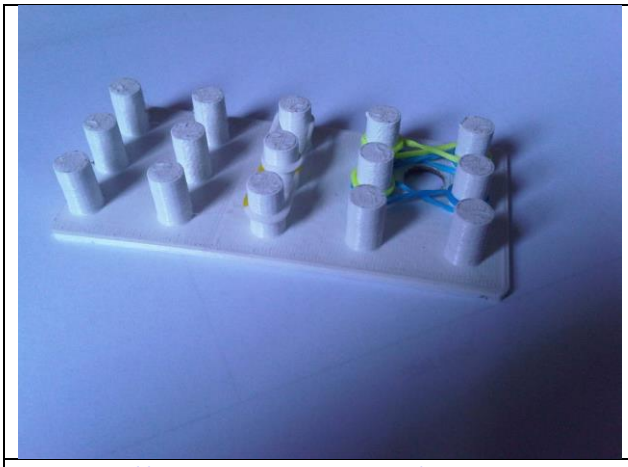
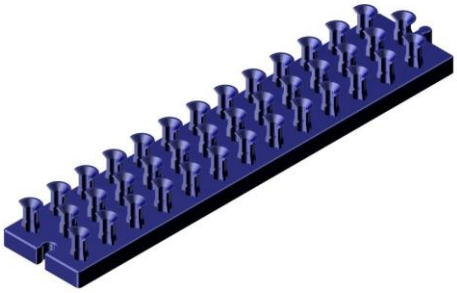
<tr><td>  </td><td>  </td></tr>
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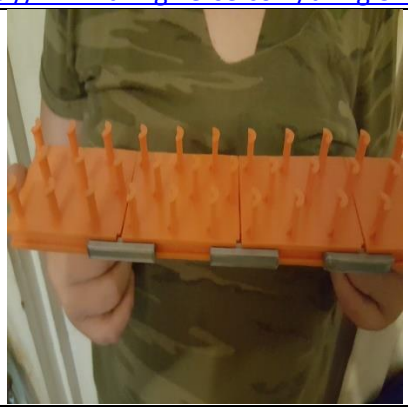
<tr><td>  </td><td>  </td></tr>
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**Figure 6. Rubber band bracelet looms examples**

## 5.1.4 Loom type – Bead loom for bracelets

A 3D printable bead loom for bracelets is a modern, customizable tool designed for crafting intricate and personalized beaded bracelets. This loom is compact and portable, allowing crafters to create beautiful beadwork with ease. The advantage of a 3D printable design is that it offers flexibility and customization, making it possible to tailor the loom to specific project requirements and personal preferences.

**Frame**: At the core of the loom is the frame, which provides the main structure and support for the other components. The frame is typically rectangular and is designed to be sturdy yet lightweight, often printed from durable plastic materials like PLA or ABS. It features evenly spaced pegs or slots along the top and bottom edges. These pegs or slots are crucial for holding the warp threads in place. The spacing and configuration of these pegs can be customized through 3D printing, accommodating different bead sizes and design styles.

**Pegs or Slots**: These components are essential for maintaining the tension of the warp threads. The pegs or slots secure the threads, keeping them taut as beads are threaded onto them. This tension is key to creating consistent and even bead patterns. With a 3D printable loom, users can adjust the size and placement of the pegs or slots to fit various bead sizes and achieve different design effects.

**Heddle Bar**: The heddle bar is a movable part that separates the warp threads into two sets. This separation makes it easier to thread beads onto the weft thread (the horizontal thread) and helps keep the beadwork organized. The heddle bar can be precisely printed to fit the frame, allowing for smooth and efficient bead placement. This component is particularly useful for creating intricate bead designs and patterns.

**Customization and Printing**: The 3D printable concept allows users to download and print loom designs from online repositories such as Thingiverse, MyMiniFactory, Cults3D, and PrusaPrinters. These platforms offer a range of loom designs that can be freely downloaded and customized. Once the STL files are obtained, they can be loaded into 3D printer slicing software, adjusted for print settings, and printed. The printed components are then assembled to create a functional bead loom tailored to individual needs.

**Additional Tips**: For those using traditional bead looms, it's important to set up warp threads properly to determine the length and width of the final bracelet. Looms that leave multiple warp threads at the ends may require backing with materials like Ultra Suede or ribbon for a polished finish. For specialized looms like the Ricks Beading Loom, which leaves fewer warp threads, finishing options may differ.

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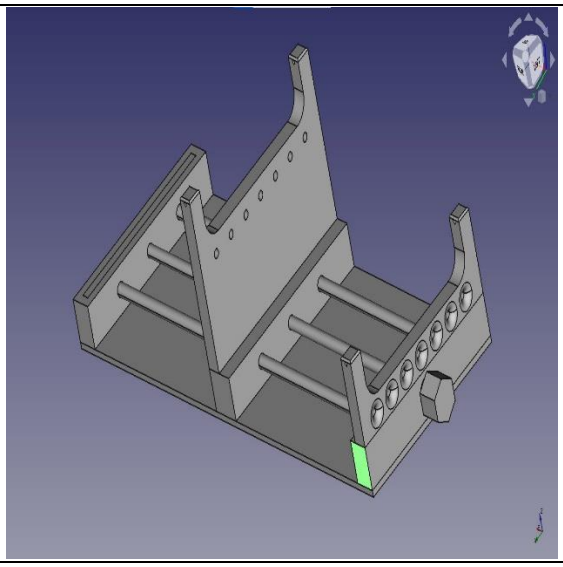
|  |  |
| https://cults3d.com/en/3d-model/tool/beading-loom-200x50mm | https://cults3d.com/en/3d-model/tool/adjustable-length-bead-loom |

**Figure 7. Bead loom for bracelets examples**

# 5.2 3D printed pottery games and pottery accessories

## 5.2.1. Pottery wheel

A 3D printable pottery wheel is an innovative tool designed for creating pottery, combining traditional crafting techniques with modern 3D printing technology. This wheel is compact, portable, and customizable, making it an excellent choice for both novice and experienced potters. The primary advantage of a 3D printable pottery wheel is its flexibility and accessibility, allowing users to design and print a wheel that fits their specific needs and creative vision.

**Base and Structure**: The base of the pottery wheel provides the main support and stability. Typically, this base is designed to be sturdy yet lightweight, printed from durable materials like PLA or ABS. The base may include slots or mounts for attaching other components, such as the wheel head and the motor. Customizable through 3D printing, the base can be tailored to different sizes and shapes to suit the user's workspace and pottery projects.

**Wheel Head**: The wheel head is the rotating platform where the clay is shaped. In a 3D printable design, the wheel head is usually circular and designed to fit snugly onto the base. It features a flat, smooth surface to ensure even rotation and stability of the clay. The size and surface texture of the wheel head can be customized through 3D printing, allowing users to create a wheel head that suits their specific pottery techniques and project requirements.

**Motor and Drive Mechanism**: A key component of the pottery wheel is the motor, which provides the rotational force needed to shape the clay. In a 3D printable design, the motor and drive mechanism can be housed within the base or attached externally. The drive mechanism typically involves a belt or gear system that connects the motor to the wheel head. The design and specifications of the motor and drive

mechanism can be customized to provide different speeds and torque levels, accommodating various pottery techniques and preferences.

**Foot Pedal or Speed Control**: To control the speed of the wheel head, a foot pedal or electronic speed control can be included in the design. This component allows the potter to adjust the wheel's speed while working, providing greater control over the shaping process. A 3D printable foot pedal can be customized for comfort and responsiveness, ensuring smooth and precise control over the wheel's rotation.

**Splash Pan**: A splash pan is an optional but useful component that surrounds the wheel head to catch excess water and clay. In a 3D printable design, the splash pan can be designed to fit snugly around the wheel head and base, preventing mess and making cleanup easier. The size and shape of the splash pan can be tailored to match the specific dimensions of the wheel head and base.

**Customization and Printing**: The 3D printable concept allows users to download and print pottery wheel designs from various online repositories, such as Thingiverse, MyMiniFactory, Cults3D, and PrusaPrinters. These platforms offer a range of designs that can be freely downloaded and customized. Once the STL files are obtained, they can be loaded into 3D printer slicing software, adjusted for print settings, and printed. The printed components can then be assembled to create a fully functional pottery wheel.

This approach provides significant advantages in terms of accessibility and customization. Users can experiment with different design elements, adjust the wheel to fit their workspace and tailor the components to their specific pottery techniques. This flexibility makes the 3D printable pottery wheel a valuable tool for both hobbyists and professional potters.

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| https://cults3d.com/en/3d-model/tool/mini-pottery-wheel | https://www.thingiverse.com/thing:3719662 |

**Figure 8. Pottery wheel examples**

## 5.2.1. 3D printable pottery accessories

The integration of 3D printing technology with traditional pottery wheel accessories introduces a new realm of possibilities for potters. These 3D printed accessories, such as specialized forming patterns, enhance the pottery-making process by allowing artists to create intricate designs and textures on their clay creations while the wheel is in motion. This innovative approach combines the timeless art of pottery with the flexibility and precision of modern technology, catering to both novice and experienced potters.

A primary advantage of 3D printed pottery wheel accessories is their customization. Artists can design and print accessories that fit their specific needs and creative visions, from unique forming patterns to custom texturing tools. These accessories are made from durable materials like PLA or ABS, ensuring they withstand the rigors of pottery making while remaining lightweight and easy to handle.

The customization extends to the size and shape of the accessories, allowing potters to tailor them to their workspace and specific projects. For instance, specialized forming patterns can be designed to create consistent, intricate designs on the clay as it rotates on the wheel. This capability transforms the traditional pottery wheel into a versatile tool that can produce a wide variety of artistic effects.

Accessibility is another significant benefit. Potters can download and print designs from online repositories such as Thingiverse, MyMiniFactory, Cults3D, and PrusaPrinters. These platforms offer a vast array of designs that can be freely downloaded, customized, and printed. Once the STL files are obtained, they can be adjusted using 3D printer slicing software and printed, allowing for the rapid creation and testing of new accessories.

This method of producing pottery wheel accessories is cost-effective, reducing the need for expensive, specialized tools. Potters can experiment with different designs without significant financial investment, encouraging innovation and creativity. The ability to print accessories on demand also eliminates the wait times associated with ordering and shipping traditional tools.

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| https://cults3d.com/en/3d-model/tool/pottery-tool-05 | https://cults3d.com/en/3d-model/tool/pottery-tools-01 |

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| https://cults3d.com/en/3d-model/tool/pottery-tool-06 | https://cults3d.com/en/3d-model/tool/pottery-tool-08 |

**Figure 9. 3D printed pottery accessories examples**

## 5.2.1. 3D printable clay rolling stamps

A 3D printable clay rolling stamp is an innovative tool designed to add intricate textures and patterns to clay surfaces, enhancing the pottery and sculpting process. This tool is customizable, allowing artisans to create unique designs that can be applied to their clay projects. The primary advantage of a 3D printable clay rolling stamp is its flexibility and accessibility, enabling users to design and print stamps that fit their specific creative needs and artistic vision.

**Design and Customization**: The design of a clay rolling stamp is essential to its function. Typically, the stamp consists of a cylindrical roller with a patterned surface. The pattern can be geometric, floral, abstract, or any design that the user desires. With 3D printing technology, these designs can be easily customized, allowing users to create unique and intricate patterns that might be difficult to achieve with traditional methods.

**Roller**: The roller is the main component of the clay rolling stamp. It is designed to be cylindrical, allowing it to roll smoothly over the clay surface, impressing the pattern into the clay. The roller can be printed from durable materials such as PLA or ABS to ensure longevity and consistent performance. The diameter and length of the roller can be adjusted through 3D printing to suit different project sizes and requirements.

**Patterned Surface**: The surface of the roller is where the design is engraved or raised. This patterned surface is what creates the texture of the clay. Using 3D modelling software, users can create intricate designs that are then translated into the roller surface. The depth and detail of the pattern can be finely tuned, allowing for a wide range of textures from subtle to highly detailed.

**Handles**: Handles are often included in the design of a clay rolling stamp to make it easier to use. These handles can be printed as part of the roller or attached separately. They provide a comfortable grip, allowing the user to apply even pressure as they roll the stamp over the clay. The handles can be customized for ergonomic comfort, making the tool easier to use for extended periods.

**Printing and Assembly**: The 3D printable concept allows users to download or create their rolling stamp designs using 3D modelling software. Online repositories like Thingiverse, MyMiniFactory, Cults3D, and PrusaPrinters offer a variety of designs that can be freely downloaded and printed. Once the STL files are obtained, they can be loaded into 3D printer slicing software, adjusted for print settings, and printed. The printed components are then assembled, if necessary, to create a functional rolling stamp.

**Application**: To use the clay rolling stamp, the roller is pressed into the clay and rolled across the surface. The patterned surface impresses the design into the clay, creating a textured effect. This tool can be used on flat surfaces, cylindrical forms, or any shape of clay project. The ease of customization means that users can create stamps specific to each project, allowing for a high degree of creativity and personalization.

**Benefits of 3D Printing**: The 3D printable clay rolling stamp offers several benefits. It allows for intricate and unique designs that can be easily customized and reproduced. The ability to print multiple stamps with different patterns gives artisans a versatile toolkit for their projects. Additionally, the cost and time savings compared to traditional methods of creating custom stamps make 3D printing an attractive option for hobbyists and professionals alike.

**Designs Exemplars**

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| https://www.printables.com/model/163193-more-potteryclay-rolling-stamps | https://www.printables.com/model/97427-potteryclay-rolling-stamps-and-handle |

**Figure 10. 3D-printed clay stamps**

# 6. Educational activities

As part of providing games in the form of educational activities lessons were authored to Craeft's eLearning platform that assist in the creation of simple tools that can then be used to start practising a craft or applying some basic problem-solving techniques.

## 6.1 Weaving

### 6.1.1. Improvised loom using a chair

An innovative and accessible way to create a loom is by repurposing a simple chair. This method utilizes the legs of the chair as the foundational structure for the loom. To start, you securely mount the warp threads onto the legs, creating a stable and taut surface for weaving. The chair's design, with its four legs, allows for a balanced and symmetrical setup, making it easier to maintain tension across the threads. This setup is particularly beneficial for larger weaving projects, as the height and spacing of the chair legs provide ample room for creating broader and more intricate patterns. Moreover, using a chair as a loom is not only cost-effective but also a practical solution for those who may not have access to traditional weaving equipment. The stability of the chair ensures that the weaving process is smooth, and the ability to adjust the positioning of the threads allows for versatility in the designs created.

Activity 1: Improvised Loom with Chairs

Materials:

- School or non-school chair
- Yarn
- Scissors

Instructions

1. Chair Placement:
   Turn the chair upside down and place it with the legs facing upward.
2. Setting Up the Yarn:
   Tie the yarn to the legs of the chair and start wrapping it around, creating parallel lines of yarn. These lines will form the warp of the loom (as shown in the pictures).
3. Securing the Yarn:
   Secure the yarn to each leg by tying it tightly to prevent it from moving.
4. Weaving Process:
   Using another color of yarn, begin weaving by passing the yarn over and under the warp threads, creating the fabric (weft).

**Figure 11. Improvised loom using a chair – eLearning activity**

## 6.1.2. Improvised loom with cardboard

For a more compact and portable weaving option, a loom can be crafted from a piece of cardboard and a couple of ice cream sticks. This method is perfect for small projects and for those new to weaving, offering an easy and inexpensive entry point into the craft. The cardboard serves as the base, with notches cut into the top and bottom to hold the warp threads in place. The ice cream sticks are then used to wrap and secure these threads, acting as anchors that keep the warp taut. This setup creates a mini loom that is both lightweight and easy to handle, making it ideal for weaving on the go or in limited spaces. The cardboard and ice cream stick loom is also highly customizable; you can adjust the size of the cardboard and the spacing of the notches to suit different project needs. This method encourages creativity and experimentation, allowing weavers to explore various patterns and techniques without the need for specialized tools.

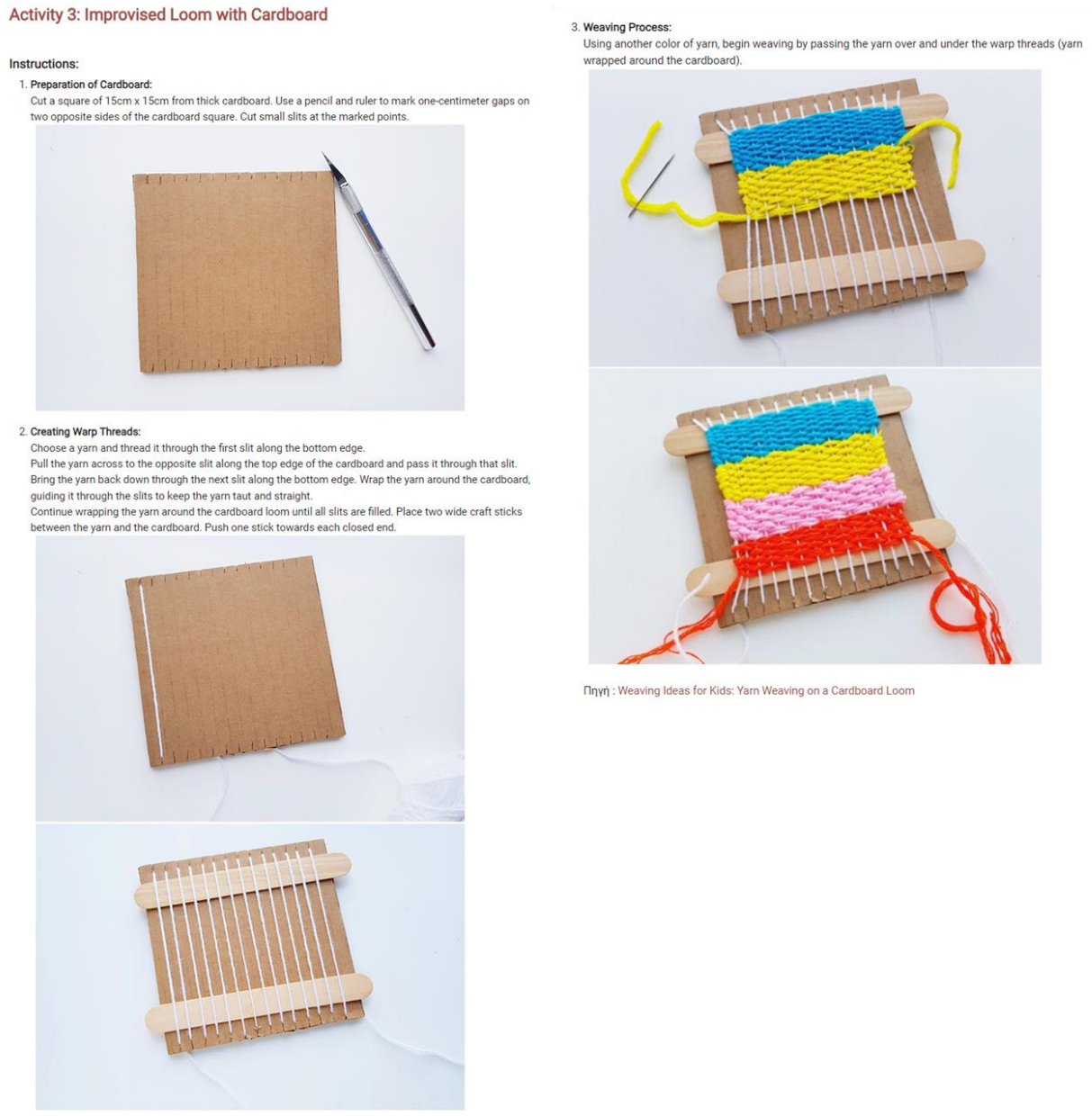
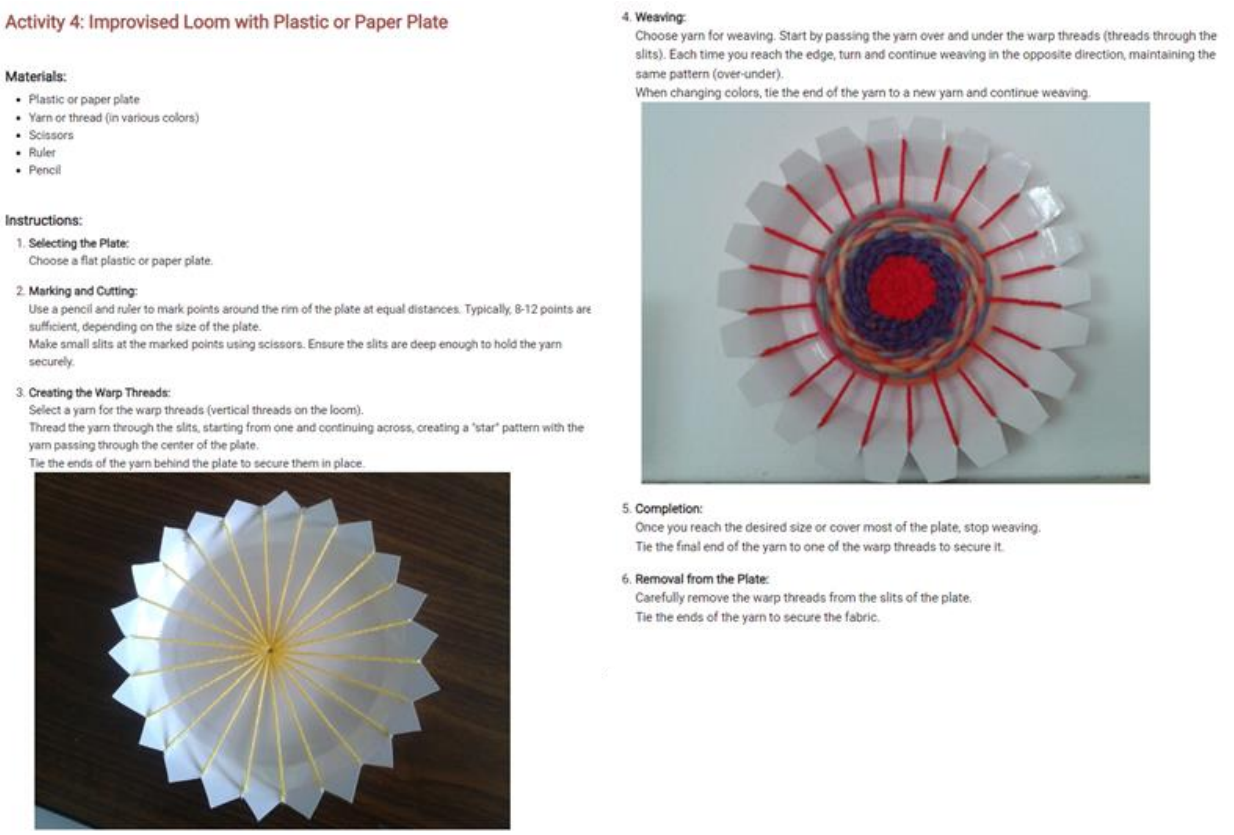



**Figure 12. Improvised loom with cardboard – eLearning activity**

## 6.1.3. Improvised loom with plastic plate

Creating a round loom using a plastic plate offers a unique approach to weaving, yielding circular patterns and designs. To make this loom, you start by cutting a plastic plate into the shape of a sunflower, with petals radiating out from the centre. Each "petal" or triangle segment of the sunflower serves as a point to attach the warp threads. By tying the threads to the inner edges of each triangle, you create a radial warp structure that is perfect for weaving in a circular pattern. This method is particularly suited for projects like coasters, mandalas, or decorative wall hangings. The plastic plate provides a sturdy base that can withstand the tension of the threads, ensuring a durable and stable loom. Additionally, the sunflower shape adds an aesthetic element to the loom itself, making the process of weaving both functional and

visually pleasing. This approach to loom-making is not only resourceful but also inspires creativity, as the round format opens up new possibilities for intricate and symmetrical designs.



Activity 4: Improvised Loom with Plastic or Paper Plate

**Materials:**

- Plastic or paper plate
- Yarn or thread (in various colors)
- Scissors
- Ruler
- Pencil

**Instructions:**

1. **Selecting the Plate:**
   Choose a flat plastic or paper plate.
2. **Marking and Cutting:**
   Use a pencil and ruler to mark points around the rim of the plate at equal distances. Typically, 8-12 points are sufficient, depending on the size of the plate.
   Make small slits at the marked points using scissors. Ensure the slits are deep enough to hold the yarn securely.
3. **Creating the Warp Threads:**
   Select a yarn for the warp threads (vertical threads on the loom).
   Thread the yarn through the slits, starting from one and continuing across, creating a "star" pattern with the yarn passing through the center of the plate.
   Tie the ends of the yarn behind the plate to secure them in place.



**Figure 13. Improvised loom with plastic plate – eLearning activity**

## 6.1.2. Learning Mathematics Through Paper Weaving

This activity regards teaching basic mathematical concepts through paper weaving, combining creativity with learning. The activities aim to provide an enjoyable and interactive experience for students, complete with detailed instructions, required materials, and the educational benefits of the process.

Overview of the Activity (see: Creating Patterns with Paper Weaving

- Introduction to Patterns:
  - Discuss the concept of patterns.
  - Show examples from everyday objects like clothes and ceramics.
  - Explain the repetition of designs and colours.
- Preparing the Papers:
  - Provide children with 2-3 coloured papers.
  - Use rulers and pencils to cut strips of paper 1-2 centimetres wide.

- Creating the Base:
    - Cut one paper lengthwise into strips, leaving 2 centimetres intact at the top.
    - Weave strips from the other coloured papers in and out of the base strips.
- Creating Patterns:
    - Arrange the strips in a specific order (e.g., red-yellow-blue).
    - Discuss the repetition of the pattern throughout the woven piece.
- Symmetry and Repetition:
    - Explain symmetry and its application in patterns.
    - Create symmetrical patterns using the coloured strips.
- Presentation and Discussion:
    - Present the finished woven pieces.
    - Discuss the symmetry or asymmetry and the repetition of elements.
- Advanced Patterns:
    - Experiment with more complex patterns, such as diagonal or zigzag designs.
    - Combine different patterns in one woven piece.
- Recap and Conclusions:
    - Recap the concepts of patterns and symmetry.
    - Discuss how weaving helps in understanding mathematical concepts.

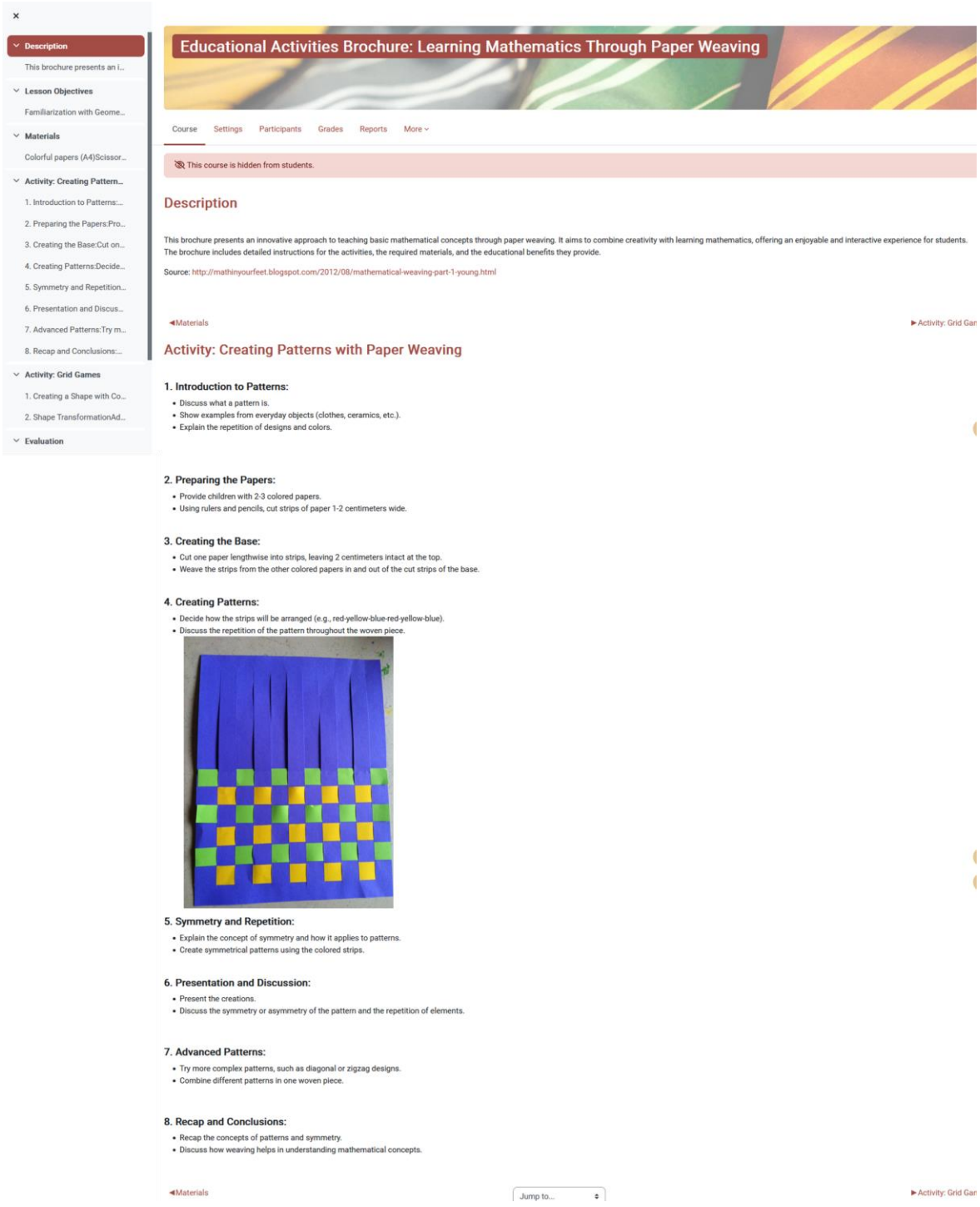



**Figure 14. Learning Mathematics Through Paper Weaving – eLearning activity**

# 7. Conclusions

This deliverable has explored the intersection of serious games and traditional crafts education, highlighting the innovative potential of using game-based approaches to preserve and teach traditional skills. Through an examination of various game formats—digital, physical, and hybrid—this work has showcased the diverse methods available to engage learners in craft education.

The integration of serious games into traditional crafts education offers significant educational benefits. By creating interactive and immersive learning experiences, these games make traditional crafts more accessible and engaging for learners of all ages. The use of digital games allows for a wide-reaching impact, bringing complex craft techniques to a broader audience in an appealing and user-friendly format.

Physical and 3D-printed games provide tangible, hands-on experiences that are crucial for mastering the manual skills required in traditional crafts. These games enable learners to directly interact with materials and tools, fostering a deeper understanding and appreciation of the crafts. The improvised loom activities demonstrate the value of creativity and resourcefulness in education, showing that effective learning can be achieved with simple, everyday materials.

The educational activities outlined in this deliverable emphasize the importance of practical, experiential learning. By engaging in these activities, learners can develop not only technical skills but also critical thinking and problem-solving abilities. The blend of traditional techniques with modern educational tools reflects a forward-thinking approach to preserving cultural heritage while adapting to contemporary educational needs.

In conclusion, this deliverable highlights the transformative potential of serious games in traditional crafts education. By combining the richness of traditional skills with the engagement of game-based learning, we can create dynamic and effective educational experiences that inspire and educate future generations. This work serves as a foundation for further innovation and development in the field, aiming to enhance the way we teach and preserve traditional crafts.

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