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Graveler: A serious game in numismatic teaching

Abstract This paper discusses the development and application of a numismatic *serious game* created as part of the *Blended Intensive Programme* (BIP) within the *CIVIS European University Alliance* in the summer semester of 2024. The game, designed to engage students in historical and technical aspects of numismatics, was incorporated into a BIP focused on the history of money and coinage. It aimed to educate students on the processes of resource extraction and coin production through interactive, immersive gameplay. This paper highlights the educational potential of *serious games* in numismatic teaching, offering insights into the design and implementation challenges, as well as the pedagogical advantages of game-based learning.

Zusammenfassung Dieser Beitrag beschreibt die Entwicklung und Anwendung eines numismatischen *Serious Games*, das im Rahmen des *Blended Intensive Programme* (BIP) der *CIVIS European University Alliance* im Sommersemester 2024 entwickelt wurde. Das Spiel, das die Studierenden mit historischen und technischen Aspekten der Numismatik vertraut machen soll, wurde in ein BIP integriert, welches sich mit der Geschichte des Geldes und der Münzprägung befasst. Ziel des Spiels war es, den Studierenden die Prozesse der Rohstoffgewinnung und der Münzherstellung durch interaktives, immersives Gameplay näher zu bringen. Dieser Beitrag beleuchtet das pädagogische Potenzial von *Serious Games* im Studium der Numismatik und bietet Einblicke in die Herausforderungen bei der Gestaltung und Umsetzung sowie in die pädagogischen Vorteile des spielbasierten Lernens.

Keywords Archaeogaming, Serious Games, Game Design Thinking, Game Based Learning, RPG Maker

Krmnicek, Stefan – Körner, Kevin (2025): Graveler: A serious game in numismatic teaching, in: Bolder-Boos, Marion – Hageneuer, Sebastian – Pantelidis, Georg (Hrsg.), *Digitale Methoden des Lernens und Lehrens in der Archäologie,* Heidelberg: Propylaeum, S. 81–93, [online] https://doi.org/10.11588/propylaeum.1572.c23242.

Introduction

The CIVIS alliance is made up of eleven European universities whose joint activities are primarily funded by the EU's ERASMUS+ programme.[1] A central CIVIS agenda concerns the organisation of so-called *Blended Intensive Programmes* (BIP), which are designed as cross-university and cross-campus teaching formats and are open to students from the partner universities represented in the alliance. The BIP are organised by various disciplines, usually with an interdisciplinary character. The BIP, in the context of which the numismatic *serious game* presented here was used, was entitled *The Heritage of Money and Coinage: Metal Matters – From the Mine to the Mint* and was organised by Annalisa Polosa (Sapienza University of Rome), Alexander Jost (University of Salzburg), Nanouschka Myrberg Burström (Stockholm University) and Stefan Krmnicek (University of Tübingen).[2] The organisers' specialist expertise included numismatics and monetary history from the perspectives of Classical Antiquity, the Scandinavian Middle Ages and early modern East Asia. The aim of the BIP was to familiarise students with the technical, social and cultural implications of resource extraction and its transformation into the medium of money from a historical perspective. The 20 students taking part in the BIP came from different universities and disciplines, specialising in archaeology, history and economics.[3] The BIP was divided into a five-week online phase ("Digital Campus") and a one-week face-to-face phase ("Summer School"); the face-to-face teaching was held at the University of Salzburg, where the scientific experiments were the focus (e.g. extraction of copper through "wet chemical processing") alongside traditional lecture formats and museum visits as well as mining archaeology excursions. In the online phase, guest lectures by international experts delved deeper into the topic of the BIP.[4] As a special event, the last session of the Digital Campus was held online on the University of Tübingen's e-learning platform *Graveler*.

As early as 2008 the Deutscher Kulturrat e.V.[5] accepted the *German Computer Games Association* (Game) into its ranks, thereby recognizing digital computer games

1 For the CIVIS-Allianz, see https://civis.eu/de [accessed 10-14-2024].

2 For further information, see https://civis.eu/en/learn/civis-courses/the-heritage-of-money-and-coinage-metal-matters-from-the-mine-to-the-mint [accessed 10-14-2024].

3 Aix-Marseille University, National and Kapodistrian University of Athens, University of Bucarest, Free University of Brussels, Sapienza University of Rome, Paris Lodron University of Salzburg, University of Stockholm and University of Tübingen.

4 Carmelo di Nicuolo (Università degli Studi di Roma Tor Vergata): A Sea of Stone, Metal and Clay. The Aegean "Eldorado"; Thomas Faucher (Centre d'Études Alexandrines): Experiments in Greek Minting Techniques; Mary Van Buren (Colorado State University): Indigenous Silver Production in the Colonial Andes; Matt Marone (Mercer University): Casting Chinese Cash Coins.

5 https://www.kulturrat.de [accessed 01-29-2025].

as cultural assets worthy of protection.[6] In the years that followed, society increasingly developed into a so-called *gamer culture*, as evidenced by the rapid growth of the game industry worldwide[7] and cultural developments such as LAN parties, cosplay and game conventions. In line with this trend, the use, research and number of publications related to game-topics, such as *gamification*, *game-based learning* and *serious games*, increased frequently (Zohari et al. 2023). However, these terms are often used synonymously although their didactic approaches differ fundamentally (Becker 2021): In *gamification* game-mechanics such as reward systems or leader boards are used to motivate people to perform a (often as "somewhat boring" mentioned) task faster, more accurate or at all. So, it can be stated that *gamification* involves the use of game mechanics in non-game contexts (Deterding 2010). *Game-based learning* (GBL) on the other hand describes the use of "normal" (digital) games for learning purposes. Two examples often used in academia are the Sid Meiers' *Civilization* series[8] for teaching historical content (Probert 2013) as well as the correlation between surgeons' experiences and playtime with the 3D-ego shooter game genre and their skillset required for surgery (Gupta et al. 2021). At last, *serious games* are individually designed and implemented (digital) games created for purposes other than, or in addition to, pure entertainment (Sawyer – Rejeski 2002). They are mostly used to create games for various topics (archaeology, health, politics, …) that focus on teaching content, changing behavior or advertising attitudes. Therefore, in contrast to "classic" games, *serious games* are primarily designed for the use in an educational, training or therapeutic context. They also integrate educational content or simulations in order to teach certain skills or solve complex problems. The concepts and strengths of games are utilized to generate the greatest possible intrinsic motivation in players so that they can learn the didactic objectives in a targeted manner while playing the game (Michael – Chen 2005). Although *serious games* mostly fit best to the didactic goals of a teaching project they often suffer the problem that game development itself is already quite complex work, requiring various expertises and the further addition of didactic objectives exacerbates this (Salen 2007). Therefore, most *serious games* are developed by academia and focus on few didactic elements to be scientifically researchable (Laamarti et al. 2014).

Based on the growing interest in games as didactic media, *Graveler* has been developed at the University of Tübingen since 2020 by the Global Awareness Education department in close collaboration with the Master's Specialization Digital Humanities, the University Didactics department and the game design company *Ncite*. The aim of the original project was to create a virtual trip around the world in the

6 https://www.game.de/topics-archive/digitalespiele [accessed 03-05-2025].

7 https://www.game.de/publikationen/jahresreport-2024 [accessed 01-29-2025].

8 https://civilization.2k.com [accessed 01-29-2025].

format of a *serious game* for the purpose of conveying and discussing the basics and perspectives of the globalisation debate. The technical realisation allows students to travel the world as a group to solve tasks in selected cities. In order to impart a broad knowledge of the regions travelled through, the game offers the possibility of integrating scientific texts in addition to video and graphic materials.[9] Based on four Global Awareness classes, an initial study was conducted to examine the students' acceptance of the game and to identify positively perceived elements as well as those needing optimisation (Körner et al. 2024). The results showed that students perceived *Graveler* as an intuitive to use and motivating tool. Moreover, the desired didactic learning outcomes were validated based on a qualitative analysis of the students' term papers. Finally, the elements of *Graveler* which were perceived worth improving by the students provided helpful feedback for the BIP-class such as an improved concept for the use of the spatial chat – an integrated video conferencing functionality component.

Two factors led to the e-learning tool *Graveler* also being utilised for the CIVIS BIP *The Heritage of Money and Coinage: Metal Matters – From the Mine to the Mint:* On the one hand, the technical functionality of the tool was particularly well-suited for the didactic scenario of the BIP, as the geographically dispersed students could engage with the material in a playful manner directly in their browser, without the need for additional hardware or software. Secondly, *Graveler* was further developed for the special needs of the BIP by Kevin Körner and Marie-Helene Baten (Tübingen Master's specialisation in Digital Humanities) with funding from the *Foundation for Innovation in Higher Education* (Stiftung Innovation in der Hochschullehre). As part of this work, two levels (or "worlds") were programmed specifically for the content of the CIVIS-BIP *The Heritage of Money and Coinage: Metal Matters – From the Mine to the Mint*: A game on Roman metal mining and coinage production as well as a game on currencies and metals in late imperial China.

The technical basis of *Graveler*

Due to its wide range of functions, *Graveler* offers students an immersive experience. In addition to learning platform characteristics such as document management and integrated literature references, it offers a freely configurable web-based multiplayer role-playing game (RPG) with a spatial chat – i.e. when several players meet in the game, a video conference opens in the browser. In order to maximise the success of

9 https://uni-tuebingen.de/einrichtungen/verwaltung/iii-studium-und-lehre/ueberfachliche-bildung-und-berufliche-orientierung/newsfullview-ueberfachlichebildung/article/innovative-lehre-mit-dem-neuen-serious-game-graveler [accessed 10-14-2024].

the game, the quality criteria recommended (Caserman et al. 2020) were considered during development, such as clear feedback, well-defined goals and graphics suitable for the target group.

In *Graveler*, students gain brief insights into the local cultural and academic environment as they virtually travel to different cities. Players navigate through scenic environments and engage with a variety of interactive elements. Non-player characters (NPCs) guide players and contribute to the storytelling. In addition, interaction points provide text and links to external resources on the World Wide Web, such as audios, videos, 360-degree images, browser games or collaborative workspaces, such as *Miro*[10] or *EduPad*[11]. During their journey, players are accompanied by their travel diary, the so-called *Traveldex*, which is inspired by the Japanese Eki stamp books. This diary graphically records the most important events of their virtual journey, e.g. the arrival and departure dates for the regions and the achievements unlocked. Interactions at specific points of interest within the virtual cities – highlighting unique objects, places or people – result in stamps that are added to the *Traveldex* and provide structured information. In addition, ideas and thoughts can be collected in a digital notebook.

Players encounter four types of tasks while playing: multiple-choice questions, collecting objects, delivering and combining objects as well as mini-games. These points primarily serve to advance the plot by blocking a passage through certain areas of the game world until they are solved. Players must collect information and objects in the virtual city and use the associated resources to progress. In addition, some game points can add entries to the *Traveldex*, especially when the main task of a region has been completed. In addition to the traditional role-playing elements, *Graveler* offers a spatial chat feature that allows players to initiate video calls in their browser when multiple characters meet in the virtual city. This integration facilitates student interaction during the exploration phases and allows them to share and discuss their findings. It also serves as the primary communication channel during group discussions. *Graveler* also has elements of learning platforms for course and document management. Additional documents can be stored in a structured manner and only made accessible to students at certain times. These include literature for further research and exercises that must be completed within a certain period of time. Students upload their solutions directly to *Graveler*, where tutors can download and assess the submissions before providing feedback.

10 https://miro.com/de [accessed 10-14-2024].

11 https://edupad.ch [accessed 10-14-2024].

Level "Roman metal extraction and minting"

The aim of the game is to teach players that, during the imperial era, Roman *denarii* were made from silver and *asses* from copper. To this end, the game was divided into an urban setting with the Roman mint, an imaginary mining region and a "travelling" game area. In Rome, users learn through interaction with NPCs that the two denominations *denarius* and *as* are made of different alloys and are also asked to obtain metals from the mines for the coin production at the mint. To do so, the players must travel to the mines and obtain the correct ore from the mine so that either *denarii* (silver) or *asses* (copper) can be minted in Rome. In the three sections of the game (Rome, travelling, mines), in addition to the information about the actual quest, in-game features convey additional knowledge about the Roman world.

Fig 1: The Colosseum in Rome (Level "Roman metal extraction and minting").

The Rome setting consists of generic Roman-looking houses, with fountains, statues, pine trees and porticoes scattered across green areas. The Colosseum can be seen at the bottom of the game area **(Fig. 1)**. The imperial mint is thus positioned in the area of today's Basilica San Clemente in accordance with archaeological research (Burnett 2001). The mint stands out from other buildings as a particularly architectural ornate building. In a Roman *caupona*, an inn, the players can learn from the imaginary innkeeper Lucius that wine and bread were paid for with silver *denarii* and copper *asses*

Fig 2: Conversation in a Roman *caupona* with innkeeper Lucius (Level "Roman metal extraction and minting").

as well as where the mint can be found **(Fig. 2)**.[12] At the same time, a linked blog entry from the British Museum on the production of Roman bread helps to contextualise the scientific facts for players without specialist knowledge.[13] At the mint, the head of the mint, the *optio* Felix, asks the players to obtain metals from the imperial mines so that new coins can be minted.[14] On site, the slave Zosimus provides additional background information for the players on the minting process from his own perspective.[15] The link to a photograph of the altar of the *optio* Felix from Mons Caelius from the image database of Ohio State University[16] is intended to connect the virtual visualisation with ancient reality – both the *optio* Felix and the *malliator* Zosimus are documented in the consecration inscriptions from Mons

12 Lucius: "Hello my dear friend, do you fancy a jug of wine and some bread for refreshment? The wine is an excellent Falernian wine, it costs one silver denarius. The bread is not expensive, it only cost two copper asses." […] "You are not a local Roman, you are a foreigner from far far away, right? I recommend you to visit the Roman mint. There you can learn more about how our coins are produced. You can't miss the mint, it is the huge building next to a fountain and a statue of Augustus."

13 Making 2,000-year-old Roman bread https://www.britishmuseum.org/blog/making-2000-year-old-roman-bread [accessed 10-14-2024].

14 *Optio* Felix: "Salve, I am Felix, I am in charge of the production process in the mint. Please help me. I must produce new *denarii* and *asses*, but we lack the metals to strike them. Please travel to the imperial mines and bring me the metals."

15 Zosimus: "Oi! You there! I am Zosimus. I am a *malliator*, I strike the coins using a hammer. I hit a die that impresses the coin-design on the blank metal disc. This is really a tough job, but I am proud to work as slave in the imperial mint. Look at my muscular arms. If we get enough silver, I strike many shining *denarii* per day."

16 A dedication by Felix, an imperial freedman in charge of the technical side of the mint in Rome http://hdl.handle.net/1811/99937 [accessed 10-14-2024].

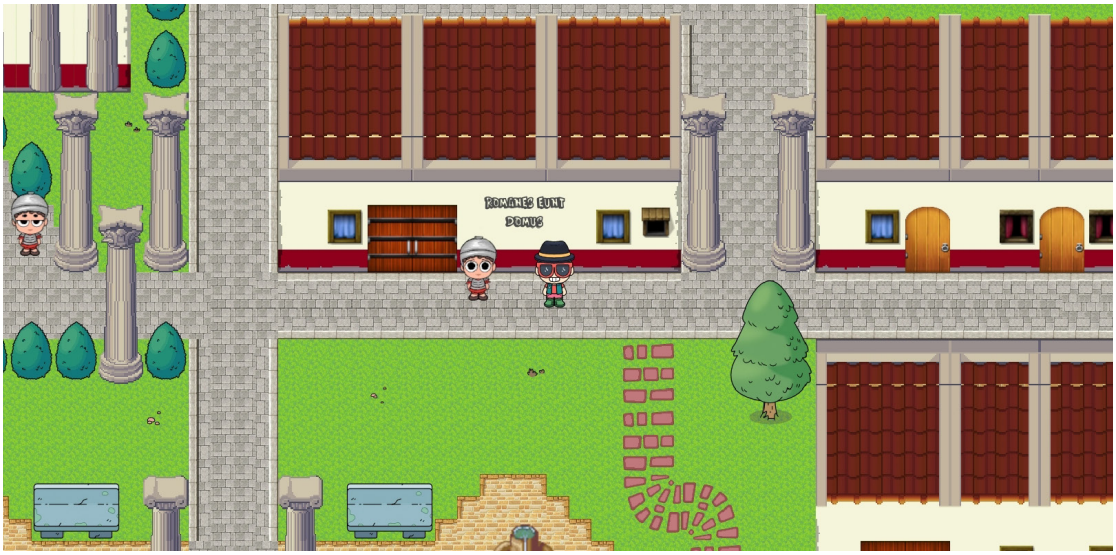

Fig 3: Roman town house with the *dipinto* "Romanes Eunt Domus" (Level "Roman metal extraction and minting").

Caelius (Jehne 2016). In order to make the setting in Rome more approachable to a non-specialist audience, popular science infotainment is also embedded at various points with video and text material, for example on the Roman water supply, the visual reconstruction of ancient Rome and the life of children in Roman antiquity.[17] Presumably for a more sophisticated audience, the *dipinto* "Romanes Eunt Domus" known from the movie *The Life of Brian* (Stiebel 2015), which can be found on a house wall, has a humorous recognition value **(Fig. 3)**. As soon as the players have explored the area and received the necessary information about their quest, they can switch to the next section using the travel button.

In the "travelling" section of the game, the knowledge acquired in Rome about *denarii* and *asses* is consolidated: in an inn along the way, the players learn from another imaginary innkeeper called Gaius about travel options in imperial times and the value of Roman money in everyday life.[18] The project ORBIS: *The Stanford Geospatial Network Model of the Roman World* linked here provides users with additional information on spatial organisation

17 National Geographic. Roman Aqueducts https://education.nationalgeographic.org/resource/roman-aqueducts [accessed 09-09-2024]. A Glimpse of Teenage Life in Ancient Rome https://www.youtube.com/watch?v=juWYhMoDTN0 [accessed 09-09-2024]; Ancient Rome Reborn Through Virtual Reality https://www.youtube.com/watch?v=XoTV1-EAcDw [accessed 10-14-2025].

18 Gaius: "Hello, my dear traveller. Would you like to stay in my hostel over night? Or do you just want some olives for a quick snack? Or would you like to buy a horse to arrive at your destination in time? You can have the olives for three *asses*. The horse is a really fine breed with speed and endurance. It costs ten *denarii*. Anyway, take a seat now and enjoy your rest. Travelling can be tiring due to the long distances in the Roman Empire."

Fig 4: The mining area with the entrances to three mine shafts (Level "Roman metal extraction and minting").

and transportation in the Roman Empire.[19] In the next section of the game, players enter the mining area. The setting is visualised by bare, earthy terrain in which the entrances to three mine shafts are located, in front of which are wooden huts and different piles of metal (silver, copper and iron) **(Fig. 4)**. The players reach the various tunnels via a beaten track. Workers in front of the mines report on the ores mined here.[20] The embedded scholarly publication on Roman mining (Hirt 2020) and the link to the *Oxford Roman Mining Database* help to learn more about Roman resource extraction.[21] Depending on which ore the players choose, they can use the travel button to return to Rome with silver, copper or iron.

When the player has brought silver and copper to the mint, new *denarii* and *asses* can be produced. As a reward, the player is praised by the *optio* Felix[22] and a coin is shown, that has been minted from the metal in question[23], which the player receives as

19 ORBIS: The Stanford Geospatial Network Model of the Roman World https://orbis.stanford.edu [accessed 10-14-2025].

20 Silver miner: "Hi there, I am Severus, I work in this mine. It is a very hard job. The Roman mint needs metal for producing coins? We extract silver from this mine." Copper miner: "What, the Roman mint needs fresh metal to strike new coins? Well, this is a copper mine. Help yourself, I must return to work." Iron miner: "Salve, my name is Narcissus, I was enslaved, but now I am a proud freedman and work for a fine salary in this mine. Yet, the work is really hard. Anyway, the Roman mint wishes to strike new coins? This is an iron mine, you can get plenty of iron ore from here."

21 Oxford Roman Mining Database https://oxrep.classics.ox.ac.uk/databases/mines_database/ [accessed 10-14-2025].

22 *Optio* Felix: "Excellent, with the silver ore we can produce new *denarii*! Hey Zosimus, your break is over, return to work and strike new *denarii*! My friend, look at this fine silver *denarius*. You can keep it as payment for your excellent service."; *Optio* Felix: "Brilliant, we need copper to strike new *asses*! Hey Zosimus, your break is over, return to work and strike new *asses*! Look, here in my hand I hold a fine copper *as*. Keep it as token of friendship for your efforts carrying all the copper ore to the mint."

23 *Denarius* of Domitianus, minted 93–94 CE https://www.ikmk.uni-tuebingen.de/object?id=ID6051; *As* of Titus from 77–78 CE https://www.ikmk.uni-tuebingen.de/object?id=ID1692 [accessed 10-14-2025].

a virtual gift. When iron ore is brought back from the mines, the *optio* Felix points out to the player that *denarii* were made from silver and *asses* from copper and one has to travel back to the mines to select the correct ore.[24]

Level "Currencies and metals in late imperial China"

In this game, which is set in an imaginary city in the Yangtze Delta in the late 18th century (similar to the historical Suzhou), players are introduced to the so-called bi-metallic Chinese currency system and the small-cash problem.

The player arrives in China with a few Maria Theresa thalers and wants to buy something to eat. He is turned away at the food stall and is told to change the Maria Theresa thalers (Buddha head money) into copper cash first. He meets a rice merchant from the south-west who has come across the Imperial Canal on his ship and offers him an excellent exchange rate. He gives him so many copper coins that he can hardly carry them. The player goes back to the food stall with the copper coins and learns that this is "small cash" and that this money is not accepted. After this he goes to the mint where small cash is being collected and has the problem explained to him. The small cash is melted down and he is given regular copper coins, from which he can use some of the coins to buy food. The player can now continue travelling to the hinterland in a camel caravan.

The caravan leader advises him not to take all the heavy copper money with him on the journey and sends him to a private money changer, who exchanges it for silver bars. With these, the player goes to the camel caravan and sets off for Xi'an. The level is now successfully completed.

The normal houses are modelled on the white houses with black roofs from the Yangtze Delta region **(Fig. 5)**. In the cookshop, one can buy some food (with regular copper money). There are different dishes, which are distinguished by the character on the flag outside the building. Ships play a major role in this level as well, since they are moored in the roadstead almost everywhere there is enough space. The players have docked on a ship and at this moment they start the game. A merchant ship arrives from the south-west, where a lot of bad money circulates. Here one can exchange thalers for bad copper coins. There are also various ships with information texts that reject the player if he wants to change money. Behind the mint, ships can be found that bring everything one needs to cast coins: Copper, lead, zinc and charcoal. Not far from the mosque, a camel caravan is being loaded. If one wants to come along, one needs Chinese silver money in the form of bars. Once the player has delivered the silver to the caravan, the player can move on with it to the city's hinterland.

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24 *Optio* Felix: "Why do you bring me iron ore? Roman coins are made either of silver or copper. Go back to the mine and bring me the right metal!"

Fig 5: The mining area with the entrances to three mine shafts (Level "Roman metal extraction and minting").

Conclusion

In summary, it can be stated that the *serious game* designed with the e-learning tool *Graveler* is an experimental project capable of presenting individual aspects of numismatics in an innovative manner. The combination of the use of new technologies and playful content leads to a new perspective on Roman coins as well as Chinese money and how to communicate academic knowledge about numismatics. The teachers and, according to the qualitative feedback received so far, also the students actively involved in the Spring School were surprised that the synthesis of historical settings visualised in the broadest sense and modern-looking avatars in 2D anime style does not detract from the fun of the game and the transfer of knowledge in any way (Krmnicek – Körner 2024). The *Graveler* application can currently be accessed via the website of the University of Tübingen, study programme *Global Awareness Education.*[25]

Thanks to funding from the ZOERR call for proposals for *Digital teaching/learning materials*, the project presented will be further developed by the authors of this article in cooperation with the Department of Provincial Roman Archaeology at the University of Freiburg as freely available digital teaching and learning material (Open Educational Resources – OER). Under the working title *AncientWorldTravels*, the *serious game* will contribute to the field of *archaeogaming* (e.g. Reinhard 2018), in which

25 https://app.graveler-staging.philosophie.uni-tuebingen.de/new/landing [accessed 10-14-2025].

students of archaeology explore the worlds created by experts directly in their browser and acquire in-depth knowledge in a playful way with in-game accessible scholarly literature, stories and additional external resources. The didactic plannings as well as the game design process will include lessons learned from the project presented in this paper. In addition, a scientific analysis of the ZOERR-projects results, in comparison to BIP-project ones, is scheduled and will provide more detailed insights in the effectiveness of the *Graveler* system in numismatics and archaeology teaching.

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