

Simulating Digital Classics in Classical Teaching: A New Approach for New Demands in the Education of Classical Archaeology*

***Forschendes Lernen*¹ and digital classics: multiple demands**

Linking research and teaching is a central goal in academic curricula,² and arguably represents the most promising approach for the demands of working in the ‘new’ field of digital classics. Since the future of young researchers will include not only the use of existing digital methods but even more the development of new methods within interdisciplinary teams, academic teaching must choose appropriate didactic models in the students’ curriculum. In order to become ‘digital classicists’, the required qualification profile for students of classical archaeology will inevitably change in the future. As experts in their discipline, these students will of course have to develop relevant research questions, detect problems of method, recognise and evaluate promising approaches, discuss these, and contribute to research networks by using their specialised, deep knowledge. In addition, students will have to do this in an environment of new and promising, computer-based methods and possibilities, which they normally will not be able to develop on their own, but in cooperation with computer scientists. Because of these interdisciplinary projects, students need to be trained in self-determined project management and teamwork, in which the sharing and development of both individual and collective skills is indispensable. Therefore, academic teaching at universities is today confronted with various notably demanding challenges.

* We would like to thank the organisers of the conference *Teaching Classics in the Digital Age* Stefan Feuser, Stephanie Merten, and Katharina Wesselmann for the invitation, and all participants for the fruitful discussion of our presentation. In addition, we would especially like to thank Ronak Kosti and Prathmesh Madhu of the Pattern Recognition Lab at the Friedrich-Alexander-Universität Erlangen-Nürnberg for generously supporting our teaching project, and Uwe Fahr, who has given us helpful advice for didactic concepts.

The video of the talk, presented at the online conference *Teaching Classics in the Digital Age* on June 15–16, 2020, is available at <https://doi.org/10.5446/51990>.

1 After: Huber 2014, 25–26. For an equivalent in English, see e.g. learning by doing research/learning by inquiry. The phrase research-based learning (as used for similar approaches) is ambiguous, see Huber 2014, 27–28.

2 For the problems of defining different ways of linking research and teaching, see e.g. Jenkins et al. 2007, 28–29 (after Healey) and Huber 2014, 22–29 (with more references). For linking research and teaching in general, see e.g.: Healey 2005, 67–78; Huber 2009, 9–35.

» This book chapter is published under the Creative Commons Attribution Attribution-ShareAlike 4.0 International licence (<https://creativecommons.org/licenses/by-sa/4.0/deed.en>). Please note that individual, appropriately marked parts of the book chapter may be excluded from the licence mentioned or may be subject to other copyright conditions. If such third party material is not under the Creative Commons license, any copying, editing or public reproduction is only permitted with the prior consent of the respective copyright owner or on the basis of relevant legal authorization regulations.

To combine teaching and research in the field of classics can fill the gap between theoretical education and practice-oriented training. In order to develop the students' skills during their entire study programme, such courses should be implemented in regular academic teaching and not only in degree theses, as is more common. With this in mind, the concept of *Forschendes Lernen*³ requires a didactic model that involves the students in the active development of digital methods that are strongly connected to a 'traditional' research question. This is of high importance, because the students should equally increase their knowledge of the subject and its appropriate methods and develop further academic and professional skills. In addition, the didactic model should encourage the creative potential of the students in a way that will be highly conducive to their future work. Because these conditions will only result in an experimental course, the students will thereby obtain for themselves the experience of trial-and-error while making their own decisions.

According to this principle, we carried out a teaching project within the Institute of Classical Archaeology at the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) in the summer term of 2020 for BA and MA students together. In order to enable our students to take part in the fast-moving world of digital classics apart from the use of already extant digital tools, we connected the course to an ongoing research project called *ICONOGRAPHICS: Computational Understanding of Iconography and Narration in Visual Cultural Heritage*, also located at the FAU. This provided the complex infrastructure required for such an experimental course. The course was implemented as a practice course with 2 credits (*European Credit Transfer System*) in the 'Basismodul'/basic module of the BA study programme, complementing other courses (seminar and lecture) in this module. Students of the MA study programme have taken this course within the 'Ergänzungsbereich'/supplementary area with 2 credits (*European Credit Transfer System*). This area allows students to choose courses according to their specific interests.

The interdisciplinary research project *Iconographics* as a point of reference

In this interdisciplinary research project, which is funded by the Emerging Fields Initiative (EFI) of the FAU, together with Peter Bell, Andreas Maier, and Ute Verstegen, we were able to take initial steps towards developing computer-based methods that support the complex cultural analysis of images. When it comes to ancient images and their cultural significance, little research exists that applies computer-based methods.⁴

³ See the differentiation in: Huber 2014, 22–29.

⁴ See, for example, with regard to Greek vase paintings: Crowley, Zisserman 2013 and the project EGRAPHSEN of Martin Langner, University of Göttingen/Germany, and Lars Schmidt-Thieme, University of Hildesheim/Germany, <https://www.uni-goettingen.de/de/598165.html> (last accessed April 4, 2021).

Since our project represents a collaboration among the traditional humanities by focusing on image studies on the one hand (art history, classical archaeology, and christian archaeology), and the informatic sciences (computer vision) on the other, we address the question of how complex image structures and narrative image systems could be analysed in a more comprehensive (and perhaps quicker) way with the help of computer-based methods. In so doing, we do not aim to replace or imitate the human researcher, but to help them in their work – for example by providing additional information in situations of comparison, where similarity is traditionally judged on a more subjective basis. As an example, we focus on the relationship between the protagonists in vase paintings analysed through the use of specific gestures and postures. By characterising these schemes in a formal way and detecting them automatically, we hope to find visual similarities within the vast corpus of vase paintings and thereby to reveal meaningful image relations that help us to understand the cultural meaning of the scenes.

The simulation game *Digital Object Recognition and Iconographics*

The experimental course was planned as a simulation game in order to support the targeted skills and competences of the students in a curricular environment. From its origins in China and over centuries of use, predominantly for training men in a military context, the simulation game was first applied within a university environment in 1908, at the Harvard Business School.⁵ After its initial use for the teaching of economics, since the 1950s other fields, such as human resources management and legal studies, have also come to apply the method as an educational approach. However, its use in the humanities in German universities is still fairly rare.⁶

A simulation game is a verbal model that offers its users the opportunity to simulate social conflicts and processes of decision-making within a pre-structured teaching space. It demands cooperative forms of learning in terms of the users' predefined roles and groups in which the students are realistically and effectively confronted with a range of complex situations. Within these structures, students have to act responsibly and according to roles that might demand skills and character traits contrary to their own personalities. Consequences, results, and repercussions are experienced directly and become visible quickly.

Taking into consideration the curricular framework and the targeted educational objectives, the method was also adapted to the distinctive conditions of the scientific field of classical archaeology. A simulation game for this context had to be designed from

⁵ On simulation games as a teaching method see: Rogers, Godloe 1973, 729–732; Geuting 2000, 15–62; Klippert 2008; Kriz 2009; Rohr, den Ouden, Zepp 2013.

⁶ Economics: Koller 1969, esp. 55–94. For a recent example, see: Rogmans 2018, 92–103. See also Porter, Riley, Ruffer 2004, 426–443. Management: Otoi 2012, 845–849; Wardaszko 2018, 69–98. Law: Bird 2001, 203–237; Kese, Zoller 2013, C 2.4. An exception in the humanities is the simulation game 'Deutungssätze', especially developed for hermeneutic science: Kampmann, Knoch 2013, D 4.3.

targeted group:	Students of Classical Archaeology		
dimensions:			
fields of competence:	knowledge	values & attitudes	skills
subject-specific / professional	basic knowledge about theories and techniques of image analysis and interpretation application of this knowledge in description and categorization of images insights into techniques of Digital Humanities	hermeneutic attitude	target group specific scientific argumentation analytical and creative dealing with ancient imagery evaluating and connecting different methodical approaches
social	confrontation with basics of scientific communication and negotiation	(empathic) consciousness of own and other interests	assertiveness / willingness to compromise cooperation capacity for communication and teamwork
self-competence / reflective	knowledge about key points of competence-oriented teaching and learning	basic attitude of autonomous learning and working motivation to learn self-reliantly	ostentive documentation of own progresses presentation of complex relations shift of perspective / role
methodical	sovereign and target group specific presentation expertise of image studies methods in Classical Archaeology differentiate, characterize and evaluate different methodical perspectives (first) experience with methods of Digital Humanities	target group specific action	target group specific presentation

Tab. 1: Model of the targeted learning objectives and competences (T. Bendschus, after: Walzik 2012 and Kampmann, Knoch 2013).

scratch, so that the learning and training of specific classical-archaeological content and skills could be introduced within a highly practice- and output-oriented digital seminar.

Thus, we created a simulation game in which the students fulfil different roles as classical archaeologists in a fictional interdisciplinary project that also involves digital humanities and computer science. In this way, we hoped to impart the multiplicity and

interdisciplinary nature of methodical and subject-specific competences and skills that we wanted to target, as demonstrated by a profile of learning objectives (Tab. 1) that applies Sebastian Walzik's biaxial competence model to the simulation game.⁷

The simulation focuses on the fictional research project *Digital Object Recognition and Iconographics*, in which both lecturers function as principal investigators (PIs). This project is supported by Ronak Kosti and Prathmesh Madhu of the Pattern Recognition Lab at FAU as computer-vision experts. The fictional project is divided into two sub-projects, the first of which is entitled *Understanding Iconography with Computer Vision*, and whose aim is to investigate scenes of Heracles' and Apollo's struggle over the tripod as case studies for mythological scenes in Attic vase paintings of the 6th and 5th centuries BC. The research questions consider, for example, which individuals are always or almost always present in the particular scenes, which objects appear most frequently, and how they contribute to characterising and identifying the scene and its key figures. A second team forms the sub-project *Recognising Objects and their Significance in Attic Vase Painting Using Deep Learning Methods*, which investigates the occurrence and function of given objects in black- and red-figure vase paintings, such as the club, the tripod, and the lion's scalp. The research questions focus on the similarities and differences between the depiction of these objects, their association with certain figures, as well as their situational or attributive occurrence. For this project, we deliberately chose objects that also occur in the first team's scenes in order to encourage comparability and cooperation. Both sub-projects were directed to involve certain state-of-the-art digital methods and to evaluate the benefits of their use, including for basic techniques of digital humanities such as labelling and annotating within images. In addition, it was required not only to reflect on the possible benefits for classical archaeology, but also to communicate directly and cooperate with the supporting computer-vision experts. This necessarily involves changing one's perspective, dealing with a very different view on the material and images, comprehensibly expressing one's wishes and demands, and finding solutions cooperatively.

Each of the teams consists of the following roles and their respective tasks, supplemented by homework (e.g. writing summaries of selected book chapters):

- A team leader who takes co-responsibility for reaching the project's goals, conceptualises the team's overall cooperative structure, takes care of internal communication, holds meetings, communicates with the PIs and the other team leader, documents all progress, and writes a final report.
- A scientific-communication manager who is informed about the character of this position, takes co-responsibility for reaching the project's goals, conceptualises the team's overall cooperative structure, takes care of internal communication, communicates with the PIs, and writes two press releases.

7 Walzik 2012. See again: Kampmann, Knoch 2013, 66–69.

- A scientist who collects the images, image credits, and metadata from online databases,⁸ communicates about a reasonable selection of metadata, and contributes to the internal scientific report for the team leader.
- A scientist who makes annotations in the images using the VGG Image Annotator 2.0.10,⁹ saves and shares the annotations in different formats, communicates about a reasonable selection of metadata, and contributes to the internal scientific report for the team leader.
- A scientist who analyses the images iconographically according to the project's research questions and contributes to the internal scientific report for the team leader.

Given the limitations of the training seminar's curricular framework for advanced students, we structured the simulation game according to Heinz Klippert's phasing,¹⁰ which includes various stages based upon one another (Tab. 2). This scheme was adapted for a purely digital seminar that consisted of three bloc virtual ZOOM meetings, as well as group-working phases between each one, for which we created a communication structure on the university's online teaching platform StudOn.¹¹

In the first of three virtual meetings, we introduced the scenario of the game to the students. Tutorials and other materials were handed out, groups were formed, and roles were assigned accordingly. So-called 'team cards' (Fig. 1) informed the members of each sub-project's research questions, tasks, goals, and schedules, whereas 'role cards' (Fig. 2) gave information about each of the five predefined roles in each sub-project.

During the first group-working phase, the teams worked individually on their tasks and developed strategies to target their respective questions. Besides collecting images from the online databases-selecting and documenting the significant metadata-annotations were made on the collected images – markings of significant objects in polygonal or rectangle boxes – and sent to the computer-vision experts in order to train the computer model in recognising the annotated objects and giving predictions in other images. The transfer of 50 images, including metadata and annotations, was requested for a given deadline. Furthermore, the team leaders and scientific managers prepared the organisation of the second virtual meeting.

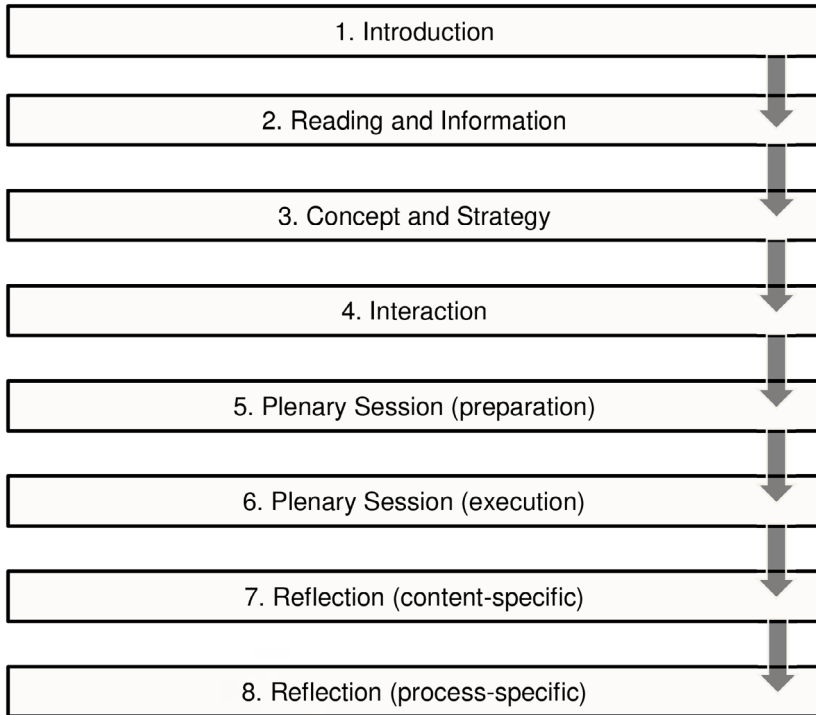
The second ZOOM meeting was held as a workshop in which the first results and problems were presented. As guests, the two computer scientists joined this meeting and offered feedback on the students' work, allowing for corrections and adjustments, especially with the annotations in the second group-working phase. The discussion was fruitful concerning the requirements, possibilities, and limitations of

8 ArkuBiD, <http://www.arkubid.uni-bonn.de/> (last accessed April 4, 2021) and Beazley Archive Pottery Database, <https://www.beazley.ox.ac.uk> (last accessed April 4, 2021).

9 <http://www.robots.ox.ac.uk/~vgg/software/via/> (last accessed April 4, 2021).

10 Klippert 2008.

11 <http://www.studon.fau.de> (last accessed April 4, 2021).



Tab. 2: General sequence of a simulation game (T. Bendschus, after: Klippert 2008).

the digital methods in supporting the classical-archaeological research. This in turn became a realistic simulation of an interdisciplinary research project, in which different perspectives and approaches communicated about the best possible solutions for various challenges.

In the second group-working phase, the teams worked independently on enhancing the data, adjusting the annotations, and correcting the metadata. Lastly, the scientific summaries, final reports, and various fictional press releases were required to be written, as well as the complete collection of images, metadata, and annotations to be provided.

Finally, a third virtual meeting was held in order to present and discuss the final results of the computer model and the classical-archaeological analysis, and to consider how one could contribute to the other. Besides this content-specific reflection, a major part of this phase of the simulation game was to give personal feedback and to reflect conclusively on each participant's individual experience in the so-called process-specific reflection phase.

Team 2: Recognizing Objects and their Significance in Attic Vase Painting Using Deep Learning Methods

TeamleiterIn: ####

Kommunikation & Orga: ####



Wissenschaftler 1: ####

Wissenschaftler 2: ####

Wissenschaftler 3: ####

Das Teilprojekt 2 des Forschungsprojekts „Digital Object Recognition and Iconographics“ (Prof. Dr. Corinna Reinhardt, Dr. Torsten Bendschus):

- Das Projekt untersucht mythische Bilder in der attischen Vasenmalerei und aktuelle Möglichkeiten, die Erforschung damit verbundener geisteswissenschaftlicher Fragestellungen mit Hilfe von Methoden der Computer Vision und Digital Humanities zu unterstützen. Zu diesem Zweck werden attische Vasenbilder des 6. und 5. Jhs. v. Chr. gesammelt, die eines oder mehrere folgender Objekte beinhalten: Dreifuß, Keule (Waffe), Kopfbedeckung mit Löwenkalp (Löwenexuvie), Löwenfell, Bogen (Waffe), geflügelte Schuhe. Als Ausgangsbasis für die weiterführende Forschung dienen diese Materialsammlung, die dazugehörigen Metadaten und eigenständig durchgeführte Annotationen (d.h. Markierungen der erwähnten Objekte im Bild) sowie die wissenschaftliche Einbettung. Die Daten werden Experten des Erlanger Pattern Recognition Lab zur Verfügung gestellt, um gemeinsam Modelle zur automatisierten Objekterkennung mittels Computer Vision zu entwickeln und zu verfeinern.

Leitfragestellungen:

- Was kennzeichnet diese Objekte ikonographisch? Wie variantenreich bzw. schematisch ist ihre künstlerische Umsetzung? Wie varianten- und facettenreich sind die (mythischen) Bilder, in denen sie auftreten? Mit welchen Haupt- & Nebenfiguren sind sie assoziiert? Wie werden diese Objekte eingesetzt, um die Protagonisten und ihre Interaktionen zu charakterisieren oder gar erst zu identifizieren? Treten sie situationsgebunden oder attributiv auf? Inwieweit sind sie in die Handlung integriert?

Zeitplan:

- 05.05.2020:** Abgabe der ersten 50 Bilder, Datensätze und der dazugehörigen Annotationen (Annotationen als json-Datei + json-Datei COCO-Format, Metadaten als CSV (Excel), Bilder als .jpg)
- 15.05.2020:** virtueller Workshop, erste Zwischenergebnisse, Plenumsbesprechung
- 06.06.2020:** Abgabe der Daten (.json, csv, Bilder)
- 01.07.2020:** Einreichung aller Abschlussberichte
- 10.07.2020:** Ende der Review-Phase / Abschlussmeeting

Fig. 1: A team card used in the simulation game (C. Reinhardt, T. Bendschus).

Evaluation of the simulation game

Besides the acquisition of specific knowledge about Attic vase paintings and iconography, we were especially interested in asking how the didactic model of the simulation game contributed to developing the skills mentioned in the beginning. Both in our estimation and according to the students, this simulation game supported their learning process in various ways. First, the course sustained the motivation of the students to

Planspiel: Digital Object Recognition and Iconographics



Rollenkarte:

TeamleiterIn

Ihr Profil: Sie sind verantwortungsvoll, strategisch, organisiert, systematisch, können Ziele definieren und vorgeben, können Aufgaben delegieren, können motivieren, können Feedback geben, können Diskussionen und Besprechungen leiten, sind problembewusst und lösungsorientiert.

Ihre weiteren Kompetenzen: Sie verfügen über gutes Englisch sowie ein fundiertes Wissen im Bereich der Klassischen Archäologie und sind interessiert an neuen digitalen Methoden.

Ihre Aufgaben:

- Lektüre von: E. J. Crowley – A. Zisserman, *Of Gods and Goats: Weakly Supervised Learning of Figurative Art*, *British Machine Vision Conference*, 2013; E. J. Crowley – A. Zisserman *The State of the Art: Object Retrieval in Paintings using Discriminative Regions*, *British Machine Vision Conference*, 2014; J. Mylonopoulos, *Odysseus with a Trident? The Use of Attributes in Ancient Greek Imagery*, in: J. Mylonopoulos (Hrsg.), *Divine Images and Human Imaginations in Ancient Greece and Rome* (Leiden 2010) 171–203
- Schriftliche Zusammenfassung von: N. Dietrich, *Das Attribut als Problem. Eine bildwissenschaftliche Untersuchung zur griechischen Kunst, Image and Context 17* (Berlin 2018) 1–27 (Teil 1: Was ist ein Attribut?) von TeamleiterIn Team 1 bzw. 28–48 (Teil 1: Was ist ein Attribut?) von TeamleiterIn Team 2
- Sie sind mitverantwortlich für das Erreichen der Projektziele und entwerfen ein Konzept für Arbeitsabläufe und Kommunikation (in Zusammenarbeit mit dem Wissenschaftsmanagement).
- Sie tauschen sich mit dem/der TeamleiterIn des anderen Projektes über die fachspezifischen Aspekte des Themas aus.
- Sie dokumentieren das Teamprojekt auf SluDoN.
- Sie verfassen [zusammen mit dem Bericht des anderen Teams (andere/r TeamleiterIn)] einen 6-8-seitigen *Abschlussbericht* auf Basis der Berichte der WissenschaftlerInnen und der Kommunikation mit den Kollegen der Computer Vision; dieser beinhaltet: die Ausgangslage, Fragestellung, den Verlauf der Arbeiten, die Durchführung, sowie Probleme und Problemlösungen und wissenschaftliche Einbettung und Perspektiven. Hierbei stellen beide Gruppen ihre unterschiedlichen Ansätze gegenüber.

Fig. 2: A role card used in the simulation game (C. Reinhardt, T. Bendschus).

learn continuously during the semester, especially under the difficult circumstances of the COVID-19 crisis, for which students have had to organise their learning system anew. A key factor for this was the teamwork involved, with different areas of responsibility. This experience of effective teamwork is very important for planning a future application of such a didactic model, because within a simulation game the lecturers should not interfere in the working process, even when the team might not proceed with their working system (trial and error).

Some of the students also took on roles which seemed not to fit closely with their personal competences and characters. This encouragement to shift their own perspective by taking on a specific role was evaluated as a benefit for both individual and professional self-management and for various communication skills. Emphasis was additionally placed on the students' reflections on the personal development of becoming part of a research team, especially regarding their own contribution to the working progress, the work of others, and the results.

Furthermore, it was our impression that most students became much more motivated to learn and work in this type of course because they saw that their own work contributed to the team's project goals and that their ideas were respected, discussed, and carried forward. Within their groups and when assigned a specific role, we saw

students become much more communicative than we thought from our experience in other courses. In the ‘workshop’ of the second virtual meeting, we especially observed their great creative potential.

Perspective: the implementation of digital classics in traditional curricula?

Despite the benefits of this didactic model, we also encountered different problems regarding the possible future implementation of such courses into traditional curricula.¹² One problem is to find space in the curricula for such experimental approaches. Especially regarding the combination or dual-subject bachelor programs that are typical of our *Kleine Fächer*, the space for such courses is limited alongside the important ‘regular’ ones, which train other important competences and deep knowledge of the discipline. A second problem regarding implementation is the proposed close relationship to an ongoing research project at a university institute or department. Because such projects are normally funded externally and are often linked to staff with temporary posts, it is difficult to make reliable long-term plans.

To solve these problems for actual curricula, one might consider including such a course chosen from a range of compulsory subjects in the curricula designed for practical experience, where normally the requirement is filled by excavation or museum work. The comparison with these work experiences is appropriate not only in terms of content but also with regard to the high workload required within the simulation game. Students and lecturers had to work more than for a customary course, which contradicts in some ways the normal workload for the *European Credit Transfer System* and the teaching load. For lecturers, various possible steps for teamwork need to be prepared with texts and materials at the beginning, since, once the course has begun, the lecturers should not be involved as ‘guiding’ figures, according to the didactic model.

Conclusion

The simulation game represents an exciting possibility for encouraging undergraduates and postgraduates in digital classics or classical archaeology at a very early stage of their future careers. In our opinion, research projects should support not only the promotion of young scientists following their PhD onward, but also regular students during their bachelor’s or master’s degrees.¹³ In connection with an ongoing project,

¹² See for various problems and possible solutions: Huber 2009, 22–28.

¹³ On the topic of linking teaching and research for undergraduates, see again: Huber 2009, 20–22.

one can also ensure that the required complex infrastructure for a simulation game already exists. Furthermore, everyone benefits from such a sustained discussion on the research project at different levels.


A simulation game, planned alongside an ongoing research project, forms an appropriate didactic model for training the multiple skills needed from graduates in the future field of digital classics. It implements actual research into everyday academic teaching and helps to create an environment of teamwork between students and professors at universities, one that forges a close link between teaching and research.

Authors

Torsten Bendschus, Institute of Classical Archaeology, Friedrich-Alexander-Universität Erlangen-Nürnberg

Torsten Bendschus finished his PhD in Classical Archaeology at the University of Rostock in 2016. Following a travelling scholarship by the German Archaeological Institute (2016/17) he was research assistant at the Institute of Classical Archaeology in Kiel. Since April 2019 he is scientific researcher within the interdisciplinary research project *Iconographics. Computational Understanding of Iconography and Narration in Visual Cultural Heritage* at the FAU Erlangen-Nürnberg.

torsten.bendschus@fau.de

Corinna Reinhardt , Institute of Classical Archaeology, Friedrich-Alexander-Universität Erlangen-Nürnberg

Corinna Reinhardt is junior professor for Classical Archaeology at the Friedrich-Alexander-Universität Erlangen-Nürnberg. Previously, she worked within the Collaborative Research Centre *Material Text Cultures* at Heidelberg. Her research focuses on Greek and Roman sculpture, the relation of image and text, the reception of antiquity as well as digital methods for image studies. She initiated together with Peter Bell, Ute Verstegen and Andreas Maier the interdisciplinary research project *Iconographics. Computational Understanding of Iconography and Narration in Visual Cultural Heritage* at the FAU Erlangen-Nürnberg.

corinna.reinhardt@fau.de

References

- Bird, Robert C. 2001. Integrating Simulation Games into Business Law Teaching, *Journal of Legal Studies Education* 19.2, 203–237.
- Crowley, Elliot J. / Zisserman, Andrew 2013. Of Gods and Goats: Weakly Supervised Learning of Figurative Art, in: *British Machine Vision Conference 2013*, Oxford.
<<http://www.robots.ox.ac.uk/~vgg/publications/2013/Crowley13/>> (last accessed April 4, 2021)
- Friedrich-Alexander Universität Erlangen-Nürnberg, Bereich Archäologische Wissenschaften. <<http://www.klassischearchaeologie.phil.fau.de/projekt-iconographics/>> (last accessed April 4, 2021)
- Geuting, Manfred 2000. Soziale Simulation und Planspiel in pädagogischer Perspektive, in: Andreas Blätte and Dietmar Herz (eds), *Simulation und Planspiel in den Sozialwissenschaften. Eine Bestandsaufnahme der internationalen Diskussion*, Münster.
- Healey, Mick 2005. Linking Research and Teaching Exploring Disciplinary Spaces and the Role of Inquiry-Based Learning, in: Ronald Barnett (ed.), *Reshaping the University: New Relationships between Research, Scholarship and Teaching*, New York, 67–78.

- Huber, Ludwig 2014. *Forschungsbasiertes, Forschungsorientiertes, Forschendes Lernen: Alles dasselbe? Ein Plädoyer für eine Verständigung über Begriffe und Unterscheidungen im Feld forschungsnahen Lehrens und Lernens, Das Hochschulwesen*, H. 1+2.
- Huber, Ludwig 2009. *Warum Forschendes Lernen nötig und möglich ist*, in: Ludwig Huber, Julia Hellmer and Friederike Schneider (eds), *Forschendes Lernen im Studium. Aktuelle Konzepte und Erfahrungen*, Bielefeld, 9–35.
- Jenkins, Alan / Healey, Mick / Zetter, Roger 2007. *Linking Teaching and Research in Disciplines and Departments*, York.
- Kampmann, Elisabeth / Knoch, Julia 2013. „Wir spielen Wissenschaft“. Ein Planspiel für die Geisteswissenschaften als Beispiel kompetenz-orientierter Hochschullehre, in: Brigitte Behrendt, Hans-Peter Voss and Johannes Wildt (eds), *Neues Handbuch Hochschullehre. Lehren und Lernen effizient gestalten*, Berlin, D 4.3.
- Kese, Volkmar / Zoller, Alexandra 2013. *Die Planspielmethode. Ein innovativer Ansatz in der juristischen Lehre*, in: Brigitte Behrendt, Hans-Peter Voss and Johannes Wildt (eds), *Neues Handbuch Hochschullehre. Lehren und Lernen effizient gestalten*, Berlin, C 2.4.
- Klippert, Heinz 2008. *Planspiele. 10 Spielvorlagen zum sozialen, politischen und methodischen Lernen in Gruppen*, Weinheim and Basel.
- Koller, Horst 1969. *Simulation und Planspieltechnik. Berechnungsexperimente in der Betriebswirtschaft*, Wiesbaden.
- Kriz, Willy C. 2009. *Lernziel: Systemkompetenz. Planspiel als Trainingsmethode*, Göttingen.
- Langner, Martin (University of Göttingen) / Schmidt-Thieme, Lars (University of Hildesheim) 2020. <<https://www.uni-goettingen.de/de/598165.html>> (last accessed April 4, 2021)
- Oțoiu, Catalina 2012. *Testing a Simulation Game as a Potential Teaching Method for a Masters Course, Human Resources Management, Procedia* 33, 845–849.
- Porter Tod S. / Riley, Teresa M. / Rochelle L. Ruffer 2004. *A Review of the Use of Simulations in Teaching Economics, Social Science Computer Review* 22.4, 426–443.
- Rheinische Friedrich-Wilhelms-Universität Bonn. arkuBID. <<http://www.arkubid.uni-bonn.de/>> (last accessed April 4, 2021)
- Rogers, Virginia M. / Godloe, Audrey H. 1973. *Simulation Games as Method, Educational Leadership* 1973, Friedrichshafen am Bodensee.
- Rogmans, Tim 2018. *Teaching Macroeconomics with the Econland Simulation Game and Learning Platform, Journal of Economics Teaching*, 92–103.
- Rohr, Dirk / den Ouden, Hendrik / Zepp, Jürgen 2013. *Planspiel in der Hochschulausbildung*, in: Brigitte Behrendt, Andreas Fleischmann, Niclas Schaper, Birgit Szczyrba and Johannes Wildt (eds), *Neues Handbuch Hochschullehre. Lehren und Lernen effizient gestalten*, Berlin.
- University of Oxford. Classical Art Research Center. <<https://www.beazley.ox.ac.uk>> (last accessed April 4, 2021)
- University of Oxford. Visual Geometry Group. <<https://www.robots.ox.ac.uk/~vgg/software/via/>> (last accessed April 4, 2021)
- Wardaszko, Marcin 2018. *Experimental Approach to Application of Simulation Games in Higher Education*, in: Christian Hühn, Birgit Zürn, Sebastian Schwägele, Sarah Hofmann and Friedrich Trautwein (eds), *Planspiele. Analyse und Wirkungen. Rückblick auf den Deutschen Planspielpreis 2015 und 2017*, Stuttgart, 69–98.
- Walzik, Sebastian 2012. *Kompetenzorientiert prüfen. Leistungsbewertung an der Hochschule in Theorie und Praxis*, Opladen. Partly based on: Weinert, Franz E. 2001. *Vergleichende Leistungsmessung in Schulen. Eine umstrittene Selbstverständlichkeit*, in: Franz E. Weinert (ed.), *Leistungsmessungen in Schulen*, Weinheim and Basel, 17–32.