

# Interdisciplinary classroom and remote learning using a newly developed Knowledge Network Online Whiteboard (KNOW)

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## Abstract

The idea for a new interactive teaching and learning tool derived from an interdisciplinary project and seminar at ETH called “Philosophical Reflections on Digital Methods in Architecture”. In order to facilitate the integration of the typically text-based work in philosophy with the more image-based work in architecture, we developed a custom-made software. The resulting *Knowledge Network Online Whiteboard* KNOW is an online tool for interactive student learning in large groups and with different media, from text, to pictures and videos. KNOW helps to make student work directly visible for everyone in real time, facilitating collaborative student learning, and creating a platform for supporting debate whilst at the same time acting as an archive. This paper first describes the didactic background of KNOW. This is followed by a brief analysis of the overall textual and pictorial structure of students’ contributions and by several small case studies on teaching formats in which KNOW was used. The paper ends with a critical discussion of KNOW and outlines goals.

## 1 Introduction – How to foster an interdisciplinary teaching practice?

In the following we will present how the analysis of didactic demands in an interdisciplinary learning environment led to the development of a collaborative online tool.

### 1.1 General considerations and didactic framework

The starting point for the present teaching concept and associated software tool was the idea of bringing together students from different disciplines, namely philosophy and architecture. As opposed to standard teaching concepts in which insights from different disciplines are presented separately rather than in direct interaction, we wanted to establish an integrated format, which nevertheless responds to the specific needs of the two disciplines involved; a format which would also be more timely with respect to student learning practices in the age of digitization and contemporary social and academic demands regarding problem-oriented work and critical reflection.

Despite the call for interdisciplinarity, students have to be well trained within their respective disciplines. At the same time, we are living in a so-called VUCA world; a world which is highly volatile, uncertain, complex, and ambiguous. Suggested strategies to cope with such a world in an academic contexts involve: (i) flat or few hierarchies; (ii) horizontal organisation structures

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that are represented as networks rather than silos; and (iii) design thinking, understood as the engagement in a generic process with many people in which rapid developments are facilitated and quick abandonments of ideas are possible (cf. Poppelreuter 2020, Baecker 2017).

It follows that students should learn about and practice such rather egalitarian and horizontally organized design thinking processes. This increases their intellectual agility and their “response-ability” because – if this training happens in an interdisciplinary context – students are encouraged to discuss their ideas and methods with students from other disciplines who use different methods and arguments to elaborate their ideas. By experiencing such an interactive and seemingly unstructured process, the students are encouraged to develop a “culture” of interacting under VUCA conditions. The students learn to become active and in this sense response-able members of a community dedicated to creating insight.

## 2 Teaching concept

We initiated a course entitled “Philosophical Reflections on Digital Methods in Architecture” in which we aimed at combining the “internal logic” of two disciplines into a single format: image-based work in architecture and text based work in philosophy. At the same time, we wanted to address different modes of teaching, in particular, remote learning of individuals and classroom discussions. Moreover, our goal was to make the whole process of knowledge acquisition and interdisciplinary discourse transparent to the students themselves, rather than encapsulating their work by means of assignments, which are only accessible to the lecturer. Our assumption was that learning success would become more sustainable if students directly contribute to, follow and reflect on the process of interdisciplinary knowledge production during the course (Sieroka et al. 2018) – and that this would be achieved best within a flat and responsive teaching format.

The overall goal of the course was to promote cooperation in knowledge generation across disciplinary boundaries and to make the processes involved transparent, instantly open to all and reflective. This required and supported collaborative work – not least because various media (text, image, design, etc.) had to be integrated and related to one another in terms of space and content, thereby establishing insight and relevance. This integration was central because knowledge exists not only in propositional form – that is, in the form of sentences and written texts (as typical for philosophy) – but is also generated through images, sketches and designs (as typical for architecture). Moreover, it arises as know-how by using these formats and the appropriate practices.

Indeed, this integration process was itself reflected and discussed during the course, which then marked a central part of the course’s philosophical ambition and significance. We read a heavily illustrated text about the concept of “objectivity”, how this concept changed over time, and how it depended on the way objects have been (pictorially) represented (Daston & Galison 2007). On the other side, Aby Warburg’s unfinished Mnemosyne Atlas can be mentioned here as a prominent historic precedence from the field of art history and history of architecture. Furthermore, the reading of Nelson Goodman’s *Ways of Worldmaking* emphasised that various worlds and worldviews can coexist without excluding each other (Goodman 1978). Nicolas Rescher elaborations on process philosophy underlined the importance of understanding processes in a dynamic world and that individual events are often “an elaborate story of interconnected developments” (Rescher 1996, 29). This was translated into the field of architecture through the associated reading of *Red is Not a Colour* by the architect Bernard Tschumi (Tschumi 2012). Tschumi is widely recognised for his study of events in architecture as an opposite of firm architecture understood as a fixed object or thing, which excludes social events.

Situated within a research environment at ETH, the ideas, methods and goals for the course are also linked to the specific research field of the Chair of Architecture and Digital Fabrication, a pioneering group in robotic fabrication and digital fabrication processes in architecture and

construction. With such background, it was our ambition to extend the idea of the course towards a critical concept of the “digital fabrication of thought” with the technical and intellectual domain closely interrelated. Thus, we considered it part of our overall aim (i.e. of promoting cooperation in knowledge generation) to involve the students in what we call a continuous *digital fabrication of thought* process.

This inevitably pointed towards the development of an online platform, where the work for a large group of contributors can be structured horizontally and everyone can be given equal rights. We started with a simple infinite online whiteboard for different media (text, images, PDFs, GIF), which in the seminar would allow for a big single representation (“map”) of all topics and discussions of the entire course. Working with the whiteboard would serve students to decode, acquire, and recall information about topics and discussions in a metaphorical spatial environment. Hence, the whiteboard becomes what educationalist call a “cognitive map” (Eden 1988), helping students to represent what they have learned. However, working with a whiteboard does much more. The students are part of the design thinking process in which this whiteboard map comes about in the first place. They are generating and organizing new knowledge, continuously restructuring their insights by “pushing aside arguments”, putting something “in focus” and establishing relations. The students become critically aware of what they are doing and, by rearranging contents and writing comments, train their response-ability as individuals within a larger group (Sieroka et al. 2018). As such, the process of knowledge acquisition itself becomes transparent to all students and resonates with the way KNOW is developed.

Allowing for such a continuous process marks a key difference to online platforms like Moodle and eScript. These are helpful tools, but serve other purposes such as course administration, annotation of given texts and the like (cf. Schiltz et al. 2017). In contrast, we aimed towards an online space of discourse. The notion of space as spatial organisation is fundamental for our ambition. Here lies a crucial difference to the “online discourses” as known from twitter or web-forums that are usually linear, discretized through links, chronological and / or weighted by quantitative methods (algorithms). In the case of KNOW the collaborative development of the space of learning (“learning context”) remains open and students develop and differentiate this context in a continuous way and always “live”, while a record is stored in the background. This comprehensive idea of collaborative development is not limited to the knowledge generation itself but extends to the software development of KNOW as students have always been active contributors, providing feedback and testing new versions.

Becoming a collective group of developers is a major advantage compared to available commercial, proprietary whiteboard applications such as *conceptboard* or *mural*. These tools cannot be scaled or adjusted for individual needs of specific fields due to their inhibiting licence. They are predominantly managerial tools that emerged within corporate environments where the customer of such a solution is a passive user and not an active developer. In contrast, KNOW uses a creative commons licence and its code will be publicly released on github, making it open to a global community of coders that can expand functionality and adapt KNOW to specific needs. Being open source, KNOW can also be hosted by any home institution (e.g. know.ethz.ch) meaning more control over where data is stored.

### **3 Teaching approach – A knowledge network online whiteboard**

In order to achieve our teaching goals and to enable students to interact in the desired fashion, we developed what we call a “Knowledge Network Online Whiteboard (KNOW). In sum, its didactic milestones and added value are:

- Enabling collaborative reflection and direct tracking of knowledge acquisition processes in conjunction with visual spatial strategies; a browser-integrated online whiteboard replaces the common linear data structures such as lists.

- Not being bound to a specific mode of knowledge acquisition (in the sense of disciplinary methods or of more rigid linear structures as in Moodle).
- Easily extendable and scalable in order to meet specific requirements.
- A use which is very low threshold and independent of location and context; KNOW is intuitively accessible and its functionality easy to use; content is created directly in the browser or dragged onto the whiteboard using the drag + drop function, where it can be freely positioned, scaled, grouped, described and commented on at any time.
- Easy processing from content on the digital platform as a “meta-level” to the generation of a print or pdf product (a subsequent graphic design of content becomes obsolete).
- Seamless documentation of the students’ work on a single platform allowing for the collaborative record of discussions in the seminar session – which are otherwise often lost.
- Suitability for remote as well as classroom learning and mixed / parallel forms of it; i.e. independent learning or learning in locally distributed groups as well as flipped or standard classroom scenarios (cf. below for detailed examples and various formats).
- Vital transparency: Everything anyone works on is open, visible and accessible live; assignments are no longer submitted to only the teacher, but to everyone; rather than “shielding” knowledge, knowledge is open and allows for instant cross-learning.
- Strong emphasis on typography and graphic design distinguishes KNOW from other available “managerial” tools, and places focus on its content: textual and visual work.

The first basic version of KNOW was developed for and within the framework of the aforementioned course “Philosophical Reflections on Digital Methods in Architecture”. This course was listed both as part of the “Science in Perspective” programme at the Department of Humanities, Social and Political Sciences (D-GESS) and within the programme of the Master of Advanced Studies in Architecture and Digital Fabrication MAS ETH DFAB at the Department of Architecture (D-ARCH). In this way, KNOW combines the requirements of a graduate course with the requirements of continuing education.

Throughout the course, KNOW has been used in the following contexts and ways:

**1) course preparation:** KNOW was used for various online assignments to enable teaching in a “flipped classroom”. All documents (texts, graphics) and contributions of the students were always visible and could be commented on.

**2) during the course – a) plenary discussions:** Since the course participants always worked with KNOW during the seminar sessions, oral discussions were documented “in real time”. Very quickly, the students developed the habit of making short notes on what has been said by others. These collective transcriptions—which we, as lecturers, actively encouraged—were then immediately commented on and completed by others (cf. Figure 2).

**2) during the course – b) group work:** Various specific formats were developed and tested in order to facilitate group discussion and knowledge acquisition. For instance, a topic which is easily accessible but highly controversial might very well need a different format than the introduction of a rather complex topic which is hard to access. The following formats work independently of each other (and we have never used more than one format during a single session) and each teaching format was complemented with a corresponding classroom layout, arrangement of tables and chairs:

- **“house of commons” format:** This format was used for topics with a clear thesis and antithesis. Course participants were then divided into two groups (pro and con) and each group was represented by a speaker. After a brief preparation period, the two speakers presented, discussed and defended the two groups’ established viewpoints. They were supported with new thoughts, arguments and examples by their group members “in real time” via KNOW (used by the speaker as a “dynamic script”). The

spatial layout of the classroom borrowed from the English parliament and featured two opposing rows with a “back bench” on either side.

- **“expert groups” format:** This format was used to build up on assignments in which several questions about given texts had to be answered on KNOW by each student. In the following seminar session, the students were split into groups, each of which had to focus on a single question. Each group then had to evaluate the answers from every student to this single question critically and document their evaluation on KNOW before presenting their analysis to everyone. At the end of the seminar session there were critical summaries on all questions of the original assignment on KNOW. The spatial layout for the “expert groups” format was distributed islands of two to three tables.
- **“meet the author” format:** This format was used in seminar sessions for foregoing assignments which had asked students to develop a substantial position on a topic after reading a text on KNOW. For the seminar session, we selected a few of these texts which were then discussed together with the students in three steps. Step 1: Two students identify the position by tracing the reasoning and highlighting the central claims. Step 2: Two students criticize the position by pointing out what they consider implausible and might have gone unnoticed. Step 3: the author of the original text gives a concluding comment, responding to criticism and elaborating alternative interpretations. Again, KNOW served as the central platform to facilitate and record the debate “real time”. The spatial layout was a classic parliamentary plenum.

**3) after the course:** Most notably, KNOW allows for a complete documentation of the course. All materials continue to be accessible after a course and the “cognitive map” of the whole course invites to retrace the debates and process of knowledge generation. Students might even “keep the course alive” by re-thinking certain topics, adding comments and creating new paths of thought.

For the evaluation of individual student learning two dimensions are to be distinguished: First, there is the role of each student in the various teaching formats as described above. This dimension focusses on presentation and discussion skills. Second, there are the written contributions on KNOW.

Independently of comprehensive online assignments and focused group work, KNOW proves to be very low threshold because it omits the send/post action, which concludes or discretizes a thought process and marks it as final or irrevocable. In contrast, working with KNOW is a constant process. It promotes exchange between students through feedback and comments. It fosters collaborative efforts in writing and thinking instead of producing self-contained texts written by single individuals. Illustrations and sketches—be it the design of a building in architecture or for that matter a mathematical expression in physics or the schematic representation of a drug interaction in the pharmaceutical sciences—can also be posted and commented on, thereby extending ways of explanation. This unweighted media openness of KNOW is central as it ensures a broad academic applicability and adaptability to the specific requirements of different disciplines. It is expected to be expanded further once published for a global community of software developers.



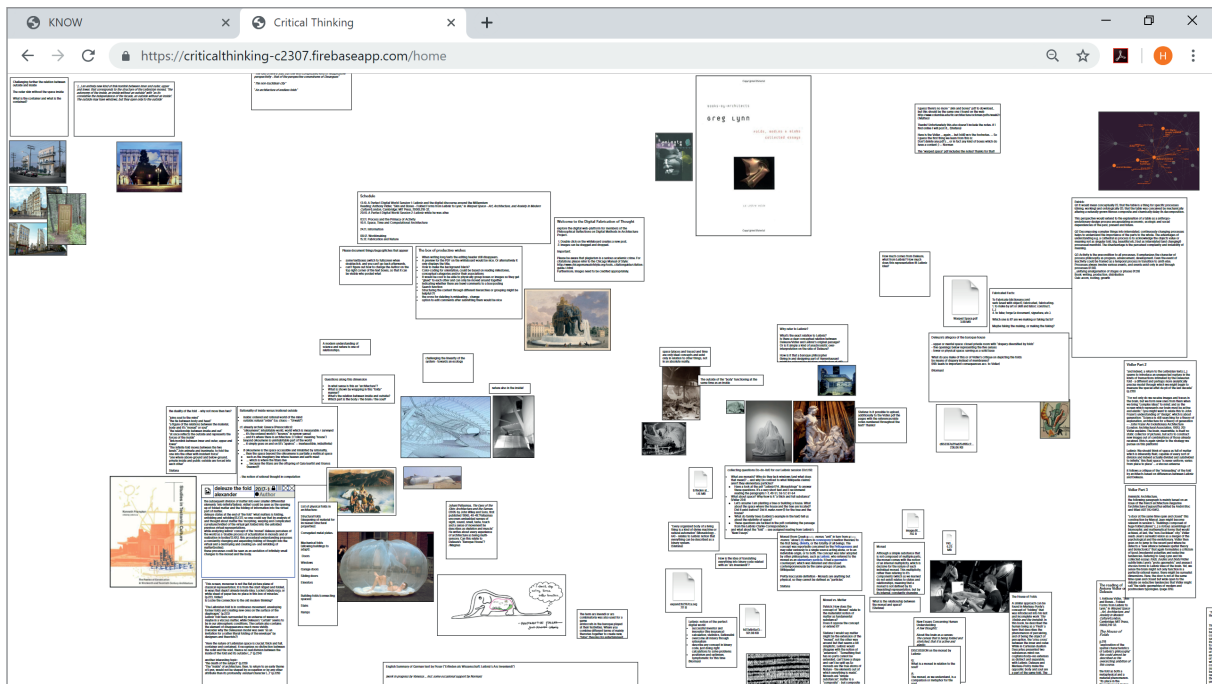


Figure 1: An impression of the clustering of texts and images. Screenshot of KNOW as used in the course “Philosophical Reflections on Digital Methods in Architecture” (ETH Zurich 2017).

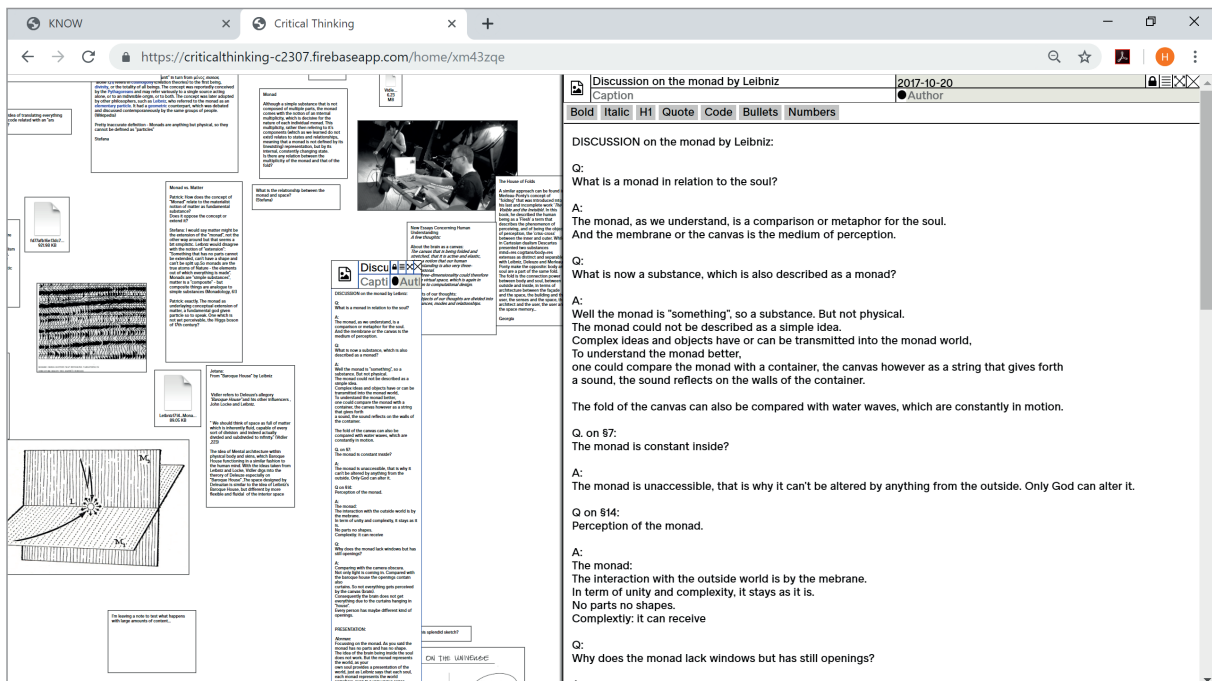


Figure 2: A collective transcript of a discussion among students. Screenshot of KNOW as used in the course “Philosophical Reflections on Digital Methods in Architecture” (ETH Zurich 2017).

#### 4 Analysis of student learning – Selected classroom examples

First insights about student learning can be gained from simple visual inspection of the whiteboard as it stood by the end of the course “Philosophical Reflections on Digital Methods in Architecture” (cf. Figure 1). The whiteboard featured more than 180 textboxes (often consisting of a main text plus comments), about sixty images (graphics, figures, pictures), and about twenty pdf-files. During the course, entries and files were continually worked with, arranged and amended. By the end of the course entries and files made up twelve “clusters”;

meaning areas where pictures, texts, and pdfs show a closer spatial grouping, reflecting relationships of their content. On a higher level, these clusters form again a network exhibiting relations between topics and certain “pathways” leading from one topic to the next.

The following table provides an overview over the composition of those twelve clusters:

cluster no.	no. of textboxes	no. of images	no. of pdf-files
1	29	17	3
2	26	5	3
3	24	0	2
4	20	10	2
5	19	4	4
6	17	1	0
7	16	8	1
8	15	6	5
9	11	1	0
10	3	5	0
11	1	1	0
12	1	1	0

*Table 1: In general, clusters are dominated by textboxes. Textboxes are often surrounded with images they refer to. Only one cluster (no.10) is dominated by images rather than texts. Within each cluster pdf-files form the least prominent group of contributions. In fact, most of the pdf-files are the compulsory readings for each session. In all cases, pdf-files worked as indirect or mediate (rather than immediate) sources in the context of KNOW.*

Finally, there are the two clusters (11 and 12) which appear to have “dropped out”. They only consist of one text and one picture each and do not show clear or close spatial relations to the other clusters. Here, the community of contributors deemed the content less relevant, pushed it aside or isolated it.

With regard to student learning, this brief analysis of the structure and usage of KNOW during the course provides evidence of the students’ engagement. They amended the given sources with their own internet searches and inquiries based on which they provided further images and texts. Moreover, as a group, the students also structured their insights and developed their own research interests and agendas as can be seen from the way certain “paths” developed—whereas others appear to be “dead ends”. Thus, they worked—visible for all—in parallel and engaged in a stepped synthesis of knowledge over time (different phases of reading and writing) and space (two-dimensional whiteboard). This reflects our intention of strengthening the students’ abilities in discussion and taking “response-ability” within a larger and diverse group. As intended, students have become part of an egalitarian design process and KNOW has proven itself as a tool for group work and interactive work in seminar formats as well as for self-study.

## 5 Achievements and lessons learnt

Interdisciplinary research demands critical thinking enabled by open debate. This is equally true for teaching. While such open conditions are easily achieved when in “live and oral” interaction, we sought to extend these conditions to a virtual and even remote environment by means of a software tool. KNOW allows collaborative, real-time interactive work for small as well as large groups using a variety of media formats (text, image, video) in any browser. This makes the process of knowledge generation itself visible and transparent to both students and lecturers. The joint MAS DFAB (D-ARCH) and SiP (D-GESS) course “Philosophical Reflections on Digital Methods in Architecture” during the fall semester 2017 and 2018 acted as a “proof of concept” or closed beta test. The sustainability of the format and easy transferability to other courses and disciplines has been proven by implementing KNOW into the course “Scientific Concepts and Methods”, which is now being taught as a compulsory course in the D-CHAB Master’s Program in Pharmaceutical Sciences.

Notwithstanding some un-avoidable technical bugs, the feedback of the students has so far been very positive and the course “Philosophical Reflections on Digital Methods in Architecture” has received very positive overall feedback in the official ETH evaluation. The course “Scientific Concepts and Methods” was even nominated for the KITE (“Key Innovation in Teaching at ETH”) Award 2020. Students particularly enjoyed the “immediacy” of KNOW; that is, the fact that discussions during the course and their documentation happened “in real time”. Furthermore, we received several requests from architecture students at ETH asking for their own KNOW platform in order to allow collaborations and exchange in relation to their own projects. This emphasises the potential of KNOW as a visual platform.

On the other hand, early versions of KNOW clearly reached their limits when it came to sufficiently fast data transfers. Furthermore, the high level of production of a big group made the orientation in the dynamic and constantly changing space difficult, placing importance on the development of an improved navigation, search functionality and management of different whiteboards. The challenge here is to strike a balance between the non-hierarchical parallel presence of all work and a necessary structure to organise larger amounts of work. This question will continue to govern the development of KNOW in the future.

While KNOW is obviously not a suitable tool for checking individual factual knowledge, the egalitarian group- and process-oriented method also entails certain limits. The responsibility for the success of a teaching format rests largely with the students as it is them who generate the knowledge and collaborate. While this is to prepare students for a VUCA world and to turn them into responsible and critically aware researchers (Sieroka et al. 2018), it also means devolving power to the group. Therefore, course content can only be fixed to a certain degree upfront. Lecturers can choose texts and topics to begin with, yet lecturers themselves need to train in managing the VUCA world. They need to sustain higher levels of uncertainty and become more agile and flexible in synthesizing and evaluating thoughts. We might observe a transformation of the role of a lecturer: namely a shift away from being someone who conveys stable and well-established knowledge, towards being a facilitator of agile knowledge acquisition and a moderator of critical discourse. Extended to the visual world it would integrate characteristics of a curator. This transformation goes along with an emphasis on pedagogical competencies. As productivity and success depends on the whole student group, motivation and incremental explanation, dialogue and relational thinking become central teaching concepts. KNOW supports this and is a contribution to what Johanna Drucker calls a “humanist dialogue with digital environments” (Drucker 2014, 178).



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