8 Inquiry-Based Learning 2.0 A Didactic Framework for Inquiry-Based Learning with Digital Media

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Abstract
German discussions of inquiry-based learning in higher education have seen the development of an approach termed inquiry-based learning 2.0 (Kergel, 2014; Kergel & Heidkamp, 2016). Inquiry-based learning 2.0 combines elements of contemporary e-learning (i.e. e-learning 2.0) with elements of inquiry-based learning. To facilitate a systematic implementation of inquiry-based learning 2.0 strategies in higher education, a so-called didactic framework for inquiry-based learning with digital media has been developed. This article introduces the framework, first providing a working definition for inquiry-based learning. It will then go on to introduce the didactic framework for inquiry-based learning with reference to the working definition. As a further step, it will discuss the concept of e-research. The didactic framework for inquiry-based learning with digital media will emerge from these considerations.

Keywords: Inquiry-based learning, E-learning, Higher education, Digital media, Web 2.0, E-learning 2.0

8.1 Inquiry-Based Learning – a Working Definition

As an umbrella term, inquiry-based learning signifies processes in which learning and research are inextricably linked. Inquiry-based learning encourages learners to learn by carrying out research: a didactically guided research process entails learning and produces knowledge. Students think and act like researchers. A perfect model would have the students identify research questions, develop a research design, collect and interpret data, and communicate the results. Ideally, students will pass through the whole research process, which can be visualized as a circle:

Figure 8.1: Visualization of a research process (own Figure).

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Inquiry-based learning does not require the learner to pass through the whole research cycle. Nonetheless, elements of a research process must be taught, thematized, and didactically guided (Reinmann, 2016; Kergel & Heidkamp, 2015).

Inquiry-based learning can be understood as a process in which knowledge is constructed. The model envisages that the research and learning processes will coincide with each other. A research process, like a learning process, sees evidence as the result of grounding propositions in systematically collected data. From this perspective, research becomes a learning process in which knowledge construction meets scientific standards of objectivity, validity, and reliability. These points could define inquiry-based learning simply as a scientifically sound learning.

However, the pedagogical implications of inquiry-based learning also require consideration: inquiry-based learning focuses on the subjective dimension of the learning process. It is less about the concrete result (*i.e*. the research outcomes) than about developing a so-called `habitus of a researcher´ (*cf*. Kergel & Heidkamp, 2015). Students are expected to acquire thinking strategies of the kind that characterize the researcher: strategic skepticism towards knowledge, rational thinking, the use of logic instead of falling back on received beliefs, and so on.

This makes the experience of the learner as researcher a crucial focus of inquiry-based learning. It requires the provision of didactically framed possibilities, which enable the learner to act as a researcher or even – eventually – to become a researcher. As an action- and product-oriented approach, inquiry-based learning rests on socio-constructivist positions in learning theory. These provide its theoretical foundations and focus on the subjective experience of learning in a collaborative context (Kergel, 2014). Learner participation, the formulation of research questions, and the experience of research as a social, interactive process, all require the learner to take an active role. Fostering such an attitude in inquiry-based learning processes means promoting self-sufficiency. The learner as researcher experiences themselves as someone who is able to raise questions and develop scientific strategies to answer them.

By encouraging the learner to develop a researcher's disposition, inquiry-based learning acquires an ethical dimension. It requires a specific way of relating to the world: inquisitive, critical, skeptical towards beliefs and established knowledge: "Our amazement. – It is a deep and fundamental stroke of luck that science discovers things that stand up under examination and that furnish the basis, again and again, for further discoveries – after all, it could be otherwise!" (Nietzsche, 1882/2001, p. 59). Inquiry-based learning can help to develop this kind of research-oriented disposition. The self-regulated and active learning process requires support: on the learner's part with a willingness to engage in self-reflection; on the teacher's part by flexibly accompanying an open-ended learning process (for the changing relationships between teachers and learners under the paradigm of inquiry-based learning see Brew, 2003). One challenge is to open up spaces within which students can engage in inquiry-based learning processes that adjust to their skills. This means that students should be challenged to fulfil their potential as researchers and thus further develop these skills. Conversely, it is up to the teacher to ensure that students are not overwhelmed by the complexity of a research process. The didactic framework for inquiry-based learning with digital media has been developed to provide strategies for guiding the learning process and adjusting the research process to students' skills.

The didactic framework provides a template for implementing inquiry-based learning in different phases of the research process and at different levels of complexity.

8.2 The Didactic Framework for Inquiry-Based Learning

The didactic framework presented here is based on the model of Willison and O`Regan (2007), which they called a `framework for students becoming researchers´. O´Regan developed criteria for inquiry-based learning in the different phases of the research process. They also took into account that inquiry-based learning can take place at different levels of complexity. Wilison and O´Regan´s differentiation into complexity levels has been modified with reference to the German debate on the definition of inquiry-based learning. Multiple labels have become established in the German discourse on the subject: one speaks of inquiry-based learning while another uses the term inquiry-oriented learning. To clarify the conceptual dimension of inquiry-based learning, Huber (2014) provided a definition which distinguishes between 'forschungsbasiertem Lernen' (inquiry-based learning), 'forschungsorientiertem Lernen' (inquiry-oriented learning), and 'forschendes Lernen' (learning through inquiry). This conceptual differentiation has provided a basic guide in the development of the didactic framework. The degree of complexity increases from inquiry-based learning to inquiry-oriented learning, to learning through inquiry.

The horizontal axis of the didactic framework depicts the different phases of a research process (see table 8.1). The vertical axis represents the increasing degree of complexity in inquiry-based learning. From inquiry-based learning to inquiry-oriented learning, to learning through inquiry, the degree of complexity increases. Increasing complexity is accompanied by increasingly self-regulated learning. This increase in complexity in line with inquiry-based learning is predicated on Huber´s conceptual distinction between inquiry-based learning, inquiry-oriented learning, and learning through inquiry (or, according Banci & Bell, `open inquiry´, *cf*. Banci & Bell, 2008). To make the different phases and stages of the didactic framework accessible, a conceptual differentiation will be provided. This is based on Huber´s distinction between the three concepts inquiry-based learning, inquiry-oriented learning, and learning through inquiry.

Inquiry-based learning is defined as a form of directed learning in which students are introduced to the research field. They get to know the different paradigms of the discipline they are studying, and are introduced to the basic research focus, typical research questions, and methodological considerations.

Research-oriented learning stresses the dynamics of the research process itself, focusing on its practical requirements. Research-oriented learning introduces students to the ways in which methods and methodological considerations are applied and reflected in the concrete research process. Students have the opportunity to reflect on epistemological questions and the societal relevance of research with reference to its practice.

Learning through inquiry means an actual research process. Students carry out research according to `real/professional´ criteria. Here, the line of demarcation between learning through inquiry and research dissolves (Wolf, 2016). Learning through inquiry includes the `discovery´ of research questions, the development of a research design, the collection and analysis of data, and finally the presentation of results.

This conceptual differentiation is fundamental to the structure of the didactic framework for inquiry-based learning. The different levels of complexity depicted on the horizontal axis, rest on the conceptual differentiation between research-based learning, research-oriented learning, and inquiry through learning.

Table 8.1: Didactic Framework for Inquiry Based Learning with digital Media, Level 1-Level 3 (own Figure).

	Level 1 (Predetermined inquiry-based learning) Students are guided through a prestructured learning environment.	**Level 2 (Guided inquiry-based learning)** Students navigate a prestructured learning environment with a high degree of guidance.	**Level 3 (Prestructured inquiry-based learning)** A less prestructured learning environment facilitates a higher degree of self-determined and self-regulated learning.
A. Heuristic phase Students develop an interest in knowledge and formulate their own research questions.	With the guidance of a teacher and working within a predetermined structure, students answer questions and define concepts which are important to the field of research. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp.	Students answer questions generated in teacher-led dicussions, using a predetermined structure or developing their own. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter.	Students generate questions relevant to a pre-defined research field. They develop their own structure to answer them. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp, Collaborative Tools like Google Drive, Authorea.
B. Research design Students discuss/develop a research design.	With the guidance of a teacher, students develop an understanding of a set research design. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter.	Students discuss advantages and disadvantages of different set research designs. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea.	Students choose one out of several set research designs and explain their decision. Digital media: *e.g.* Collaborative Tools like Google Drive, Authorea.
C. Data collection Students find required data or collect their own data.	With the guidance of a teacher, students research available data. Digital media: *e.g.* online databases, opendata.europa.eu.	Using a set method, students collect new data. Digital media: *e.g.* online databases, opendata.europa.eu., Wikis, Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.	Students choose one out of several set methods to collect data, explain their decision, and apply the method. Digital media: *e.g*. online databases, opendata.europa.eu., Wikis, Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.
D. Evaluation & reflection Students critically evaluate the process of data collection, or the selected data, according to scientific standards such as objectivity, reliability, and validity.	With the guidance of a teacher, students evaluate data/information according to set criteria. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea.	Students evaluate data/information according to criteria developed in teacher-led discussions. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea.	Students evaluate data/information that they themselves have collected. They evaluate the data according to criteria developed in teacher-led discussions. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea.
E. Analysis & synthesis Students interpret data with reference to the research question, constructing data-based knowledge.	With the guidance of a teacher, students analyze and interpret data according to set data analysis techniques and strategies. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea.	Students analyze and interpret data according to set data analysis techniques and strategies. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea.	Students analyze and interpret data that they themselves have collected. They analyze the data according to techniques and strategies developed in teacher-led discussions. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.
F. Findings & presentation of results Students communicate their findings and the outcome of their inquiry-based learning process.	With the guidance of a teacher, students present their findings. They use terms/concepts which are important to the field of research. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea or Presentation Tools like Prezis.	Students are familiar with the terminology of their research field. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea or Presentation Tools like Prezis.	Students are familiar with the terminology of their research field and can relate concepts to each other. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea or Presentation Tools like Prezis.

Stage 1 (‘predetermined inquiry-based learning’) and stage 2 (‘guided inquiry-based learning’) are based on the concept of inquiry-based learning: students are introduced to the research field and its paradigms.

Stage 3 (‘prestructured inquiry-based learning’) and stage 4 (‘autonomous inquiry-based learning’) are based on the conception of inquiry-oriented learning described above: theoretical and methodological challenges are reflected upon and discussed with reference to the students’ research. Research is guided by the teacher.

Stage 5 (‘learning through inquiry’) is based on the concept of learning through inquiry, which

involves self-regulated learning without elements of directed or teacher-guided activity.

At each of these stages, the degree of self-regulated learning increases. Each box of the didactic framework lists the criteria which define inquiry-based learning in the particular phase and on the corresponding level of complexity. These criteria may help to develop inquiry-based learning scenarios, or to analyze or classify them.

Table 8.2: Didactic Framework for Inquiry Based Learning with digital Media, Level 4-Level 5 (own Figure).

	Level 4 (Autonomous learning) Students initiate and structure the research process. The teacher provides flexible guidance.	**Level 5 (Learning through inquiry)** Students carry out their research in a self-determined and self-regulated manner.
A. Heuristic phase Students develop an interest in knowledge and formulate their own research questions.	Students generate research questions relevant to a pre-defined research field. They develop their own structure to answer them. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp, Collaborative Tools like Google Drive, Authorea.	Students generate research questions in a research field which they themselves have chosen. Digital media: *e.g.* Chat-Tools like WhatsApp, Collaborative Tools like Google Drive, Authorea.
B. Research design Students discuss/develop a research design.	Students develop their own research design with the guidance of a teacher. Digital media: *e.g.* Collaborative Tools like Google Drive, Authorea.	Students develop their own research design independently. Digital media: *e.g.* Collaborative Tools like Google Drive, Authorea.
C. Data collection Students find required data or collect their own data.	Using a method chosen by themselves, students collect data with the guidance of a teacher. Digital media: *e.g.* online databases, opendata.europa.eu., Wikis, Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.	Using a method chosen by themselves, students collect data independently. Digital media: *e.g.* online databases, opendata.europa.eu., Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.
D. Evaluation & reflection Students critically evaluate the process of data collection, or the selected data, according to scientific standards such as objectivity, reliability, and validity.	Students evaluate data/information that they themselves have collected. They evaluate the data according to criteria developed in teacher-led discussions, or use criteria which they have defined independently according to scientific standards. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea.	Students evaluate data/information that they themselves have collected. They evaluate the data according to criteria which they have defined independently according to scientific standards. Digital media: *e.g.* Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.
E. Analysis & synthesis Students interpret data with reference to the research question, constructing data-based knowledge.	Students analyze and interpret data which they themselves have collected. With the guidance of a teacher, they apply data analysis techniques and strategies which they have chosen independently. Digital media: *e.g.* Wikis, Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.	Students analyze and interpret data which they themselves have collected. They apply data analysis techniques and strategies which they have chosen independently. Digital media: *e.g.* Collaborative Tools like Google Drive, Authorea, Online Survey Tools like Limesurvey.
F. Findings & presentation of results Students communicate their findings and the outcome of their inquiry-based learning process.	Students are familiar with the terminology of their research field and can relate concepts to each other. They can redefine concepts, and define new ones, on the basis of their research. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea or Presentation Tools like Prezis.	Students can redefine concepts, and define new ones, on the basis of their research. Digital media: *e.g.* Wikis, Chat-Tools like WhatsApp or Twitter, Collaborative Tools like Google Drive, Authorea or Presentation Tools like Prezis.

8.3 Towards e-Science/e-Research – Research in the Digital Age

Ongoing media change pervades all parts of society, including academia. It is both a field for research and an agent of changing research practices. The development of participative online tools such as blogs, wikis, collaborative writing tools, and podcasts is increasingly shaping

academic practice. Not only accepted formats like open-access journals, but also more advanced projects such as public-peer-review journals or video journals, are indicators of the media-based transformation taking place in the academic field. Research, the presentation of research outcomes, and teaching in higher education are increasingly going online. This digitalization, and the extension of scientific practice into the digital world, can be conceptualized as `e-science´. The idea first emerged in the early 2000s: "'e-Science' is an exciting new buzz-word for computer science and information technology in the service of science" (Gardner & Manduchi, 2000, p. 1). Henry Gardner and Gabriele Manduchi identified shared computing power as a key feature of e-science: "It is particularly associated with the support of `big´ and/or `distributed´ science and engineering. It recognizes the revolution in global collaboration which is being wrought by broadband communications and the internet" (Gardner & Manduchi, 2000, p. 1). In view of the participative and collaborative possibilities of Web 2.0 tools, it would be helpful to revisit the definition of e-science. This re-definition has to consider how Web 2.0 tools such as Twitter and publication formats like open-access journals change the process of scholarly communication: "In addition to formal channels of scholarly communication, a wide array of semi-formal and informal channels such as email, mailing lists, blogs, microblogs and social networking sites (SNS) are widely used by scientists to discuss their research" (Puschmann, 2014, para. 1). With these considerations in mind, one may define e-science or in a borader sense e-research as follows: the extension of e-science/e-reserach into the digital world and the use of Web 2.0 media, which are re-defining scholarly communication and the ways in which researchers collect, analyze, and present data.

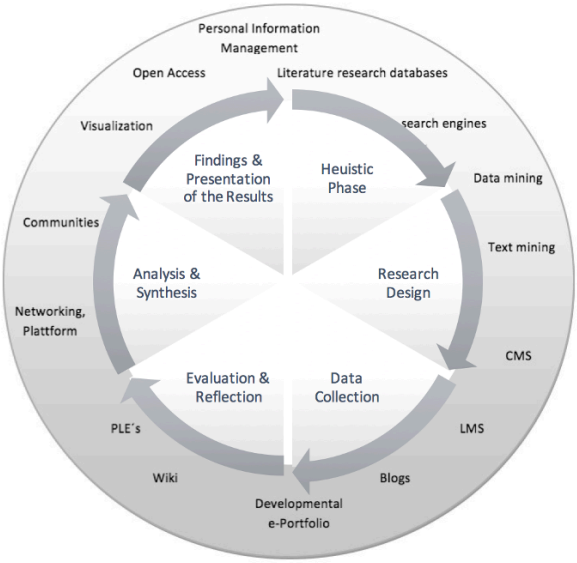

Figure 8.2: Visualization of a research process with an added digital dimension (own Figure).

From the perspective of higher education, a synergetic meeting of e-science/e-research and

learning is needed: students have to acquire the academic media skills required in the digital age. Inquiry-based learning with digital media represents a strategy for implementing contemporary forms of media use in the academic field. Implementation would extend action- and product-oriented learning processes into the digital sphere. Different phases of the research process can harness digital media, using Web 2.0 tools to foster students' inquiry-based learning processes. The focus of inquiry-based learning on action and end-product, enables students to acquire academic media skills and thus to enhance their employability in the digital age. A digital dimension can therefore be added to the research cycle depicting the structure of inquiry-based learning (see Figure 8.2).

The following subsection introduces the didactic framework for inquiry-based learning with an added digital dimension. This extended didactic framework systematizes the implementation of digital media in the process of inquiry-based learning.

8.4 The Didactic Framework for Inquiry-Based Learning with Digital Media

To facilitate the systematic implementation of Web 2.0 tools in the inquiry-based learning process, proposals for the use of digital media have been added to the didactic framework. An essential feature of the framework is that it provides a guide to adjusting the degree of complexity to the skills of the students. The extended didactic framework provides a systematized approach to implementing inquiry-based learning with digital media.

Corresponding to the increasing proportion of self-regulated learning from stages 1 to 5, proposals for implementation begin with pre-structured/receptive media use and end in an open, self-regulated level of media usage. At stage 1, Web 2.0 tools are recommended for specific purposes: for example, wikis can be used in the collaborative production of an encyclopedia defining the most important concepts and methodologies behind a scientific paradigm. The structure of a wiki corresponds to the didactic structure of the collaborative project, which is located at phase 1 (heuristic phase), stage 1 (predetermined inquiry-based learning) of the didactic framework: With the guidance of a teacher and working within a given structure, students answer questions and define concepts which are important to the field of research.

In this approach, which combines the interactive potential of Web 2.0 tools with didactic reflections, templates for the use of Web 2.0 media in inquiry-based learning have been developed. Web 2.0 tools such as wikis or chat apps, in which the structure of interaction is more predefined/directed, can be used for inquiry-based learning at complexity levels 1 (predetermined inquiry-based learning) and 2 (guided inquiry-based learning). More interactive and open Web 2.0 tools – e.g. collaborative writing tools such as Authorea or GoogleDrive – open up multiple possibilities. These tools can be used as collaborative platforms for organizing the research process, annotating memos, collecting sources, and writing the research report. The potential of such tools is best harnessed at levels 3-5 of the didactic framework.

These categories of course represent an exercise in schematization. The use of Web 2.0 media can be deconstructed. A WordPress blog can be used as wiki tool, and the polyvalence of Web 2.0 tools also requires consideration. Twitter, for instance, can become the vehicle for

an exchange of arguments within a broader discussion – e.g. on theoretical issues. The Twitter discussion may help students develop an understanding of key theoretical positions and controversies in a given field. Such a discussion should be located at phase 1 (heuristic phase), stage 2 (guided inquiry-based learning): Students answer questions developed in teacher-led discussions. To answer these questions, students use a predetermined structure or develop their own.

Twitter, however, can become a connecting tool across different phases and stages by establishing a research community through a common hashtag. Despite the schematizing tendencies of the didactic framework, it establishes a heuristic approach to the systematic implementation of inquiry-based learning with digital media – i.e. inquiry-based learning 2.0 – in higher education.

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