Supporting the Processes of Teaching and Learning

How Digital Learning Platforms Support Progressive Teaching

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Abstract

This paper presents a theoretical framework focusing on the processes of teaching. The framework can be used for analysis of teaching and learning practice, as well as analysis of the intended processes proposed and supported in teaching/learning materials; on the other hand, the framework can be used when planning teaching and designing learning materials, in casu digital learning platforms. Processes are examined at the micro-level, identified as interaction sequences, and at the meso-level as workflows. The macro-level, the level of modules, is only addressed sporadically in this paper. A course consists of several modules integrating several workflows, each of which comprises several interaction sequences.

Two common processes are identified. At the micro-level, the most common interaction sequence is (the teacher's) Initiation- (student's) Response- (teacher's) Feedback (IRF) while an equally widespread process at the meso-level is a workflow called Lecture-Recitation-Seatwork-Plenary session (abbreviated as LeReSeP).

These two structures are discussed and analysed, and they are criticised on a theoretical basis for being too teacher-centred, and leaving insufficient room for developing more complex competences in students. A number of alternative interaction sequences and workflows are described and discussed. These alternatives all have their advantages, but they are evaluated as more complex, troublesome, and inconvenient to work with.

Teaching and learning materials support interaction sequences and workflows in a variety of ways by helping the teacher and students carry out their respective tasks. With digital technologies, it is possible to develop far more sophisticated support for the processes of teaching and learning. In the last part of the paper, an innovative type of digital learning platform, called Practice Scaffolding Interactive Platforms or PracSIPs, is presented, followed by two examples of how such platforms can support, project-oriented workflows by structuring the students' work, organising their collaboration, managing their products, presenting relevant subject matter knowledge and methods when it is needed, etc.

Keywords

Workflow, interaction sequence, Practice Scaffolding Interactive Platforms, process management, teaching, Computer Supported Collaborative Learning

1 Introduction

Teaching and learning are complex processes involving complicated organisational adaptations of participants' interactions. This paper presents a perspective on how learning material – text-based as well as digital – encourages and/or supports processes by facilitating the implementation of given activities.

In teaching and learning, as in all other complex systems (cf. Liljenström and Svedin 2005), one can differentiate between micro-, meso- and macro-levels. Looking at a class from a structural perspective one could identify the meso level as a group of students and/or teachers, the macro-level as the whole class, and the micro-level as an individual. From the temporal perspective three corresponding process levels can be identified: On the micro level one can identify interaction sequences, that is sequences of mutually referring actions performed by individuals. At the meso-level a process which could be called a workflow connects more interaction sequences into a coherent process with a beginning, a middle and an end; and at the macro-level the workflows are combined into a module and/or a course. In this paper, the focus is on the micro- and meso-levels.
The relations between the three levels is, put very simplistic, that a course consists of several modules that integrate several workflows, which again comprise several interaction sequences. The teacher's level of planning is mostly on the level of workflow. Thus when planning a (series of) lesson(s), the teacher decides the workflows' learning goals and the subject matter content, and then how to reach these goals, focussing on interaction sequences, including the participants relations, roles, ways of working with the subject matter etc.

2 Interaction sequences

An interaction sequence is an interconnected sequence of utterances or actions performed by students and teachers.

2.1 IRF

The most common interaction sequence has been described in a large number of studies. Sinclair and Coulthard (1975) describe it as an Initiation-Response-Feedback sequence (IRF). Gage calls the sequence recitation – “the almost universal pattern whereby the teachers ask questions, and the students respond” (Gage 2009, p. 66) – and identifies it as part of the Conventional-Direct-Recitation (CDR) teaching model as opposed to Progressive-Discovery-Constructivist teaching. Gage reports from a number of early and newer American studies – for example, Bellack et al., who subdivide the process into four steps: Structuring, Soliciting, Responding, Reacting (Bellack et al. 1966, in Gage 2009). Gage argues that the prevalence of CDR is global in terms of place and time as well as in fields of application (subject matter, educational level). The IRF interaction sequence responds to some of the most pressing challenges of teaching: It makes it possible for the teacher to control what is going on in the classroom; it ensures that all students hear what the teacher considers as important content knowledge; it gives the teacher an opportunity to gain insight into what the students have learned from the lectures and the textbooks; and it prompts the students to participate by preparing an answer to the question in case they are called on to answer. But IRF has a number of weaknesses connected to its advantages. First of all, the most active participant in IRF interaction sequences is the teacher. The students spend a lot of time listening to answers to questions, questions that might very well be either too easy or incomprehensible to them. The students can “play the game” by sitting quietly and looking interested or observant, while their minds are drifting along completely irrelevant paths. And the content of IRF interactions is most often of a rather basic kind, leaving more complex knowledge, skills, and literacies out of focus.

The Norwegian scholar Olga Dysthe (Dysthe 1995) has introduced a perspective on the traditional IRF interaction sequence, showing that the sequence can be reformed to accommodate the insights of constructivist learning theories. She argues that the teacher should aim at establishing a more equal relationship with the students, foster authentic communication by posing authentic questions, show high esteem for student contributions, and focus on elaborating on students’ points in her own contributions. Thus, Dysthe’s plea for authentic dialogue is more of a change in approach than in the structure of IRF. But the IRF structure will regularly be replaced by students talking among themselves in which case the teacher does not have an opportunity for feedback.

IRF is the most prevalent interaction sequence in schools (cf. Gage 2009) and, therefore, we can assume that it responds in an efficient manner to challenges teachers face in their teaching practice. IRF might appear to be the best choice for teachers. However, it is often challenged by theoreticians of learning, because it does not support the development of the necessary knowledge, skills, and competences in students (Gage 2009). Other interaction sequences can be judged on their ability to meet the challenges to which IRF responds while, at the same time, promoting more complex learning goals. More complex interaction sequences might have advantages in theory but can be less manageable and practicable and, therefore, are rejected. Gage (2009) develops a theory of teaching based on the IRF interaction sequence. This paper goes in another direction proposing to develop digital technologies that are able to support more complex interaction sequences.

2.2 Interactive lecture

An ordinary lecture (which is an interaction sequence) in which the teacher presents a subject matter, describes a procedure, or explains causal relations, etc., occupies around one-fifth of classroom time according to Burns (1984, in Gage 2009). Lectures may be well-prepared, supported by a slide show or the teacher's notes, thus they are comparable to the linear structure of a book. The challenge of a
lecture is that the teacher is directed by her own conception of the subject matter and emphasises what she finds most important, while the students might need further explanation of other aspects of the subject matter.

This problem can be addressed by a similar interaction sequence termed the interactive lecture, identified in empirical studies (Bundsgaard 2010). An interactive lecture involves student participation in a form connected to the IRF interaction sequence but focusing less on the feedback step and more on creating a common understanding or recollection of the subject matter. In an interactive lecture, for instance, the teacher might want to create a connection between the subject matter dealt with earlier and the subject matter to be dealt with thereafter. The teacher leads a conversation, trying to incorporate student knowledge by asking about factual matters and encouraging association. And the students are expected to point out areas they do not understand or comprehend. The challenge in an interactive lecture is that, even in a short interactive lecture, e.g., on World War II, there might very well be a fairly large number of places, persons, ideologies, states, events, etc., that the students are supposed to connect to their imaginations, other concepts, contexts, etc. (Bundsgaard 2010).

A traditional lecture can be prepared by presenting images, maps, written explanations, etc. in a linear manner in a slide show; but because an interactive lecture is interactive, the teacher cannot be sure exactly in what direction the conversation will move and, therefore, she cannot prepare a linear presentation. However, because the computer is interactive, she can prepare images, etc., in another hierarchical way, making it easier to move through categories to the relevant image, as she interacts with the students. This technology, called Thematic Whiteboard, is being developed in the Danish research and development project, User-Driven Innovation of Digital Learning Material (cf. Bundsgaard 2010).

2.3 Students talking together

At the other end of the scale, we find interaction sequences without a teacher being present. Mercer and Wegerif have conducted a number of research projects investigating different types of talk. They have identified three prevalent talk categories, which they call cumulative talk, disputational talk and exploratory talk. All three interaction sequences are characterised by students taking turns more or less equally, but the content and the attitude differ among the three types. Disputational talk is characterised by disagreement, which is not solved collectively. The students do not investigate what is said but contradict or refute without giving a reason. In cumulative talk, the students uncritically but positively relate to what the other students say. When engaged in exploratory talk, the students build critically and constructively on what the other party has said, offering suggestions and statements for joint consideration. Arguments and counterarguments are justified, and alternative solutions and perspectives are offered (Wegerif and Mercer 1997). Exploratory talk is desirable from an educational point of view among other because students' ability to engage in exploratory talk not only makes a group of students better suited to solve tasks in common, but also results in the individual student being capable of solving tasks better (Mercer, Wegerif, and Dawes 1999). However, the interaction sequence exploratory talk is not easy to enact because it requires the students to be able to leave personal aversion and prejudice aside, to criticise without being personal, to search for uncharted solutions etc. Therefore, Mercer and Wegerif have developed a teaching approach, called Thinking Together (e.g., Dawes, Mercer and Wegerif 2000), which supports students in developing competence in exploratory talk. To support this approach, they have developed software programs; e.g., Kate's Choice, which is a decision-making program in which the students are prompted to discuss how to guide the main character. Such computer programs participates in an interaction sequence to scaffold the students in interacting still more exploratory by making them focus on the singular steps of exploratory talk.

3 Workflow

On the meso-level, we can identify workflows. A workflow is an interrelated series of interaction sequences connected by an overall learning goal or a shared content, e.g. a short story or a physical phenomenon. This level of process seems to be rather poorly understood in research on teaching and learning. Often, processes on the level of interaction sequences are intermingled with workflow processes. For example, Gage (2009) seems to equate recitation (that is, the IRF interaction sequence) with the Conventional-Direct-Recitation “model of teaching”, which in this framework is identified as the LeReSeP workflow (see below). The claim made in this paper is that there is a large
uncharted area in understanding workflows in school and in understanding how computers can support teachers and students in undertaking more complex workflows and modules.

3.1 Lecture-Recitation-Seatwork-Plenary Session (LeReSeP)

The most common workflow seen in school is, without doubt, the Lecture-Recitation-Seatwork-Plenary Session (LeReSeP) series of interaction sequences. First, a subject matter is presented through the teacher’s lecture or students reading in their textbooks. Then, the teacher asks questions in a recitation/IRF interaction sequence to check students’ understanding of the subject matter. Next, the students do seatwork by solving problems, writing assignments, talking together, etc., and, finally, the class recapitulates the results of the seatwork in a plenary session. This prototypical workflow can be observed in a number of variants, but the basic structure is the same. Most textbooks support this kind of workflow by presenting content and providing tasks in a form suitable to be accomplished in a single lesson.

LeReSeP is the workflow of what Gage (2009) calls the Conventional-Direct-Recitation teaching model. It is, without compare, the most durable and widespread workflow in the history of teaching in schools (Gage 2009). The workflow is easy for teachers as well as students to handle for several reasons: It does not require the teacher to do any particular organisational preparation: both teacher and students are familiar with the workflow; they know what to do, and how to enact their role. The LeReSeP workflow is easy to control because all students are present in the same room and work in parallel processes. Thus, classroom management is incorporated into the workflow.

The shortcomings of LeReSeP are closely related to its advantages: The teacher is the most active party, leaving the students in a more passive role (but, of course, not necessarily mentally inactive). Secondly, because the students are working in parallel LeReSeP is not very good at differentiated teaching, since the teacher cannot focus her attention for very long on the individual student. Thirdly, the teacher can control the classroom and keep discipline, but cannot ensure the students’ mentally presence. And, finally, LeReSeP is not well-suited to support students in developing more complex competences, e.g., competences to participate in joint problem-solving, to interact in collaborative settings, to investigate physical phenomena, etc.

3.2 Project-based learning (PBL) and project-oriented learning (POL)

While the LeReSeP workflow is characterised by being very well-organised and easy to implement, the workflows of project-based learning (PBL) is at the other end of the scale.

PBL is a constructivist pedagogical approach that attaches importance to the students’ autonomous interdisciplinary and collaborative work with the subject matter. There is evidence that PBL can be successful and promote flexible (Thomas 2000), deep and long-lasting learning in students (Barron, Schwartz, Vye, Moore, Petrosino, Zech et al. 1998).

A PBL module consists of a row of workflows, each different in scope, participant roles, working method, content, etc. A relatively basic summary of the phases in a PBL is: (1) Understanding the topic and formulating the problem (in class), (2) research (individually and/or in groups), (3) organizing, discussing and preparing information (individually and/or in groups), (4) producing a product, (5) presenting and receiving and giving feedback (in class or other plenary settings), and (6) evaluating the process, product, and learning outcome (individually and in class) (cf. Nielsen 1995). Each workflow is a complex process. E.g. doing research could consist of contemplating what one knows, deciding what to search for, deciding where to search, evaluating the data etc.

PBL is a special case of what is often termed project-oriented learning approaches (POL), examples of which are entrepreneurial learning, simulated professional learning (being a journalist, a film maker etc.), and to a certain degree inquiry based learning. These approaches share a number of characteristics, like student autonomy, focus on project and product, student responsibility in arranging and structuring disordered content, differing and individually complex workflows, etc.

Thus, in POL, students participate in a series of very complex non-synchronised workflows and, thus, the teacher has to keep up with these diffuse, extensive, and complex processes; she has to be able to acquaint herself with student projects at the subject matter level as well as in relation to the student’s understanding and conception of the subject; she has to be able to provide feedback in a
way that challenges the students' understanding on their level, and to help them accomplish their
individual goals in due time. In other words, her overview and sense of perspective need to be
immense. The students, for their part, are challenged to plan and forecast their work process; they
should be able to understand what they need to know, and they should be able to find, coordinate,
and discuss information, etc.

These challenges make POL a very intricate task for teachers and students. “[P]rojects offer many
attractive promises, but they are often difficult to implement” (Barron et al. 1998, p. 306; cf.
Bundsgaard 2005). Therefore, POL might very well function as a tool for merciless social selection (cf.
Gregersen and Mikkelsen 2007).

Bundsgaard (2009) summarises the challenges in this way: 1) the challenges of chaotic social
contexts (organisation of collaboration, classroom management), 2) the challenges of what to do next
(how to do the right thing in the workflow), 3) the challenges of promoting subject-matter learning
central to curriculum standards (subject learning and competences), and 4) the challenges of
including the low-achieving and low-income students.

While the textbook is an excellent companion and support to LeReSeP teaching, the question is what
plays that role in POL. POL, consisting of a number of complex workflows, is far more difficult to
implement, but it seems that there has been only sporadic focus on developing tools and conceptual
support for participants in POL.

3.3 Storyline

The Storyline methodology (e.g., Falkenberg and Håkonsson 2000; Bell, Harkness and White 2007)
developed in Scotland as a way to live up to the progressive Primary Memorandum of 1965,
prescribing an integrated curriculum in the subject of Environmental Studies (Bell 2000).

This methodology is an example of a project-oriented approach, which has a clear focus on
supporting the workflows’ structure, as well as collaboration and subject-matter learning. The storyline
approach uses creative, experimental, active, hands-on activities, such as visual arts, puppet design,
and drama and is a thematic, problem-based, well-structured course of events constructed as a fiction
narrative. “The children are not given didactic talks but challenged” (Falkenberg and Håkonsson 2000,
p. 29, my translation). A storyline module is comprised of a number of workflows, each spanning
several lessons – perhaps, even weeks of teaching. The workflows are described in a series of steps
or phases, each consisting of a key question, key activities (cf. interaction sequences), an
organisation of participants, materials to use, products to produce, and a description of subject matter
and educational goals.

The structure of and focus on subject matter, educational goals, and workflows make storyline a
promising methodology if the goal is to move in the direction of a more substantiated student-centred
teaching practice. The development of project-oriented e-learning-approaches can benefit from this
methodology.

4 Digital learning platforms supporting complex workflows

In the Computer Support for Collaborative Learning (CSCL) area, there has primarily been a focus on
development and research of applications that mediate between groups of students at different
phases in the workflow. Most CSCL applications, therefore, support teaching and learning at the level
of interaction sequences. But there is also a potential for supporting complex workflows. Referring
back to the challenges summarised in 3.2, the following aspects could be supported:

- Organisation (responsibility for subtasks, deadlines, interactions around and handling of
  products, classroom management).
- Structure of the workflow.
- Integration of subject-matter learning.
- Providing tools necessary or suitable for implementing the work.
- Providing tools for the teachers – supporting organisation, supervision and interaction with
  students.
The following sections go through two cases of Practice Scaffolding Interactive Platforms (PracSIPs), a term introduced by Bundsgaard (2009), in order to give an example of applications supporting teaching and learning at the level of workflow. A PracSIP is an interactive platform intended to help teachers and students simulate (parts of) the community of practice of a profession (e.g., as journalists, forensic investigators, engineers, etc.) by scaffolding the full practice through supporting all five aspects mentioned above.

The framework is used to analyse how these platforms are intended to scaffold the students' practice on the levels of workflow and interaction sequences.

4.1.1 Editorial Office

*Editorial Office* (in Danish: *Redaktionen*), developed by the Danish newspaper *Ekstra Bladet*, supports many of the workflows in a journalist's practice, such as collaboration, planning, research, writing, and layout. The students write and layout a newspaper, which is then sent to a printing office and printed in 4 or 8 pages in colour in 1000 copies on real newsprint.

*Editorial Office* organises collaboration by managing the distribution of students in editorial offices, supporting time-planning and task distribution (using a simple Gantt chart tool) (cf. Figure 1a). The planner helps the students decide which articles to write, responsibility for subtasks (researching, taking photos, writing, layout, etc.) and subtask deadlines. On the status bar, the students can indicate which article subtask they are working on or have finished. In this way, the students as well as the teacher can monitor how well they comply with the agreements.

There are a series of phases in producing a newspaper, and these phases involve a variety of workflows. The structure of the phases comprising the journalistic practice – that is, the overall sequence of planning, researching, focusing, writing, and layout – is reproduced in the order of the menu points (cf. the ellipse in Figure 1b).

Each phase comprises one or more workflows. For example, the workflow of writing and revising an article is constituted by a number of interaction sequences (writing first draft, getting comments, revising, sending to layout etc.). These steps are suggested and supported in the platform through a list in which the student can set the status of the article ('being prepared', 'ready for comments', 'ready for layout', etc. (cf. the circle in Figure 1b)). When the student shifts the status, the platform responds by opening new options, requesting information etc.; for example the article does not appear in the layout tool before it has been assigned the status of 'ready for layout'. The PracSIP thereby imposes a certain sequence of the workflows, but to avoid making the system too inflexible, it is possible to skip some interaction sequences and workflows, for example students can refrain from doing an interview, or they can do more than one interview.

A PracSIP also supports students in developing relevant competences. In *Editorial Office*, it is done through the integration of *interactive assistants* (a notion introduced in Bundsgaard 2005, cf. Bundsgaard 2009), which guides the students through complex problem-solving by asking questions based on an analysis of the ways the problem is typically handled, and integrating communication of relevant subject area knowledge. The interactive assistant's point of departure is the students' sub-project, it integrates student answers into later questions, and collects the input of the students in an
overview that the students can print out and discuss with teachers and peers and use in later work. An interactive assistant thereby integrates the dual goal of being relevant both for the students' project and academically.

When doing research, for example, the students might want to perform an interview. A typical interview workflow is to prepare what to ask, carry out the interview and recollect the answers in order to present the most important ones in the article. An interactive assistant can go into an interaction sequence with the students helping them prepare the interview by asking them questions like what they know already, what they want to focus on, which open questions they could ask, and how they might follow up on the answers etc. Thereby the interactive assistant both helps the student in the process of getting a usable interview, and teaches them relevant terminology (e.g. open questions) and typical ways of working as a journalist (e.g. to follow up on answers).

The interaction sequence of an interactive assistant can be compared to the IRF interaction sequence in some ways, being composed of initiation and student response. But the interactive assistant does not give feedback on the correctness or quality of the answer, it only integrates the responses in later questions, thereby promoting the students' own considerations.

4.1.2 Future City

The next case, Future City (developed for the Danish Association of Consulting Engineers (FRI)), is a science education PracSIP that scaffolds students in developing a conceptual solution for a city in a very bad condition. The students simulate working in different departments of a consulting engineering company (see Figure 2). The end product is a slide show with the class' proposed solutions for Future City.

![Figure 2. a) The domicile of the consulting engineering company, b) Energy department workroom.](image)

In Future City, the essential organisation tool is a timetable (see Figure 3a). For each group, the teacher selects tasks from a pool of lessons. When the students indicate which lesson they are about to do, an interactive assistant (see Figure 3b) guides the students through the discovery (Gage 2009) or inquiry based learning type of workflows of investigating the physical, chemical, biological, societal, or other challenges of Future City by doing experiments, studying articles, and discuss how to use the knowledge and understanding gained in creating solutions for Future City. Thus, they can be expected to develop a deeper understanding of the science behind the concrete challenges, and they become able to deliver a more well-founded and thought-out solution to the municipality of Future City.
The teacher’s overview and supervision is supported in a number of ways. Before each workday, the teacher gets an overview of what the students are going to work with, where they are going to work, and which tools and materials they need to do their laboratory work (Figure 4a). The students’ work with the interactive assistants are summarised in reports, which appear in the teacher’s directory of student work (Figure 4b), ready for the teacher’s response.

The Future City platform, thus, supports the complex workflows involved in simulating the profession of consulting engineers, which consists of analysing, evaluating, discussing, and communicating the challenges of and solutions for Future City and involving interaction sequences as diverse as exploratory talk, computer- as well as class-based authentic IRF-like dialogue, discovery, etc.

Future City and Editorial Office are platforms which support students in structuring their workflows and collaboration, help them find out what to do, how to do it, and support them in developing the necessary academic competences, while making it possible for teachers to maintain overview and supervision, and focus on students who need it the most.

5 Conclusion

In this paper a theoretical framework for analysing and designing processes in teaching and learning has been presented. The theoretical framework is suitable for empirical studies of the processes of teaching and for the design of digital learning platforms. The theoretical framework describes processes on three levels: Interactional sequences, workflows, and modules.

Further research into characteristics of workflow and interaction sequences could focus on the relation between:

- Participant roles (teachers, students, external participants).
- Authority and classroom management.
- Competences that can be developed.
- Educational goals.
- How digital learning material can support the processes.
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7 References


