Orchestrating Bridges for Institutionalizing Students' Contributions in Classroom Teaching

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Introduction and Motivation

As a university student as well as a teacher and observer at university level, I have experienced rather disconnected transitions between student activities and teacher-led classroom lectures. Students learn by being active and relating new knowledge to their previous knowledge and experience. Therefore, it is important to present new material in ways that activate students and relate their existing knowledge to the topic at issue (Ulriksen, 2021). Yet, this is not always easy to practice, because teachers often feel a need of being in control of the course's content and form (Jørgensen, 2015). When lecturing, the teacher knows that the students had the opportunity to get the relevant information. However, the teacher neither knows if the students have learned the taught material nor in what ways they interpret the information given (Ulriksen, 2021). Thus, when presenting new theory and material, teachers must engage the students in ways that inform such questions for the teacher (Johannsen et al., 2015).

The Theory of Didactic Situations (TDS) focuses on the connection between students' personal knowledge and established official knowledge (Winsløw, 2006). It addresses student interaction with a didactical situation through five phases. The last two phases 'validation' and 'institutionalization' concern the transition between student activities and teacher-led discussion and presentation. Based on this terminology, my question of inquiry for the final project of UP is: *What instructional means can help orchestrate the transition to the institutionalization in student-centered classroom teaching such that it values and relates student contributions?*

During spring 2025, I was teaching two lessons on the course 'The Mathematical Modelling Sciences' (NNDK20003U) at the Master program in STEM education offered by UCPH. The lesson of the intervention reported upon in this project was on *critical* (Skovsmose, 2011) and *technocritical mathematics education* (Jankvist et al., 2023). Most students on this course are former primary and lower secondary teachers, who have been working for several years and are doing their master while working as a teacher. The class consisted of about 20 students and all the teaching of this course toke place in the same classroom at University of Southern Denmark (SDU), implying the teaching format to be class-based.

The Intervention of Institutionalizing Students' Contributions

The intervention concerned how to structure the validation and institutionalization (row 3 and 4 in Table 1, Appendix A), that is to say presenting new material based on students' work. In the Danish 6F-model of inquiry-based science education, the phase '*forklar'* (explanation) entails elements of both validation and institutionalization, which may remedy the transition between them. In line with this, my intention was to bridge this transition. In a meeting with my two UP supervisors prior to the intervention, my department supervisor, Prof. Morten Misfeldt, advised that students' contributions and new material should be present in the room at the same time, which became the key point for the further planning.

The first task for the students was to answer the two questions: "What do you mean by the word 'critical'?" and "How can this meaning be thought of in the context of mathematics education?" by writing multiple answers on post-its (one answer pr. one post-it) and hang them on the blackboard. The intention with this formulation was that the students should begin with their own understanding and then put it in relation to the new concept of critical mathematics education. The questions are formulated such that all students can answer even with no prior knowledge to the topic at issue. Moreover, the formulations were

meant to leave room for further discussion and for the following institutionalization to be dialogical, while referring to the students' work.

As part of the validation, I wanted the students to stay by the blackboard and cluster their answers in categories to afterwards keep their validation present during the following institutionalization. The institutionalization should be a dialogue rather than a one-way lecture (Christiansen & Olsen, 2006). Therefore, I placed a post-it icon on several slides as a reminder to myself and the students to reflect on how the presented part of the theory was connected to our previous categorization, and whether something should be added or changed.

For evaluating the intervention, I took small reflections notes on the go about what to do differently in the future. Both my supervisors of the UP course observed the lesson and provided feedback and observation notes afterwards. I asked the students to answer the following question by hand after the lesson: "How did the post-it activity contribute to your learning about critical and technocritical mathematics education? Did you experience that it was followed up upon throughout the rest of the lesson?" Particularly, the second part of the questions addressed the question of inquiry, namely whether they experienced a connection between their activity and the following institutionalization. I collected their handwritten answers immediately after the lesson.

How It Went and Results

The overall picture from the students' evaluation was that the slide presentation had a good connection with the students' previous work with post-its and categorizations. However, where I had intended the students to stay at the blackboard and categorize the post-its, they just went back to their seats to make room for their classmates. The space by the blackboard was rather narrow and with 20 students in the room, it can be difficult to negotiate who is in front and takes charge of the collective categorization. Obviously, this part of the instruction had not been thought through. Thus, in a more teacher-led manner than I intended, I did the categorization at the blackboard and asked the students for names and suggestions, and they were still involved and participating actively. However, as one student wrote in the evaluation: "The systematic

categorization of the sticky notes could be more inclusive. It eventually was. If the purpose was for us to relate to all of them, it could be structured differently." In general, the students responded positively on the activity and the division of categories, as for instance: "Grabbed our preconceptions and extended hereafter on it [...] Was good that it was put into categories" and "I gained insight into several different angles and sorted it into groups and contexts. It gave a good insight/overview and a starting point for the topic."

During the presentation, the post-it icon worked as the intended reflection reminder, making my expectations on their participation during the presentation clear. One student wrote in the evaluation that "You were clear in your communication that we should consider how the theory fit into the common categorization along the way."

During the institutionalization, no new post-its were added, but new categories and relations between the categories were drawn and named, which resulted in a form of concept map (Nowak & Gowin, 1984) on the blackboard (Figure 1).

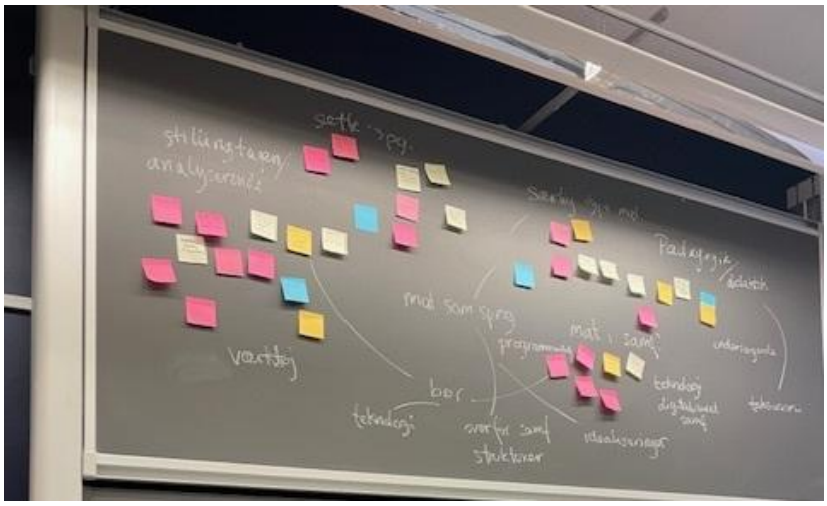

Fig. 1. Picture of the blackboard with the students' post-its and our categorization and relation-arrows.

This linked the new knowledge from the theory with the initial thoughts on the topic. All students reported positively back on this with formulations like: "There was good follow-up and the activity was in play throughout the lesson," "you went back along the way, so it became a guiding tool" and "The relationship arrows were good at govern our

conversations and getting us to put more words to our reflections." One student wrote: "However, too much on slides. See the TED talk 'How to avoid Death by PowerPoint'" which surprised me, as I had thought a lot about how to use these slides, make variations and encourage discussion. Still, the general picture from the students' feedback, the supervisors' observations and my own experience, indicate that the institutionalization became a dialogue connected to the validation through active participation from the students.

Reflections on Future Institutionalizations

Returning to the question of inquiry I found that mainly two instructional means were in place for a successful transition between validation and institutionalization in classroom teaching.

The first instructional means was the advice from the department supervisor, saying that the students' contributions should be present at the same time as institutionalizing the activity. In the concrete teaching situation this was done by doing the validation on the blackboard and having prepared the main ideas and concepts of the institutionalization in a slideshow. The blackboard made it possible to return to the students' contributions during the entire lesson (Ulriksen, 2021). Furthermore, the setup allowed me as a teacher to physically move between the two surfaces, pointing out concepts and categories simultaneously. In that way, I could apply my physical appearance as a relation-arrow between the students' contributions and the official knowledge.

The second important instructional means was to use the visual post-it icon in the slideshow to emphasize my expectations and remind the students as well as myself to stop, reflect and participate during the presentation. In this way, the institutionalization became dialogic, was connected to the validation, and avoided the students being passive, which can often be the case during lectures (Ulriksen, 2021).

Then of course, not all intentions were realized. Particularly, the evaluation showed that the validation carried out by me the teacher doing the categorization, could have been more inclusive and that one student still felt that the slideshow was too heavy. For another time, bigger post-its could be used for better visibility from a distance, yet doing a

collective validation from a distance would probably still be rather difficult, without the teacher taking over. Otherwise, the students could be called back to the blackboard to study all post-its either in small groups or as part of a break such that there would be room for everybody on the board. Finally, students could sit in small groups to do a group validation of their own post-its and find categories before going to the blackboard, which could then be summarized together with the other groups. In this way, it would still be the teacher leading the collective validation session, but with more obvious contributions from the students.

Moreover, when students contribute to the validation of clustering their post-its, or when commenting during the institutionalization, the teacher could respond with questions such as "could you add a post-it that encapsulate that point?" or "will you name that post-it/categorization/relation up here?" In this way, it would be their contribution to the common work rather than the teacher controlling their input. Hence, bridging validation and institutionalization requires orchestrating opportunities for the students to contribute during the institutionalization such that they answer and not the teacher providing the correct answers, but it becomes a common understanding of the topic at issue.

Conversation with Colleague Andreas Tamborg

As part of writing the report of the project, I talked to Tenure Track Associate Professor Andreas Tamborg at my department (IND). He had read the project from the perspective of the report to be included in the teaching portfolio and gave comments on how the report could better reflect considerations of my own teaching practice.

He suggested starting the report with my experienced problem and elaborate on why this is relevant, what teaching ideals the problem reflect, and why it can be difficult to carry out in practice, which I have now tried to include. Furthermore, he suggested making clear the reflections and considerations behind the formulation of the task given to the students. After his comment, I emphasized the intention of student dialogue, reflecting the problem of inquiry. In general, these changes should be to

emphasize that the choices I made in the planning of the lesson are taken on a well-reflective background.

References

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NNDK20003U De matematisk modellerende videnskaber: The Mathematical Modelling Sciences - 2024/2025

Appendix A

Lesson plan on critical mathematics education, May 26, 2025
The mathematical modelling sciences, Ms in STEM education, UCPH.

Section	Phase	Content
1	Devolution	Brief introduction. Theme of the lesson: Critical mathematics education
2	Action, formulation, own/group validation	Answer the two questions on sticky notes (in small groups or by your self). Give one response pr. note. - What do you mean by the word "critical"? - How can this meaning be thought of in the context of mathematics education? Place your notes on the blackboard.
3	Validation	Teacher-led class discussion. Clustering notes and naming categories.
4	Institutionalization	Teacher-led presentation and dialogue of Ole Skovsmose's critical mathematics education, with planned interruptions and periods of reflections on how the student considered his view to fit our categorizations and their content. Adding and changing sticky notes and categories.
5	Devolution	Encrypted messaging services

		Technocritical mathematics teaching: Mathematics in action. Complicated mathematics that can be opened and closed depending on level.
6	Action, formulation, group validation	Go to a "Magic chart" hanging on the wall to answer how critical and/or techno-critical mathematics education can be actualized, by answering: - You are in the process of redidactising your task from assignment 1 or 2. If you were to think this into a critical mathematics teaching context - what would you emphasize? - Is there any mathematics in action that can be opened - what points would you bring up? - Formulate an exercise/activity around your model/modelling that could have elements of critical mathematics teaching. - Presentations of their sketches for teaching courses.
7	Class validation with references to the previous institutionalization	- Good considerations in connection with mathematical modelling and critical maths teaching Main headlines from the presentation round on which aspects of the critical and techno-critical mathematics education the students emphasized and how.
8	Evaluation	Hand writing answering four questions, two related to the first round on what critical mathematics education is and two

	related to the second round of designing critical mathematical teaching activities.