

# Action research for STEOP courses

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This teaching project took place during my StEOP courses held for future teachers in WS2017/18. Its motivation roots in my previous, not completely satisfactory, experience with similar courses in WS2015/16 and in my belief that teacher's education is of special importance, see section 1. Since 2016, I have held several other courses and seminars for future teachers and this project offered a systematic and critical framework for testing my new teaching strategies, see section 2. The analysis and evaluations of the project are given in sections 3 and 5. In WS2018/19, I will be teaching StEOP again, and therefore I devote sections 3.1 and 3.2 to reflections on further possible improvements of my teaching style.

## 1 My motivation for the choice of StEOP

StEOP lectures welcome the new students at the beginning of each academic year and are greatly feared by the students. I think that StEOP is often mistaken for an entrance exam by the lecturers and its orienting flavor is often neglected. The students believe that they are being sieved out, but the parameters of this sieving process are not specified. It would be preferable to provide instead an introduction to the future profession combined with a fair and transparent evaluation of necessary professional abilities.

**My previous experience with StEOP:** I held two exercise sessions for a StEOP lecture in the winter term of 2015/16. The classes were relatively big (circa 35 students each). It was difficult to call the students to the blackboard for presentations of their homework - all rows were fully packed, with no isles between the rows. I decided to write the solutions, which were dictated to me by volunteers, on the blackboard myself and, then, ask the others to comment. The real discussion within the group had never taken place, only a one-to-one interaction with the author of the homework's solution. This way however we did manage to discuss all the homework exercises. Then the

students started asking me a lot of questions after the class which indicated a need for more personal and intense interaction. It did not occur to me then how I could re-organize the class accordingly. It was clear though that the whole group would profit from the answers given to a selected group that stayed after class. At that time I was new to the Austrian organization of the exercise sessions, in Germany the homework exercises were always divided into the ones discussed in class and the ones that were assigned to be solved at home. The latter were collected and graded by tutors, and the questions about the graded exercises were answered during the next class. These two additional rounds of understanding and reflection were missing and could not be really imitated for my StEOP courses. It left me wondering about ways for instigating active discussions, for breaking through passive resistance to active learning and for demonstrating teaching strategies.

At the beginning of this project, the main directions for improvement were

- 1) to create a stimulating discussion climate,
- 2) to transfer learning and teaching strategies within a group,
- 3) to motivate the future plan of studies with emphasis on teacher's skills.

## 2 Goals and strategies for my project

To achieve the goals 1) – 3) mentioned in section 1, I tried to implement four action research cycles in my courses with the goal of further development and reflection upon student's learning and teaching strategies.

1. Cycle I assumed that at least half of the students do their homework and, thus, had already **activated the learning process**. The reason for this assumption was the number of homework exercises marked (Kreuzerl ubunglisten) by the students.
2. Cycle **Working in groups** was organized in a way that one of the students (a volunteer) was playing a role of a teacher and explained his solution to circa 4 to 5 other students. The groups were built on a voluntary basis. The work in groups imitated an environment of a small classroom with an improvised blackboard - a sheet of paper from a flip-chart attached to a wall. There were 5 to 6 groups discussing simultaneously. The other members of each group played the roles of pupils whose task was to ask questions and to spot and clarify possible mistakes.
3. Cycle After discussions in small groups, the solutions were structured logically and all steps that led to the solution were supplied with explanations. These solutions

were presented to the whole group, the final **peer quality control**. Each group decided who (a student different from the teacher in 2.Cycle) would present their solution.

4. Cycle The last step was to create **solution sets** (Musterlösungen) of the discussed exercises. These sets were to incorporate all the improvements suggested during the 3d Cycle and these sets were posted in Moodle for everybody's use.

My role was to control the group discussions and to interfere, when my help is needed. On the one hand, cycles 1-4 were designed to illustrate the following basic learning stages:

Receptive stage - listening to the explanations of the colleges.

Application stage - selecting appropriate tools for problem solving and for checking the correctness of solutions either alone at home or in a group discussion.

Creative stage - finding and discussing more efficient ways to solutions.

On the other hand, cycles 1-4 were to provide a basis for illustration of possible teaching strategies coupled with a corresponding learning stage. I hoped that discussions in smaller groups, when facing a specific task, were more effective. I selected the following teaching strategies for our discussions

- teaching by repetition (cycles 1-4),
- teaching by stimulating critical questions (cycles 2-3),
- teaching by structuring the knowledge (cycles 2-4).

### **3 Analysis and discussion of the project**

My two main criteria for success of the project were

- open discussion climate and
- quality of learning.

These criteria were accessed by the quality of the homework solutions (Musterlösungen), by the standard evaluation forms and the additional multiple choice questionnaire filled out by the students at the end of the semester.

**My questionnaire (in German):**

1. Wurden Sie über die Studienziele ausreichend informiert? ja (39), nein (2).

2. Haben Sie den Ablauf der Übungen sinnvoll gefunden? ja (38), nein (3).

Kommentare: Die abwechslungsreiche Gestaltung hat gut getan; Einstieg mit Gruppenarbeit hat sozial geholfen; Ja, insbesondere starke Berücksichtigung Lehramt als Ziel, angenehmes Klima.

Verbesserungsvorschläge: Besseres Zeitmanagement, um alle Aufgaben zu besprechen; Frontalunterricht ist sinnvoller.

3. Haben Sie neue Lernmethoden (z.B. Lernen durch Wiederholung, Gruppenarbeit, u.s.w) kennengelernt (anderes erlebt)? ja (35), nein (6).

Kommentare: Alle Methoden waren schon bekannt; Lehrmethodik hat zu meinem subjektiven Lernerfolg stark beigetragen; Durch Gruppenarbeit wurde viel Zeit verschwendet; Durch den Austausch in den Gruppen habe ich mir besseren Zugang zu manchen Aufgaben verschafft; Gruppenarbeit war nicht immer effektiv.

**My comments:**

The outcome of this assessment is not very surprising to me. On the one hand, the idea of starting the class by discussing the homework in small groups did find approval. It stimulated mathematical interactions, eased the agitation of the first blackboard presentation and helped to improve the quality of learning. On the other hand, I also sympathize with the ones who would prefer to have a sure solution provided by the teacher instead of wasting time on possibly pointless discussions with the other students. The latter strategy is appealing, but flawed: firstly, it does not prepare students for independent problem solving; secondly, it easily gives the students a feeling of fake confidence (they think to have understood, but cannot reproduce the material). Certainly, the approach of making students explain their solutions themselves is more adequate, but trying sometimes. My idea of starting the class with group work was an attempt to eliminate painful and embarrassing one-to-one disputes with the students who believe to have solved the homework exercise, but who are actually not well prepared at all. Certainly the same can also happen during group discussions in smaller groups, but, then, the quality of solutions becomes the responsibility of the whole group. In smaller groups, discussions (comparisons of different solutions) happen more naturally and lead faster to a sound solution - their own success. Let them make mistakes, correct each other and finally come up with a question that puzzles the whole group. At the end, their solution methods get more transparent and the solution sets emerging from this process are of higher quality. Moreover, the more the future teachers interact on both personal and teacher-classroom levels the merrier. I prefer to interfere only if the discussion stalls or goes in a totally wrong direction.

After this project I became an even stronger supporter of the 1-2-3-4 method described in section 2. A highlight was to experience how the students become one working and personally connected group.

There are some **problems and questions that remain:**

- After discussions in small groups, the students expect their solution to be perfect and, sometimes, any further corrections are considered to be my failure to help them and are blamed on me.
- Should the advantages of working in groups, teaching strategies and so on be explained or just experienced?
- How to prevent laziness at the expense of the other hard working members of a group?
- How to guide several groups simultaneously?
- How close is my 1-2-3-4 method to the concept of a flipped classroom?

### **3.1 Improvements: modified teaching strategies**

The two main, rightfully criticized, aspects were

- time management of discussion versus presentation time and
- selection of the homework exercises for discussions.

This semester (SS2018) the selection of the assigned homework exercises is more balanced in length/effort and the working groups do not need more than 30 minutes to prepare their solutions. This leaves enough time for the blackboard presentations and discussions in front of the whole class. Certainly, better time management is also possible due to several exceptionally good students that make my interference almost unnecessary and set up the quality of group discussions to a high level. A possible strategy for the future is to plant at least one good student into each group. This also could partially resolve the difficulty of simultaneous guidance of several working groups.

A possible answer to the question, if all the homework exercises should be discussed, is to assign fewer exercises and to have the similar rest for additional, independent study at home. The problem is that the lectures and exercise sessions are formally independent, but the lecturer is prescribing the corresponding homework sets which is done sometimes without even coordinating the process or inquiring about the progress. The students get agitated wanting to discuss all the solutions and, then, ironically the exam looks totally different from what was done in the exercise sessions.

## 3.2 New insights: teaching evaluations SS2018

In this section, I present the student's comments to my slightly modified 1-2-3-4 method tried out in SS2018. The modifications were based on observations in subsection 3.1. I was positively surprised by the homogeneity of the student's assessments, students of higher semesters (3.-4. semester), who have had already an extended experience with standard exercise sessions and some even with teaching practice. They pointed out

- enhancement of the learning success when being exposed to several different solutions of the same problem discussed in a group instead of listening to only one presentation by a single individual,
- eradication of fear, due to self-assuring group work,
- fair working load, due to the appropriate selection of homework exercises.

One of my main goals, see subsection 3.1, was to improve the time management of group discussions versus blackboard presentations. To meet this goal, the 2. and 3.Cycles in section 2 were slightly reorganized: the solution to be presented during the 3.Cycle was written on the board already during the 2.Cycle; the oral presentation in front of the whole group had been followed by a pause for copying down the solution. These slight changes resulted in the increased number of relevant questions (probably, the students have had more time to think things through) and almost totally eliminated the need for the solution sets (Musterlösungen in the 4.Cycle).

**My personal observations:** Group discussions seem to assure everybody of their leaning success. This results in attentiveness during the whole class. Furthermore, the stronger students, who usually learn little from the forced blackboard presentations of the others, flourished during group discussions and contributed willingly to the learning successes of the others.

**The only negative comment** was pointing out the organizational chaos at the beginning of each exercise session. At the moment this seems unavoidable to me: the groups are self-organized and it does take a couple of minutes till everybody finds his/her discussion group.

## 4 Selected workshops

### 4.1 Was tun, wenn's nicht läuft? Analyseinstrumente und Interventionsmöglichkeiten bei Widerständen in Lehrveranstaltungen. Eva Pelosi, 18.10.2017

Slowly we all learn to accept personal, mostly reasonable or, sometimes, unfounded dislikes of others. We also learn to respect the resistance to our wants, help, wishes and advice. It is easy to learn to treat the dislikes and resistance almost impersonally, when the confrontations are avoidable or distant. It is almost impossible NOT to take things personally when having to face any kind of resistance in a confining atmosphere of a classroom - our own intellectual kingdom. This kingdom, in which our educational attempts are expected to be met and cherished with care, friendliness and awe.

5 years ago in Dortmund, I was teaching a big lecture (circa 300 students) to future physicists and chemical engineers. It was the worst teaching experience of my whole carrier - the toughest resistance to learning from some of the students - and my strong motivation to attend this workshop. The final analysis of the situation (during the personal coaching) made me realize that the students were attacking the curriculum that forced physicist and chemical engineers into one lecture that could never address their professional interests simultaneously. This made me realize that the roots of resistance are entangled and difficult to expose. Especially, when the reasons for resistance are vague and unclear to both parties involved.

I find the first step towards acknowledging the resistance the hardest: it is so tempting to pretend that nothing unusual is happening; it is so scary to face the situation being alone in front of a group; it is so unsettling to waste lectures on psychological experiments. The advice we got is to start exploring the situation by employing subtle means: changing one's own position in the classroom and analyzing its effect; restating the goals and expectations to clarify the tasks; creating activities that foster personal interactions.

In my opinion, the amphitheater shape of any big lecture room at the university does not leave much space for reshaping the traditional teacher-centered (frontal) teaching style and, thus, for changing of the lecturer's position. I do try to leave the blackboard and step down the podium towards the students, but the formulas pull me back into writing.

However, I find it very fruitful to spend time polishing my course's goals and expectations. It sets the core of the course, the point to which I keep coming back to offer the students a safe ground of familiarity. For example, the main goal of my "Analysis for future teachers" is the mathematical justification of the school knowledge: everything about numbers and functions. The material is difficult, but in the midst of the struggle

we keep coming back to soothing and familiar numbers and functions.

In my opinion, bringing personal interactions to life during lectures depends greatly on the way the very first question is being received and answered. I guess my strategy in this case is probably too simple - answer thoroughly and thank for the question. I have experienced that students naturally seek contact during or after lectures to be confirmed in their thoughts and learning progress, unless they are met with indifference. In my opinion, there is no place for teachers indifference in any classroom. Indifference could be another reason for a passive resistance revolt - be present but refuse to participate. It is so unpleasant to be teaching to a wall.

There are so many facets of resistance and they cannot be addressed even on several pages. What bothers me the most is the resistance born from the lack of self-confidence in personal learning abilities. Whatever caused it, it does settle deep and firm. The question that remained open for me is to what extent do didactic methods and tricks help to alleviate this cause of resistance. The answer was reasonable - the cause is sometimes beyond any teacher's abilities, e.g. being that of some inborn defect, - but unsatisfactory. This answer does not provide any insight into the other cases, which are not caused by inborn defects. Should we try to lead the students to experiences of individual learning successes, or, maybe, integrate them into groups to show that others might be struggling as well, but nevertheless prefer to keep on going and achieving? There are certainly no universal techniques and cures, but some might be more effective than others. How can we reasonably differentiate among causes of learning resistance?

## **4.2 Critical questions - critical mind: effective questions and how to use them in seminars. Olivia Vrabl, 1.12.2017**

We all have experienced silence in reply to the questions we ask and have volunteered to answer our questions ourselves, to fill in the unsettling silence. The assumption being that the audience does not know the answer to the question. This workshop made me realize that it does not have to be the case and the silence could be caused by

- the vagueness of the question (which was not a very surprising revelation),
- the thoughtfulness of the audience,
- the unwillingness to participate.

The second reason, so simple and obvious, had never occurred to me before. It is natural to reformulate questions and tasks when one sees the lack of understanding in the eyes of the students, but how does one spot thoughtfulness. The students might



as well be thinking about something else. Giving more time for thinking might lead to the loss or to the deviation of attention. Answering oneself does not really lead to a balanced discussion. The solution was simple and elegant - ask the student to write down their thoughts in a brain-storming way and to read what they wrote. It is acceptable, if someone has nothing to say, but on another similar occasion they are expected to participate.

I tried this approach at a bachelor seminar and was amazed how willing the students were to participate in the discussion after they had time to verbalize their thoughts on paper. The subject of the discussion was the attributes of a good talk and the students were asked to write down their thoughts on the subject while listening to the talks presented that day.

This semester, at the exercise sessions for analysis, I asked the students to write down the topics that were left unclear, but are relevant for our first test. The received replies made me wonder, if I failed to express myself clearly - the questions were more about the structure of the test than to its content.

This leads us to the second part of the workshop - what is a good question and what is a good argument. After a long discussion that day, I believe that a good question is the one that serves its purpose. Even the question - would the topic such and such be on the test? - is a good question, if one gets the desired answer yes or no. It becomes a bad question, if it irritates the teacher and does not receive a clear answer. How do we teach our students to ask good questions? Certainly by asking good questions ourselves.

- Questions that allows for a clear-cut, well founded argument - claims supported by examples and evidence or proofs: What line of reasoning led you to your claim? How can we find out, if what you are saying is true?
- Question that concentrate on one particular aspect, e.g., precision, of the argument: Could you be more specific about ...?
- Question leading to a broader perspective on the subject: What would someone who disagrees say?

and so on. To illustrate good answers to questions, we simply need to step down from our Olymp of knowledge and not only answer questions, but show how we think about questions to arrive at the appropriate argument.

## 5 Visits

It was important for me to get feedback on the effectiveness of my approach for

- stimulating a relevant, lively discussion among students and
- presenting the teaching strategies they can use later at work.

The colleges that visited my classes were Thomas Ratei and Sonja Buchberger. I find Thomas's views on course's organization interesting and wanted to use his expertise for the assessment of my class. Sonja has a deep, professional understanding of the nuances of teaching and already has had an experience with similar types of teaching projects.

## 5.1 Description of procedure

The two classes (Übungen zur StEOP) of the same course that were selected did not differ much in the organizational sense. However, they were attended by different students. The classes started by building 5-6 discussion groups, each responsible for a detailed presentation of one particular homework exercise. The first 30-45 minutes were spent on working out a corresponding solution based on homework solutions of the group members. I was supervising the discussion process and was suggesting improvements or answering questions. It was common that some of the students were listening to the discussions in several groups after finishing their own assignment. Therefore, the visitors could freely join any of the groups and were accepted as rightful members of the group. The last 45 minutes were spent on the blackboard presentations of the solutions in front of the whole class. As the paces of presentations varied and I was also giving feedback on different teaching styles, we were running out of time and not all of the discussed solutions were presented to the whole group. Those were offered in written form in Moodle.

The selection of the homework exercises was given to us at the beginning of the semester. Neither the choice of the exercises nor the quantity assigned for one week was negotiable.

## 5.2 Comments of the visitors and my reflection upon the comments

The general impression was that I did manage to involve all the participants into discussions and active work on the solutions.

### **Other and more detailed comments of Thomas Ratei:**

Comment: The class started without a proper, formal welcome and overview of the goals.

Answer: True, thinking back, I was in a hurry to discuss as many exercise as possible - omitting one could mean that the students would be unprepared for the exam. Personally I am against assigning more than 4 exercises for a two-hour class and I follow this rule, when I give my own lectures. This semester, I also tell the students to write their solutions directly on the blackboard and keep them for their presentations in front of the whole class. This also saves some time.

Comment: Good working climate during discussions. Some groups finished earlier and there was some irrelevant small talk.

Answer: This I still do not know how to control. Except that with my own sets of exercises I can better equalize the level of difficulty and the time required for preparation for the class.

Comment: Some groups spent more time than needed on speculations rather than on fruitful discussions.

Answer: I would not see it negatively and prefer not to intervene too early. In mathematics some time is always needed for working out a hypothesis. If the students did not manage to do that by themselves at home, they should try brain-storming in a group.

Comment: The group representatives selected for the solution presentation were not always qualified for the task. Would it be better, if you decide on who is doing the presentation? Anyhow the discussions even during the presentations were lively and the students tried to connect the exercises with the content of the lecture.

Answer: Here I am not sure, what approach is better: ask for volunteers and mostly likely get a reasonable presentation of the solutions, or select myself and run into a danger of a long and unfruitful struggle at the blackboard. I am inclined to follow the first approach. Anyway, every one in the class has to present at some point. Following the second approach, at the end, I would have to take over and possibly redo everything myself.

Comment: The class finished too abruptly without a recognition of the student's contributions and without a summary.

Answer: True, this semester we do all thank the ones that come to the blackboard. I prefer to summarize after each exercise and not at the end of the class. Each of the exercises addresses different aspects of the lecture. This way I also hope that what I say would be placed into the content more appropriately.

### **Other and more detailed comments by Sonja Buchberger:**

Comment: During the orientation phase, put more emphasis on the comparison between the university and school and stress how the knowledge obtained at the university

is applicable later when they teach at school.

Answer: At the beginning of the last semester, I did mention that the study at the university is a test of their learning, communication and social skills that are vital for a future teacher. The students should be able to learn a difficult (more abstract) material efficiently (a lot faster than at school) and to present the obtained knowledge comprehensively in both verbal form (exercise sessions) and written form (exams). I could try to repeat the above several times during the semester, every time paraphrasing accordingly. Last semester I found only one connection between what we were doing and what the students can use at school: testing and comparing their learning skills in order to be able to show the pupils how to learn. In my current lecture (also for the future teachers but in their 3d semester) I do show how to restate the formal mathematical statements in a way that a pupil at school will be able to understand them.

Comment: It could be good to let the students judge the teaching abilities of their colleagues. Discuss criteria of good teaching, e.g., finding several different explanations/solutions for one question/exercise.

Answer: I agree that the teacher should be able to access the level of the audience and to adjust the explanations accordingly. Or, even to offer several explanations on different levels when teaching to a heterogeneous group. I ask the students to explain first the intuition behind their solution method which could be done e.g. graphically and then to be more precise when writing down the solution. This I could certainly do more systematically by incorporating intuition and precision stages into the statement of the homework exercises. Afterwards, I could also require to put the exercises in a bigger perspective explaining how the topics fit with the previously discussed material. Here, I think, I could use the question catalogue from the workshop described in section 4.2.

Comment: To alleviate uncertainties with technical language during discussion in small groups: the students correcting their colleagues.

Answer: I think it is a good idea, yet to be tried.

Comment: To incorporate case studies about teacher's reaction to difficult classroom situations. Relate them to what has happened today in class.

Answer: I do this sporadically, I do however forget sometimes to do that. What I do when the explanation of a student was not understood and there are no questions afterwards is I turn to the blackboard and ask those who did not understand to raise their hands. It works marvelously, the student who was presenting sighs "oh my God" and starts explaining again. It helps to spot the difficult points and rephrase the explanations.

Comment: Discuss what exercises should be presented. Involve the whole group into discussions about the correctness of the presented solutions to avoid lack of questions after presentations.

Answer: There will always be one student who wants to see the solutions to all homework exercises. Instead of disregarding this opinion, I prefer to assign fewer mandatory exercises and offer extra ones for volunteers. The check for the correctness of the solutions is done in small groups. This is less scary and less stressful. I have not yet found a universal way to involve the whole group into a discussion. In small groups the students are more willing to talk to each other and to me directly.