On Strategies Contributing to Active Learning

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Abstract

There are well documented reasons for University staff to become even more effective teachers to meet the challenges arising from
- dropping of learning skills in mathematics during recent decades,
- changes in life conditions,
- preference for visual forms of information,
- university audiences not fully oriented to the study.

As a starting point in our considerations we take the idea that teaching means helping students to learn. In this paper we introduce and discuss ideas and strategies for active learning from Krantz (1999), together with those of Bressaud (1999). We also cite the thoughts of Zucker (1996) and a summary of strategies formulated by Zweck (2006). The inceasing web frequency of the theme of active learning shows its significance and special web pages within universities are now reserved for instructions on how to engage students in active learning.
Apart from the technical aspects there are other, inner, aspects associated with active learning: to promote positive feelings, to cultivate mastery and to provide a joy of discovery for a learner. Research of human brain implies that it is impossible to separate emotion from logical thought and learning. Some strategies that have been proved as effective include:
- questions posing,
- problem formulating as a story to be continued,
- communication with learners,
- creating a conviction that learning means self-work, mainly outside of a class.

We present our experience with some of these, and discuss also Zucker's (1996) proposal to provide a "survival guide" to students new to university study.

Introduction

We start with a short story acting as "a case study". Some years ago, I taught a student - let us call her Ann - in a two semester mathematics course. Ann was an average student, with an average knowledge of secondary school mathematics. She showed no special interests concerning mathematics, and was probably oriented more on her major study of financial management, but was able to pass all her exams at an average level. Sometimes, she came to me for advice / consultation on how to solve some more complicated problems, and I tried to show her "the whole picture", not only the single solution steps, and not only in mathematics. I also directed her to relevant chapters in the recommended reading.

Later on, I no longer worked with her in classes but saw her often helping younger fellows - explaining them maths problems. Ann was ready and even interested to help students, and she was very active when her boy-friend needed a long, patient paper-and-pencil explanation of rather elementary mathematical ideas. Due to the frequency and repetition of that work, I am convinced that in this way, Ann had read mathematical courses not only for the second time, but maybe for the eighth time or so. She had

clearly found out this is not boring but even highly interesting, with gaining deeper and deeper insight into maths! This was the "side-work" done to help her colleagues, but now, of new importance for her. Now, Ann is able to solve theoretical problems in a specialised area of maths in which she was interested and works in a group with other teachers and doctoral students. Ann contributes to scientific seminars arising from her own study and own results; she will be applying for doctoral study – and with a very high probability of success.

What happened and why values have been totally changed?

Teacher's roles

In the Czech Republic as similar to other European countries there are two official duties for university teacher, and we are regularly appraised in both of them: to teach and at the same time to do a scientific research. In teaching this means to read lectures on different mathematics majors, to run practical exercises, exams, diploma works etc. A lot of university teachers of mathematics recognize that as they are fully involved in mathematics they need not be deeply devoted to the study of special pedagogical methods on how to teach mathematics or at least, teaching is often perceived as an activity of secondary importance.

The common perception is that if we are professional mathematicians, having achieved a diploma and our own mathematical education, then there is no strong need to worry about teaching or even to be specially prepared for it. Of course, for those who are interested in pedagogy there are brilliant textbooks devoted to didactics of mathematics. There is a very wide conviction for teaching mathematics on university level, the best encyclopedia on how to do this are our own predecessors, e.g. our old teachers, that we liked and we tend very much to follow just them.

It was very interesting to find a concise book of summaries on teaching practices by Krantz (1999), showing the principles on how to professionally manage single aspects of mathematics lecturing. In our opinion, the main message of Krantz‘s book is that, for a teacher, it is necessary to be instructed, well-prepared, active, curious, totally involved. But, concerning learners, he supposes - mainly - that the learner in our audience is ready and fully prepared to be educated.

This fails to be true in general, we have experienced a dropping of learning skills in mathematics during recent decades, visual form of information is mostly preferable, and university audiences are not fully oriented to study and for students the principles of successful study have not been learnt. Recent trends of the Bologna process across European countries now impose learning outcomes as the criteria of main importance. Those are defined for certain cycles of high education study, but curricula or syllabus are suppressed by them.

Special topics in Krantz's book show that standard teaching methods are taken as an undoubtedly minimal requirement for the success, but very often they are not satisfactory, even when sophistically prepared. The main problem for the majority of

teachers is that our audiences are not those students who had been chosen mathematics as their life‘s ambition. Simply lecturing, even qualified explanation, the use of special computer software and other classical, or very technical methods, are not enough. We are searching for some "added value" enriching our teaching, independently on its form. What might it be?

Even remembering our own old university professors, we recognize only some of them as extraordinary. Only some of them took us virtuously into mathematical world, and only the best ones are remembered such as those who were the most enthusiastic about teaching. Nowadays, a university maths teacher has to be curious, totally involved but first of all, he/she has to be an *active teacher*, and he/she has to recognize, based on personal experience, what does it mean. That is, the extraordinary feeling has to be given to us as students or learners first, either sooner or later and only then is there a chance to pass it to our audience.

What is active learning, active teaching?

According to Zweck (2006):

- active learning means getting involved — analyzing, synthesizing, evaluating,
- active learning involves students in doing things and thinking about the things they are doing,
- active learning usually results in generation of something new, e.g., a relationship between two ideas.

To learn in an active way means *to be engaged into the topic, to deal with a problem, to overthink it, to observe connections between notions* - not only to listen or „to be informed*“: to be forced to gain information himself/herself* (with conclusions from that information as well - and this is especially important at our faculty), *and to transform it into knowledge*. Active learning is based on learner‘s smaller or greater discovery, and discovery generates positive emotions. A question arises: it is possible to create the joy of acquiring knowledge as a positive emotion, even under conditions mentioned above? But trying to do this, first we, teachers, need to tackle the active attempt; a passive teacher probably would not meet an active audience.

Active learning begins first with the interest and motivation. We are convinced that each more or less experienced teacher is able to make use of facts from history of mathematics, starting, say, from ancient Egypt through Golden Ratio notion to fractals or three-dimensional surfaces in constructions, as tools for forcing study motivation, electronic multimedia support included. Experience suggests that teacher’s personal interpretation or enthusiasm plays the crucial role, and facts only follow them.

As an initial point of consideration, we accept the idea that teaching means helping students to learn. We cannot assume that any of our students is able to find his/her engagement by oneself in a given time. How to engage students to work, to learn in an active way?

Zweck (2006) provides a short list of types of active learning:

- Blackboard work by teaching assistant (TA) with continuous, active input from students.
- Think-pair-share: Students individually think for a moment about a question posed by TA, then pair up with a classmate next to them to discuss their thoughts. Finally, a few students are called on to share their ideas with the entire class.
- Pair summarizing/checking: Students work in pairs. One summarizes a concept, an approach to solving a class of problems, or a particular problem. The other listens and checks for errors, correcting them as they arise.
- Problem posing: Individual students construct a problem regarding a particular concept, and then exchange problems with a classmate for solving.
- Critiques: Students have short pair-wise or entire-group discussions to find flaws in an argument presented by TA.

Bressaud (1999) suggests to make students active participants to provide the most effective learning. He describes a common effort of 3-4 students trying to cope with an unfamiliar problem, taking it out of the class and continuing to work on it; sharing the knowledge in a productive and inspiring way. He also stresses the role of posing questions into lectures.

In summary, either guided or directed dialogue of any form seems to be crucial – historically, this was the main principle of teaching.

Ask questions – lead effective questioning

It is useful to cite Zweck (2006) recommendations concerning strategies for asking questions:

- Ask a lot of questions at low cognitive levels to help students shore up basic skills from previous courses or earlier in current course.
- Also ask some questions at high cognitive levels.
- Wait 3 - 5 seconds after asking a question.
- Encourage students to respond.
- Probe students' responses for clarification and to stimulate thinking.
- Acknowledge correct responses: "Praise should be used genuinely, sparingly, and it should be specific."
- Design questions so that about 70% are answered correctly.
- Balance responses from volunteering and non-volunteering students.

The reader of Zweck's (2006) remarks could find there very clear suggestions how to lead effective discussion with audience, including also managerial methods - those require e.g. also *Sense of timing: When to ask a question, when to offer a summary, when to be silent.*

The following observation shows our experience of another type. Practically all courses at Faculty of Informatics and Management are located as e-learning support on the university website in a WebCT environment. Environment tools enable, for example, collaboration with fellow students organized in discussion groups. Last semester, a very intensive discussion group was generated – students invented even the own mathematical notation, and helped mutually in solving problems ("the best way to learn a subject is to teach it to another“). The communication with teaching assistants was also very rich and fruitful and it was rather surprising that this indirect electronic tool enabled the breakdown of some barriers between students and lecturers/instructors; in this way, we got a lot of questions not readily posed directly before. After this, we made use of open discussion based directly on those topics, which helped us to recognize very substantial problems not treated before.

Active learning ability contains a very significant social aspect; it can be a base of an active attempt to life in general, or to life-long learning. This is very important in connection with phenomenon of ageing generations in European population.

How to tune the audience to active learning?

At the start, majority of our students shows very poor secondary school math skills. According to Zucker (1996): "students must be told immediately that they are about to face a big jump in level from high school“, and the basic task for new students is to reorder their thinking. University students are very often given a list of basic study demands required for their successful transition from secondary level to university study level, named "Survival Guides“ to new "Academic Orientation“. Their content depends on their branch of study, but it is worth announcing these prerequisites at the beginning of their study. Response to such demands could be summarized by teachers, or students as well (Zweck (2006)). In the University of Hradec Králové, the Faculty of Informatics and Management organizes special introductory lectures into study methods where psychologists are involved as authors or consultants.

Some items from Zucker’s (1996) demands list inform new students that they can expect university study materials covering two or three times the pace of high school, that it is up to the responsibility of students to learn them, and the role of a teacher is primarily to work as an instructor only. Any department could provide recommendations how to work with textbooks, but it is student’s responsibility to learn the material. And let us add that in European tertiary education framework, evaluation based on ECTS credit system directly defines one credit as linked to corresponding students workload.

So, these are students roles. Concerning those of teachers, let us cite again Zweck’s (2006) remarks as Cautionary Notes:

- Design your sessions so that students come fully prepared to participate.
- You need to continually explain why you want active learning.
- Explain the specific goal of each active learning exercise.

- Give clear and concise instructions.
- Match type of activity to content.
- If a strategy is not working, fix it and/or change it!

Provide some feedback to your work, formulate questions:

- How is your activity a good match to the content?
- How does activity generate meaning for students?
- What instructions will you give students?
- How will you measure success?

Conclusions

At university level, students must learn on their own, outside the class, and this is the main feature that distinguishes college from the high school (Zucker (1996)). In addition, this has to be also an active study, in a large extent, and our role is to involve students into learning activities in general.

Let us state this as a necessary starting condition. Then, we suggest to consider two strategies for active teaching implementation:

1. A change of conventional lecturing, using specific methods, into an active way of delivering knowledge.
2. Apply question-posing, in different and specific forms, depending on subject and audience as well, in teaching and learning.

Let us add that the use of questions in teaching belongs to the most powerful instructional strategies leading to active learning, as shown on special workshops delivered to active learning (Eison (2008)).

Appendix

In a personal conversation with Ann, the student from introductory "case study", she confirmed that she forced herself to become immersed into a branch of mathematics, and due to her own effort, she became more and more engaged, and positively motivated by her success.

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