5 Interpreting Instead of Teaching Facts in the Classroom

Wolfgang Gatterbauer

Both students and teachers spend, on average, far more time preparing for classes and exams than actually together in the classroom. As new university teachers, it makes sense to ask ourselves, how we can put this limited amount of time in the classroom to its optimal use or to put the question differently: *what is the optimal value of the classroom* in the learning process?

In this short essay I will argue that students get most from the classroom experience if we use it for *interpreting facts already familiar to the students* instead of *teaching completely new facts*. For this to be possible, the students must have already been previously exposed to the subject, which requires independent work on their part before, and not only after the class. Preparation before a learning unit creates a basic roadmap of the material to be covered and allows one to focus on the more difficult parts. The classroom interpretation then adds to it by enriching the basic facts with personal experience and, sometimes, twists and turns the students would not have expected. This can happen more interactively in a smaller setting, but also one-way in a bigger class. In both cases, the class will help the students to build upon some existing notions, to rethink already learned facts, to put things into perspective, or at least consolidate knowledge. At the same time, it will make the classroom experience more valuable and interesting to students and motivate them for class without enforcing compulsory attendance.

In contrast to most other contributors in this volume, I teach engineering and natural science classes, not political science. The following observations on the classroom, however, should be general enough to apply to any subject domain. To motivate them, let us first look at a possible and perhaps familiar classroom experience.

5.1 The Common Classroom Mission: Teaching New Facts to Students

The following is an example university course design that is fundamentally motivated by a school of thought that it is the teacher who introduces new knowledge to the student. The description of this scenario is largely inspired

by my experience as mechanical engineering student at an Austrian university in the late 90s.

In such a university course, the university teacher presents the subject matter in class. The students take notes during the class and, later at home, reflect and repeat for the exams. Presence is mandatory for additional exercise sessions, which consist of either students or teachers presenting solutions to exercises on the blackboard. Official class notes are not available for classes, and if they are, then they are not useful for understanding and learning the subject autonomously.[1] Unofficial class notes might be available from students having taken the course the last year or from colleagues who have better handwriting than oneself. Motivation of teachers not to provide class notes is twofold: (i) preparing class notes takes time, something they think they are not paid for; (ii) denying a priori access to the classroom material stimulates some level of "curiosity", which make class more interesting (so they think). The argument goes as follows: If students could already look into a well prepared presentation of the subject before class, they would be able to learn it themselves, lose their "innocence" and could not be "surprised" anymore in the classroom with facts new to them. And curiosity, as those teachers have heard before, is an essential requirement for effective learning.[2] Put differently, students would not see the value of attending class. Actually, there is probably not much value if the teacher cannot add some additional experience and personal touch to the basic facts.

Given the structure of such a course with the basic sequence of (i) learning in the classroom and (ii) repeating at home, I will argue that it does not provide an optimal learning experience for the students. And that as new university teachers, we should not repeat the obviously spurious and self-motivated argument of forcing our students to show up in class "for their sake", but should rather create some level of surprise by providing them with some "new" insights or interpretations that will add value to their learning and will make them not want to miss class. Despite often a dream, it should at least remain our goal. In order to better explain the rationale, let us shortly analyze three forms of learning in an academic setting.

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1 There is a relatively new and positive trend with Austrian university teachers towards basing their class curricula on textbooks. Such textbook based classes are already de fact standard at many universities in the US. Those books are often not cheap, but those that are established and well-prepared are well worth the money and really allow students to study, understand and repeat the material on their own. I think it is a good development as, (i) for students, the price burden should generally be offset by the improved quality of studying from such books, and (ii) for teachers, as those books take away the burden of preparing pedagogically valuable class notes and let them concentrate on their actual tasks: research and teaching.

2 Those arguments are repeated often today by presenters who hand out printed versions of their slides only after their talks, as earlier they would "distract the viewers from the actual content" of the presentation.

5.2 Short Background: Three Elements of Learning Established Knowledge

It will be helpful to distinguish the following three elements of learning:

- *Learning new Facts.* Learning of established knowledge is characterized by a one-directional flow of information from the teacher or other source of information to the student. According to their preferred learning styles (e.g. preference for visual, auditory or kinesthetic presentation in the VAK terminology or preference for autonomous or group learning depending on their Myers Briggs Type Indicator (Keirsey and Bates 1984)), students will show differing preferences for certain presentation styles of those facts (e.g. textbooks, audio books, videos or teachers).
- *Interpreting those facts*. The notion of interpretation, as it is used in this essay, happens when a student can reflect on some subject matter, comes to a preliminary hypothesis or conclusion, and learns different, contrasting views or answers to the implied questions of the topics. Basically, it involves the two steps of (i) individual interpretation, and (ii) some external interpretation, in exactly this sequence. The importance of the first step is evident, as it trains the basic cognitive task of analyzing a problem, which necessarily requires an active effort of reflecting and creating hypotheses by the student. The second step is essentially receiving feedback on those interpretations, which can create some powerful "aha-effect" and which allows the student to compare his or her line of thoughts with alternative ones instead of being left alone with those thoughts. Such interpretational learning happens, for example, during an oral exam when the student puts forward one solution or interpretation and the teacher the correct interpretation. It also happens when students first individually search for solutions to a problem and then have them discussed and compared in class. Therefore, the two steps of interpretational learning do not necessarily require a reverse exchange of information from student to teacher such as by homeworks or in an exam setting. It is helpful and straight forward – but the point I want to make here – for the actual learning effect, it is neither essential nor possible to implement in a big classroom.
- *Repeating those facts*. Repetition requires the student's steady recapitulation of learning material in order to obtain a certain level of internalization and automation (e.g. to learn the names of bones in medicine or the basic multiplication tables in mathematics). Such repetitive training or "drill" also requires feedback after or during

repetition, but in contrast to the previous form, control can most often be done by the students alone (e.g. by simply checking the correct answer).[3]

The first two forms of learning above can be compared to the P and Q input to Reginald Revans' "Active Learning" equation L = P + Q (Revans 1980). Revan proposes explicit or "programmed knowledge" from others (P), and insightful questioning (Q) as the two principal sources of learning (L). Repetition is not considered in his model, as Active Learning does not focus on problems to which the answer is already known. In contrast, when teaching traditional knowledge and skills at a university, learning by repetition does play an important role, for example when learning definitions, paragraphs or formulas by heart. Using Revans' nomenclature and adapting the equation to our context, we could write

Learning = Programmed knowledge + Questioning + Repetition

or in the nomenclature used in this essay,

Learning = Facts + Interpretation+ Repetition

5.3 Alternative Use of the Classroom: Interpreting Facts

In the previously mentioned course design, the classroom is used for teaching basic facts. The first step of interpretation happens at home and during the exam; the second step can only happen during an oral exam or after a written exam if the students care to review the answers or corrected tests afterwards. Repetition happens in between, either at home by the student or during some recitation sessions at the university.

I think teaching new facts to the students is not the best we can do with the classroom as one "learning medium". Actually, it is a highly inefficient use for reasons related to how we best work when learning established knowledge:

- *Different learning speeds*. Students vary in the speed by which they can absorb given facts and draw preliminary conclusions. Adapting the speed in the classroom to the median will always leave some behind and other completely bored. Bored students are not excited students.
- *Different level of previous knowledge*. Students vary in their previous knowledge on subtopics covered in class. They cannot skip well-known

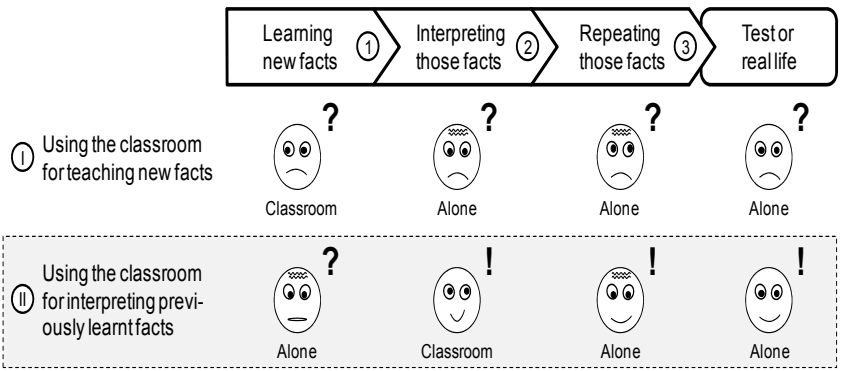
3 Such autonomy in learning repetitive patterns is not necessarily possible in settings where feedback about the style of task execution is still required like when learning motion sequences in dancing or figure skating. But, those play a lesser role in a common university setting.

passages or repeat less known ones as they could with a textbook. Again, bored or left behind students.

- *Different preferred learning styles*. As mentioned before, students have different preferences of how to learn. Just listening to a teacher as he or she talks does not help many students. In addition, denying students well prepared textbooks and, thereby, forcing them to copy the text from the blackboard deprives them from the last bit of focus they had to reflect on the subjects in real-time.
- *No pause for reflection*. This lack of time for reflecting the subject matter is partly due to the fact that students are often exposed to the facts for the first time (as desired by the university professors who want the students without previous knowledge). Questions will only surface after the class, most times when the students are alone back home, studying for the exam.

A different approach is to let the students acquaint themselves with the course subject individually and to make the classroom the time and place of reflection and interpretation instead of just "feeding" facts (see figure 1).

Figure 1: Students get more from the classroom experience when it is used for interpreting already familiar facts instead of presenting them for the first time.



One such approach to teaching is the *Socratic method*, which is only possible in a smaller classroom setting. In its purest form, the teacher is only allowed to pose questions to the students and never provide the answers himself. It is well described on Wikipedia (2007):

The Socratic method is widely used in contemporary legal education by many law schools in the United States. In a typical class setting, the professor asks a question and calls on a student who may or may not have volunteered an answer. The professor then continues to

ask the student questions or moves on to another student. For this method to work, the students are expected to be prepared for class in advance by reading the assigned materials (case opinions, notes, law review articles, etc.) and by familiarizing themselves with the general outlines of the subject matter.

The described teaching style is also widespread in US business schools and, in the U.S., it is better known as the *casebook* or *case method*. Cold calling students often forms an essential part of it, especially in law schools, with basically two rationales to it. On the one hand (i), it should prepare them for their later professional lives as lawyers who have to use their wits on the spot in order to withstand heavy argumentative and often unpredictable disputes in court. On the other hand (ii), it should increase their attention and, thus, their learning activity as students know they might be asked a question any time.

I think, the second argument is similarly questionable to when teachers withhold class notes form their entrusted students for the spurious reason of increasing their attention. The reason is that while cold calling students will increase their attention in class, it does not necessarily increase their *attention on the subject* and, therefore, it does not increase their overall learning efficiency. At least part of the positive effects of this increased state of alert gets compensated by a negative fear of being cold called and "cold caught". This becomes more obvious when we move to other disciplines like science or engineering that attract more introverted people who prefer a non-invasive learning style. Cold calling simply introduces a fear factor, which makes students less receptive to the things they hear *in the long term*, and the focus of students may shift from the actual content, on not getting caught. Long-term retention simply diminishes with people who are nervous. University teachers in other disciplines than law and business can learn something from the interpretational value added in the classroom of the Socratic method, but I also think we should strive to find methods to replace an external with some internal motivation and should not force every student to actively participate in every class.

The best classroom learning experience I had was actually able to do exactly that: provide some strong internal motivation. It was the recitation section of an advanced undergraduate computer science class at a US university (Computer System Engineering 2001). For each lesson, we had to read a research paper or solve a problem. In the class, the teachers introduced the paper or problem, gave some interesting insights, and then opened the class up for discussion. The most fascinating part of the class was to hear all those aspects of papers and students solution to the problems one did not think of before. And this part was really motivation for both, (i) reading the paper and on it in advance in order to be able to contribute some good insights to the discussion and being able to actually follow the discussion, and (ii) paying good attention in the class in order not to miss one single insight.

At first sight, it seems that such an *interactive interpretational teaching style* is only possible in a small classroom setting, not in a large freshman class. But looking more closely, the superior learning experience was not due to the "interactive" part, but rather the "surprising interpretations" found by others that you yourself did not see before when looking at the same problem. It was these continuous surprises that achieved a powerful motivation and learning effect. Here, I like to cite Paul Graham on that aspect of surprise (Graham 2004):

Surprises are things that you not only didn't know, but that contradict things you thought you knew. And so they're the most valuable sort of fact you can get.

Such surprises or unexpected twists in the storyline of a class can also be achieved in a larger classroom without two-way interaction, it is only a bit more difficult. The essential part is that such a class always needs some independent preparation by the students in advance in order to "contradict" or at least add to some existing knowledge.

5.4 Keeping Students on their Toes: Unexpected Twists in the Classroom

As an example of one such powerful "twist", I once tried in a class is to temporarily lead students into "the wrong" direction when setting up their homework, only to later reveal the actual intention during discussion next class. It was a smaller class where interaction was possible, the important element, however was not the verbal interaction, but rather the part of "*contradict(ing) things they (thought) they knew*."

The class was a seminar on scientific work in computer science at Vienna University of Technology (Proseminar Web Informaiton Extraction). Science and the scientific method is among many things the art of analyzing and scrutinizing facts and existing knowledge. I wanted to combine some experience of critical thinking on one example in computer science, where I do not agree with common opinion. Many computer scientists hold the little-reflected belief that the text processing system Latex is the only acceptable text processing system, superior to any standard WYSIWYG (What You See Is What You Get) word processing system. Without going into the actual discourse, there are some serious drawbacks often overseen or even taken as advantages. Doubting the superiority of Latex is a bit like heresy amongst computer scientists, which leaves no space for discussion and prevents the community of actually improving it in such a way that it really becomes useful for a lot of purposes. Just merely listing these drawbacks to the students would not have had such a great impact. So, I was searching for

some possibility of creating a "deeper" scrutinizing learning experience in the classroom.

At the end of one class, I mentioned that next class we would cover Latex, the standard typesetting system used for writing research papers in computer science. As preparation, the students had to read a position paper on the advantages of Latex and afterwards write up their own opinions about the subject, as succinct as possible and ideally just in a bullet list of arguments (Cottrell 1999). The paper they had to read is widely cited and translated for the merit of its seemingly convincing arguments in favor of Latex over common word processors, which do not hold scrutiny at a closer look.[4] Next class, students were first allowed to explain their reasoning in favor of one or the other system. The arguments were mostly in favor of Latex as given in the paper. We then proceeded to read the important passages of the paper together. When we actually thought through the claims put forward in the paper, we had to come to the conclusion that most of them were in fact logically false, leaving the paper as a mere emotional rant without any substantial basis for its arguments.

The effect on the mental presence of the students after this "surprise" was quite sharp. It seemed that they got very attentive during classes as they anticipated more unpredicted shifts in class. This mental presence and putting in question from now on also what I was telling them was exactly what I intended with this course. Basically, it was an introduction to scientific research, and science above all should emphasize critical thought, critical even of the teacher.

My inspiration for the "plot" of the class was a famous classroom experience in a Californian high school during the 60s named The Third Wave (Jones 1972), which later became known by the film and the book The Wave (1981) during the 80s. A history teacher answered the question of one student about how German people during the Third Reich could follow their leader in such an obedient manner by an experiment on the students themselves. During a short period of time, he made the students, step by step, unquestioningly obey his new rules of order and discipline. Only after some time did he suddenly reveal to the students that they were actually set up and that they were beginning to behave no different than the Germans during the Nazi regime, something they could not understand before.

4 In short, the common argument for the superiority of the Latex over word processors is that Latex separates *form* from *content* of a text. Neither is this true in reality, as anyone knows who had to make use of a Latex template and a maximum page limit when submitting to a conference, nor is the lack of a visualization of the structure of a text beneficial during the creative writing process. The benefits that actually make Latex ideally suited for computer science is its superior handling of complicated formulas, references, graphics, and in general, very long documents. Also, the printed results just look better than in Microsoft Word or OpenOffice. The separation of form from content is – in my opinion – actually a handicap which prevents its adoption by a larger community.

This last example immediately evokes the question to what extend teachers can "experiment" with students. I personally see no ethical problem with these two cases as they finally get resolved and the students have learned some essential lesson in the end: questioning the authority. In a world where the authorities of whole nations continuously and blatantly lie to their people without ever admitting it in the end, the best a teacher can do is to actually prepare the students for the real life with a bit of *critical thinking test exercise* in the classroom. But basically, the two mentioned classroom experiences should merely serve as examples of how we as teachers can add something in class that cannot be easily gained by studying by oneself. And, in order to be able to focus more on the interpretational part of knowledge in the class, the students have to prepare the factual knowledge already before, mainly by themselves.

For the sake of distinguishing between what students can learn by themselves and what rather not, we can make the distinction between (i) *factual knowledge* and (ii) *interpretational knowledge* along the lines of the difference between factual and interpretational learning from before. This distinction is not exact as interpretational learning can also happen when first reading a problem with non-trivial solution, then shortly reflecting upon it, and finally reading one or more provided example solutions. Learning material I know that provide such *autonomous interpretational learning experience* are some tricky intelligence test questions with provided solutions, example Q&A of the analytical part of standard tests like SAT or GRE, or case books that prepare for interviews with some consulting companies. However, in a university setting, these kind of textbooks are very rare and for our purpose of analyzing the value of the classroom this distinction does not oversimplify reality more than Nonaka and Takeuchi's binary distinction between explicit and tacit knowledge in their often cited knowledge creation spiral or SECI model (Nonaka and Takeuchi 1995) .

Let me use the following child-nail-hammer example to illustrate different approaches to classroom teaching (Epstein 2002). Imagine you want to teach a child how to drive nails in a piece of wood. The child has never seen a hammer before. (i) In the first scenario, you simply show the child how to use a hammer for the task. He or she will repeat and learn it by time. This scenario basically represents the basic sequence in a university course. (ii) In the second scenario, you do not show the child a hammer, but rather ask him/her consecutive questions about what it would take to efficiently drive a nail into a piece of wood. After the right questions and more or less time the child will realize that some weight on a shaft does the job very well (at least for the sake of the example). This scenario basically represents the Socratic teaching method of constantly asking and never giving answer. (iii) In the third scenario, you first give the child a couple of different stones for the task. Only after he or she has played with it for some time, you provide

the child with a hammer. Now that the child has played with different options for some time and made up some hypotheses, he or she can appreciate the advantage of a "modern" hammer over its ancient predecessor, stones, and the experience can become a memorable event. This scenario basically corresponds to "unexpected twists" in the classroom. (iv) In a fourth optimal scenario – which we will most likely not be able to create in a classroom – a child actually wants to drive a nail into a piece of wood. After reflecting and searching for some time it finds a hammer and asks a grown-up to show him or her how to use it. This is probably the best learning experience, but it requires genuine interest and previous experience from the learner before attending the class.

5.5 Conclusion

In times of increasingly easy access for students to well-prepared textbooks, internet resources, videos and new e-learning tools,[5] new university teachers should ask themselves what the inherent value is added to the classroom.

In this short essay, I argued that we should not focus on teaching new facts to students in the classroom and, thereby, compete with well-prepared educational material available for self-study, rather, we should encourage students to learn those facts on their own prior to the class, and then use the time together for *interpreting these already at least slightly familiar facts*. In this context, "interpreting" basically means to put facts into perspective, to add some personal experiences or make the connection to current research problems, to make the students question what they have read before, and thus to put their previously self-prepared minds as much as possible on the test. "On the test" does not at all refer to cold-calling students, but rather, making them aware early that they have to be on their toes and, then, from time to time, surprising them with unforeseen twists and endings in the storyline.

5 What I think will create some momentum in computer-enhanced learning will be a gradual shift of a few influential institutions to provide tools to their members that help learners to autonomously learn instead of teachers to teach. Such tools might well allow for some interpretational learning by facilitating some types of exchange or collaboration between students. Still, I think that a well-conceived interpretational learning experience will remain the most difficult to translate from a classroom to an e-learning context.

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