

Systems Approach to Education: General Ideas

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Abstract

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1 Before the Study Process

High school students often do not have a good idea of what is a university, what is the meaning of different majors, etc. As a result, they are sometimes not well prepared for the university studies, sometimes have wrong expectations, choose wrong majors, etc. To avoid such problems, it is important to provide as much information as possible to high school students – via well-organized and attractive university websites, open houses, students visiting their schools, etc.

2 During the Study Process

General idea: today's students are different. Today's students are accustomed to using smart phones, social media. This should be taken into account when teaching.

For example, the fact that many students love to play computer games can be used via a *gamification* of the teaching process – when a task is presented not as solving a boring problem, but as defeating the bad guys in a challenge, it becomes more interesting.

The students' familiarity with computer-related techniques makes it easier to individualize education as much as possible – and thus make education maximally efficient for each student: automatic systems can provide a student with an individualized sequence of problems and individualized schedule, determined by the student's pace of learning this particular material.

Before the class (or in the beginning of the class): pre-views are important. If possible, students should know, as early as possible, what exactly will be studied in the forthcoming class.

If students have this information before the class, they can read the corresponding material and thus, get better prepared for the class.

Even when the objectives for each class are announced only at the beginning of each class, it is still helpful – it helps students better understand how the material presented in class fits into the big picture.

During the class: need to make tasks as meaningful and as realistic as possible. For some topics, we feel that they are too complex to teach to students of certain level.

For example, it is usually assumed that teaching proofs is very difficult for everyone but math majors. According to Aslanbek Naziev from Ryazan, Russia, the problem is that we start teaching proofs by asking

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students to memorize and reproduce the known proofs, e.g., the proof of Pythagoras theorem. For such tasks, students do not understand the need to prove this theorem again, since this theorem has already been proven.

A solution is to teach them to prove *different* results. These results may not be that complex, they will probably have to be very close to the original already-proven statement, but they should be somewhat different.

Interestingly, with this modification, most kids learn to prove!

Another aspect that makes projects more realistic is that in real life, there are often constraint – time constraints, financial constraints. It is important to learn optimal techniques, but it is also important to learn to make decisions under such constraints. An additional advantage of such constrained tasks is that they boost creativity – there are many different possible types of constraints, and the usual techniques do not automatically cover them all, students need to be creative to be able not just to provide a solution to the problem, but also to provide a solution that satisfies all the given constraints. It is known that constraints enhance creativity: e.g., great musical pieces and great paintings were designed when the artist was not free to improvise, when a general theme (e.g., a religious theme) was given.

Need to solve realistic (thus complex) problems necessitates the use of group projects. When students work on their own, then, during a course, they can only take on reasonably small projects. To be able to handle larger projects, it is important to have several students working together. Such projects also prepare students for future after-graduation work, where many tasks are solved in groups.

Many real-life problems require collaboration between specialists of different disciplines. It is therefore desirable to have problems that would enhance such collaboration. For such projects to be successful, instructors teaching different disciplines must coordinate their efforts and work together.

An important issue is that when the task is sufficiently complex, there is no guarantee that the corresponding problem will be solved during a semester. Instructors try to avoid such situations, as a result of which many group projects are simpler than what students may encounter in their future work. It is therefore desirable to make group projects more complex – and develop a plan for what to do when it turns out that the project is not doable in a semester.

This is also important since at school, students are usually only encountering projects that almost always succeed, while in real life, failed attempts, failed projects are ubiquitous. Students need to be prepared to view it as normal part of life, to be able to recover from failure and use the learned experience to boost future successes.

Need to also make students happy. It is important not only to make sure that the students learn the material, it is also very important to make sure that they are happy, that they enjoy the process of study.

For example, pedagogical research has shown that individualized teaching, teaching that takes into account different students' teaching style (visual, oral, etc.) does not statistically significantly boost the students' knowledge, but it does drastically increase their happiness.

Another important aspect of happiness is aesthetic: good architecture, nice arrangements are important. In the words of Alexei Lubkov, President of Moscow Pedagogical State University, a school must look like and feel like a temple of study.

Students helping students. It is known that when students help each other, everyone wins. It is desirable to use this help as much as possible, to use all kinds of mutual help ranging from informal one-on-one help sessions to study groups to institutionalized mentoring, when more skilled students are officially assigned as helpers to students who have not yet reached this level of mastery – be it students from the same class or from one of the previous classes.

When setting up and running such a program, it is important to take into account that mentoring is not just a question of agreeing to do it, it is a difficult task that need to be taught – and recognized and awarded when done successfully. The most successful person is not always the best mentor – since this person may not understand the difficulties that other students have.

Need to make students healthy and active. To keep oneself healthy and active and happy, students need some physical activity – and studying does not provide such an opportunity. It is therefore helpful to encourage students to be more physically active – e.g., by requiring PE classes at the university level and/or spending some time in the middle of some classes on physical exercises.

Good feedback is important. As with every other control process, the more feedback we get during the study, the more we can adjust this control process (in our case, teaching process) to make the final result

better. A usual way to gauge the state of the student's knowledge is to have tests, quizzes, etc.

Feedback is also important for group projects. For such projects, it is helpful to keep up-to-now information about the current status of different parts of this project, what were the original deadlines, etc. Experience shows that the introduction of such a visible picture raises the number of points by about 15%.

How to make feedback timely. For the feedback to be useful, it is important to make grading fast: it is usually better to give students approximate feedback right away than a more detailed feedback after several weeks, when they have possibly switched to a different topic.

How to provide more feedback: use (much-maligned) multiple-choice exams. The ability to test students is limited by our ability to grade all these tests. This is especially challenging for large classes, even when we have Teaching Assistants.

From this viewpoint, it is advantageous to use multiple-choice tests, since these tests can be graded automatically. Instructors teaching upper-level or graduate courses often shun multiple-choice questions as more appropriate for simple knowledge, but this is a mistake: for many complex questions requiring complicated reasoning and/or computations, it is possible to ask students to perform these computations on a separate sheet of paper and then check which of the given possible expressions or numbers they got. Preparing such questions is not easy – but it often takes much less time that grading numerous papers.

Such grading also sounds more fair to students.

In the feedback, it is important to understand not only how the students are doing but also why. Usual tests describe the current state of the student's knowledge. However, to better control the situation, it is important not only to understand *how* the students are doing, but also *why* – this will help develop steps aimed at improving the students' knowledge.

There may be many reasons why a student is not doing well: lack of motivation, insufficient knowledge of the required background information, not enough time spent outside the class, too fast presentation of the in-class material, illness, need to work after hours, psychological and social problems.

We can learn this why-information by explicitly asking a student to mention possible problems preventing him/her from studying better.

How to make grading less subjective. One of the problems is that grading is often very subjective: different instructors may assign different partial credit for the same partly correct answer. Usually, in each department, instructors come to a consensus, but it takes time, and grades given by young instructors are often different. To avoid such situations, Snezhana Dobreva from Bulgaria recommended that we *teach* future and newcoming instructors *the art of grading*. For example, one way to make grading sound fair is to, e.g., post points assigned for each topic and points taken away for each possible mistake.

To increase the perception of fairness, a good idea may be to have *students grade each other's* papers under the supervision of an instructor, to avoid a possible perception of unfairness when an instructor is the only one doing the grading.

Grading should also boost students' motivation. An important aspect of the feedback is its ability to boost student's motivation. When grading, we instructors are often in a hurry – especially for large classes – so while we try our best to point out mistakes, i.e., to provide negative comments, we skip positive comments: the only positive comment is often the good grade itself. Such positive comments are very important for students, it is important to give them even if it takes time. They are especially needed for a student who did much better on this test than on the previous tests – and, vice versa, if a student did worse on this test than on the previous tests, this should be pointed out.

From this viewpoint, a good idea is to give extra credit if the student's answer goes beyond what was needed – even if such an extra credit was not promised. Another related idea is to give detailed grades like B– or A+, even in situations when such grades are not official and thus, not reflected in official documents – this is a widely used practice in Russian education.

Need to prepare students for continuing education. It is important not only to provide the students with up-to-date knowledge and skills, but also to make them able to later on independently acquire future knowledge and skills.

In general, new knowledge comes from two sources: from listening to a lecture or a talk, and from reading the corresponding material – be it a paper or a website. Students need to be ready to acquire information both ways.

How to prepare students to learn from a lecture. At first glance, it may seem that the whole process of university education prepares students to learn from the lecture. This is not exactly so.

- Yes, students listen to lectures, but since the material presented at a lecture is also available in a textbook, on the web, etc., students supplement what they learn on a lecture by reading the textbook and/or accessing the website.
- In the future, they may lack this possibility, so they need to learn to get this material from the lecture only.

Moreover:

- for the existing material, many pedagogical techniques have been developed that make learning this material easier, while
- for the future up-to-date skill or knowledge the lecture will be more rough.

It is therefore important to prepare students for gaining information from such imperfect lectures.

One way to do it is to train students in note taking – e.g., by grading their notes at the end of some classes, and/or giving them an opportunity to summarize their notes and grading the resulting summaries. This is taught at many school in many introductory classes, but we need more of it:

- at present, this is taught mostly to make sure that the student successfully finishes school, where lectures are supplemented with textbooks etc., while
- what we also need is to teach students the ability to student after graduation, which includes the ability to understand from lecture only – and not necessarily from a lecture by a skilled professor.

How to prepare students to learn by reading. In view of the fact that a large part of new knowledge comes in a form of a paper, it is important to teach the students to learn by reading. For this purpose, students need to have experience of such learning, i.e., they need to be given papers and to be able to understand and reproduce the paper's main content. This skill is usually taught to graduate and doctoral students, because without it, they will not be able to graduate. However, this skill is important to undergraduate students as well – they will need it after graduation, to be able to stay up-to-date with the progress in their field.

We need to teach life. It is not sufficient for a student to gain technical skills. In addition to knowledge, we also need to teach social and behavioral skills. In general, it is important to prepare students in the four skills needed to succeed in the 21 century (“four C’s”): critical thinking, communication, collaboration, and creativity. Many researchers even believe that creativity and ability to communicate are even more important than technical skills.

We must also prepare good citizens, we need to develop our students into knowledgeable creative people who will apply their knowledge and their creativity to solving technical problems, but also to problems of society, to problem facing our civilization as a whole. At the university, we must do our best to prepare them for such applications, to encourage them to apply their knowledge to problems outside their narrow area of expertise.

In general, we need a constant feedback about our educational process. Not only students need feedback, every professor, every department, every university needs a constant feedback, we need to know our strength and our weakness, so as to be able to direct our efforts in the right direction. Even a very subjective feedback – e.g., own subjective impression of education successes and challenges – is often very helpful.

One thing in which we are behind is that while modern technologies provide numerous opportunities to enhance teaching and students are ready to use these technologies, we instructors are not utilizing them as efficiently as possible: we are behind the technology, there is a lot of potential for improvement here.

An important dead end to avoid is catching up. Often, when a university or department finds itself behind some other school or department, it tries to catch up by emulating what the other school or department is doing. This is a losing game, because that other school is also trying to improve and to change the way it functions – so when we follow this naive catch-up strategy, we emulate methods and techniques which are known to be imperfect and which are in the process of being discarded. By the time we implement these methods, the other school will switch to something better – so will always lag behind, we will never really

catch up. The correct strategy is to be creative, to creatively combine the current university's strengths and resources with experience of better schools and with modern education techniques – this way it is possible to get to the same level as the better schools. This is how top schools became what they are – not by blindly emulating their peers, but by cultivating their own strengths.

3 After the Study Process

Main objectives. The main *immediate* objective of a degree is to prepare students for real-life jobs. Knowledge acquired at school should be sufficient to make their jobs successful.

In the *long term*, however, new ideas and skills appear, so a graduate also need to continue learning new skills and techniques even after graduation.

How to help students transition to a job: need for feedback. Transition from a university to a job is often not easy. It is therefore desirable to make it easier. Of course, it is important to teach the students corresponding skills during their study, to prepare them for this transition, but it is also important to help them after the transition.

To be able to provide such a help, it is important to know what are their problems – this way, we will not only be able to help our graduates, but also start thinking of how to avoid such problems for future graduates by better preparing them for the corresponding transition.

How to help students transition to a job: alumni helping alumni. In principle, there is a feedback venue for such information – alumni organizations, but these organizations, in many places, mostly focus of helping their alma mater. It is desirable to have them also focus on transition problems.

Also, reporting problems back to the university is important, but with the alumni far away, it is not easy for the university to provide help, it may be often better to have alumni help each other – e.g., within the corresponding alumni association, via their website, mailing list, etc. In addition to reporting problems, it is useful to advertise cases of successful alumni – following their example, others will also learn how to succeed.

Some of the transition problems may be specific for alumni of a given university, some may be related to the specifics of a company, others may be general. From this viewpoint, it is a good idea, in addition to alumni associations, to also organize an organization of all your specialists, both within each company and, more generally, within each region – e.g., based on a certain profession. Companies are interested in making sure that the new hires become productive as soon as possible, so they will be helpful in setting up such organization-wide organizations – and the limitation to a company allows to deal with problems without worrying about proprietary issues. Such associations have been functioning in Russia for several decades, and, judging by presentations at the conference, do help transition from university to a job.

How to help students transition to a job: institutionalized mentoring. In addition to case-by-case advising, it is a good idea to officially assign mentors to new hires – either from the company or from the alumni association.

In some companies, mentoring is an official task, releasing the mentor for a certain number of other duties.

How to help students learn new skills and techniques after graduation. In the modern world, for a successful career, it is not sufficient to keep the knowledge acquired at school, it is also vitally important to keep up with the latest developments, to continually learn new skills and techniques.

In thus, universities, alumni associations, and places of work can help by organizing special seminars, webinars, workshops, webpages, etc. – all this will help alumni stay up-to-date and thus, be more successful.

4 General Ideas

Accreditors and supervisors: pre-action is needed. We often complain about micromanagement – be it by the university administration, by the supervising political bodies, or by accreditation agencies. They thrust upon us policies, regulations. etc. which we believe, mildly speaking, not to be perfect for us.

In most cases, the reason why these bosses develop policies without taking out interests into account is that some policies are needed, and we ourselves do not develop them. So, the best way to deal with these issues is to prepare our own policies and recommendations in coordination with other universities, and send

these proposals – with as much explanations as possible – to the coordinating bodies. They may make some changes, but they will appreciate our help, and, as a result, their policies will be much closer to what we want.

In general, for teaching to be successful, we need more freedom. Overall, we should aim at making the regulations as flexible as possible.

All situations are different, we need flexibility, we need freedom to have solutions most appropriate for a given situation.

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References

- [1] *Program of the International Forum on Teacher Education*, Kazan, Russian, May 28–31, 2019.