How to support students during projects?

Foundations for Teaching in Higher Education

Roland Tormey
Ingrid Le Duc
Cécile Hardebolle

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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Video

EPFL

How can you help students to:

- Learn from **the process** when working on a project?
- Develop transferable **solution design skills**?
- Work on **ill-defined problems** with incomplete or ambiguous data?
- **Organize their work** into collaborative projects?

In the chapter on the big goals of higher education, we have seen how projects can be used to teach solution design. We have also seen that projects can pose a number of specific challenges to students. In this video we going to analyze how YOU as a teaching assistant can best support students during projects. More specifically we will discuss how you can help students to learn from the process of working on a project in order to develop solution design skills that they can transfer to other situations. Then in a second part of the video we will focus on two specific difficulties students have in projects, namely working with incomplete or ambiguous data and organizing their work into collaborative projects.

Notes

Summary

0m 04s

Balance product / process

(Hmelo et al., 2000 ; Barron et al., 1998)

As we have seen previously, one specific challenge of projects comes from the tension between two different outcomes. The final result of the project on one hand and student learning on the other hand. When the focus is on the result of the project it is much more challenging for students to learn from doing the project. So, one important role for you is to have students balance their attention between the product and the process.

Notes

Summary

0m 54s

But what is the process ?

But what process are we talking about? Research on the process of designing solutions has been going on for years in a wide range of domains especially in engineering and design disciplines. Now as you can expect the design process described in different fields is different. So, it would be impossible to present a generic design process that would work in all contexts. Instead we're going to look at this from the point of view of the skills that are the most frequently described in these processes. Based on the literature we can reduce the list to four essential skills.

Notes

Summary

1m 27s

12 members of junior a soccer team have gone missing while exploring a cave complex where water is rising at a very alarming pace.

(Tham Luang cave rescue, 2018)

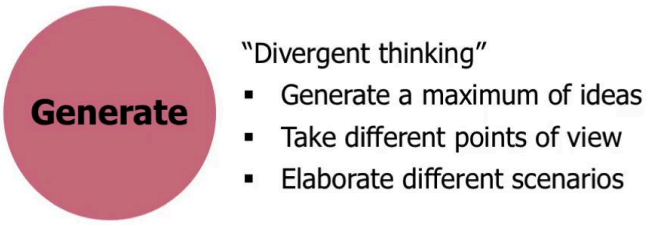
I'm going to review them now and will illustrate them on the cave rescue problem that we have seen in the earlier video. Then we will discuss how to help students learn these skills.

Notes

Summary

2m 10s

Essential solution design skills (Sheppard et al., 2006 ; Dym et al., 2005)



The first skill is problem scoping. Because complex problems are ill-defined, the ability to analyze and to define the problem at stake, actually is a crucial skill. It usually involves figuring out missing information and also delineating a frame for the next steps. In a case of the cave risk example, collecting more information to understand better the situation, was clearly a prerequisite. The rescuers had to get maps of the cave complex from different speleology associations. It turned out that the maps were incomplete and in the end they had to work with very partial information. A second skill is to generate ideas either to fill out the gaps in the available data or to start thinking about the possible solutions. In the cave rescue operation for instance the rescuers have generated multiple plans. One of them was waiting until the end of the monsoon season with divers providing food and water. Another option was to drill a rescue shaft that would allow the boys to escape. Now generating ideas that requires a specific way of thinking called 'Divergent thinking'. It is this ability to elaborate diverse ideas by connecting concept to other concepts and by asking questions. The result of divergent thinking is what we call creativity, but not as a magical inspiration: as a purposeful process that maximizes the chances to generate new or innovative ideas.

Notes

Summary

2m 22s

Essential solution design skills

(Sheppard et al., 2006 ; Dym et al., 2005)

Evaluate

"Convergent thinking"

- List criteria for choice
- Evaluate and compare scenarios
- Make a decision

Divergent thinking goes in pair with its opposite convergent thinking. It is the ability to narrow down the set of ideas by making decisions using certain criteria or constraints. This involves evaluating each idea in a way that makes them compatible with the others. In the cave rescue operation, one important factor to make a decision among the different options was the level of risk. A difficulty for the rescuers was that the level of risk changed over time depending on the evolution of the weather. So the rescuers had to regularly re-evaluate the different options.

Notes

Summary

4m 18s

Essential solution design skills (Sheppard et al., 2006 ; Dym et al., 2005)

Realize

- Prototype
- Simulate
- Test

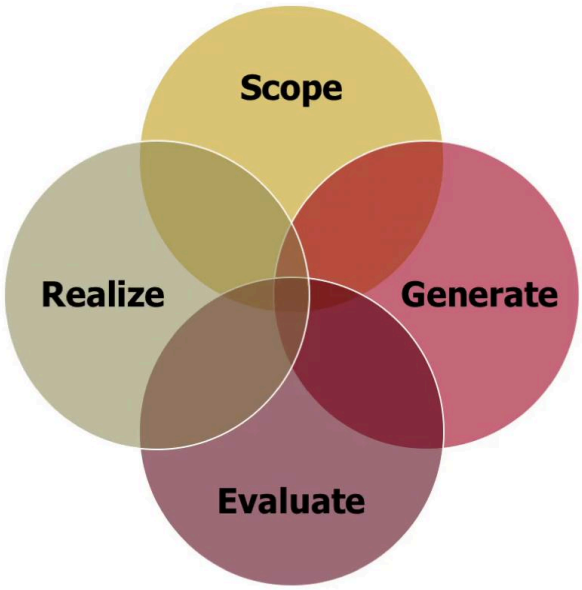
The last skill we're introducing is the ability to realize ideas. It is used when the final solution has to be implemented but also before that when the ideas are to be tested. Testing includes prototyping the ideas but more importantly designing an experiment using the prototype in order to answer questions around aspects such as feasibility, usability, stability etc. In the cave rescue operation, the divers had to verify very carefully that the technique they were planning to use would work because of the high risks involved. So, they ended up building a mockup of a tight passage with chairs in the swimming pool and have practiced with volunteers to control that it was doable.

Notes

Summary

5m 04s

Essential solution design skills (Sheppard et al., 2006 ; Dym et al., 2005)



OK so, so far, we have seen that the design process involves four essential design skills which are scoping, generating, evaluating and realizing ideas. As the diagram here tries to illustrate, these skills are not necessarily used in a defined sequence. Actually, the design process as described in the literature are generally non-linear and highly iterative. So, a better way to describe them is more as different thinking modes that need to be used at different moments in the project. Now students are often not aware that a design project involves these different thinking modes and these different thinking modes have different goals which derive different types of difficulties. So if those don't know about those modes then first they have more difficulties using the appropriate thinking strategies. And second, they cannot learn from it and reuse this knowledge in future project.

Notes

Summary

5m 57s

This is why a very important role for you when you supervise projects is to make these thinking modes, and the whole process more generally, visible to students. A powerful strategy to do this is to use a three sentence feedback as you have seen in earlier videos. The idea is to use the first and the last sentence of the feedback to flag the thinking mode students have to learn from the project. So let's see how that would look like in practice.

Notes

Summary

7m 06s

Using a 3-sentence feedback

Scope

- Collect information
- Estimate missing parameters
- Make some hypothesis
- Delineate a perimeter
- Decompose into sub-problems

1. One of the goals of the project is that you learn how to **define the problem** at stake. It is normal to have incomplete information about the user needs and working it out is a crucial step in all projects.
2. You have done… but you could improve…
3. What additional information could you **collect** from users to better define their needs?

The first skill, scoping, involves working with incomplete or ambiguous data. And this is challenging for everyone but it is particularly difficult for students and we will come back to this issue in a minute. But part of the challenge for students is the contrast between ill-defined projects and the traditional problem sets which come with detailed instructions and all the necessary information. So a typical feedback will start by highlighting to students that they need to learn how to define a problem then it would underline that it is perfectly normal that the information they have on the needs of the users is incomplete and that working it out is actually a crucial step in all projects. The final question in the feedback could be used to suggest strategies that students could use to define the problem. For instance, you could suggest that collecting information from the users would help to define their needs.

Notes

Summary

7m 38s

Using a 3-sentence feedback

Generate

"Divergent thinking"

- Generate a maximum of ideas
- Take different points of view
- Elaborate different scenarios

1. To maximize your chances to come up with a viable solution, it is important to **generate many different ideas as possible**.
2. You have done... but you could improve...
3. What **brainstorming techniques** do you know? Could you use one to generate more ideas before our next meeting?

On the divergent thinking skills, a feedback would typically start by emphasizing the importance of generating as many ideas as possible to maximize the chances of finding a solution to the problem. This would be particularly adapted if you see a group jumping on one solution too early. Now you would be surprised at the number of students who believe that ideas should just come to their mind without any special effort. Many have no clues about brainstorming technique. So a good question at the end of your feedback would be to check whether they know or not how to proceed. And to encourage them to make use of brainstorming strategies.

Notes

Summary

8m 43s

Using a 3-sentence feedback

Evaluate

"Convergent thinking"

- List criteria for choice
- Evaluate and compare scenarios
- Make a decision

1. At that point in the project, it is important to **select the idea** that you will further explore, otherwise you risk falling behind schedule.
2. You have done… but you could improve…
3. What **criteria** will you use for choosing among your different ideas?

Selecting one of the ideas that have been generated in the Divergent phase is a frustrating process because it means dropping all the others. Students might have difficulty with the decision process, sometimes to a point where they put the decision off to a later time or even split the team to explore different ideas in parallel. In both cases there is a risk that they would fall behind schedule. So, a typical feedback will start by making them conscious that now is the time to select one option to explore. The question at the end can be used to help students clarify which evaluation criteria they want to use to compare the solutions. Alternatively it could also be used to guide students toward different strategies for making decisions, such as starburst or multi voting strategies, for instance.

Notes

Summary

9m 28s

Using a 3-sentence feedback

Realize

- Prototype
- Simulate
- Test

1. One thing you will always have to do in design projects is to **prototype your idea.** But the goal of the prototype is actually to **test** whether your idea really matches the constraints set.
2. You have done… but you could improve…
3. What **questions** do you want to answer with your prototype? What **experiments** could you design to answer those questions? What **data** do you need to collect?

When realizing the solution, there is a risk that students focus too much on the implementation of the prototype and forget about actually testing the solution. This is why a feedback would ideally emphasize the importance of approaching testing like a scientific experiment. So, the first sentence could be used to remind students that testing is the goal of making a prototype. The question at the end of the feedback would typically focus student's attention to the elements of scientific inquiry such as starting with a question designing an experiment collecting data and drawing conclusions based on evidence. For more ideas of questions around scientific inquiry, you can look at the videos on that.

Notes

Summary

10m 26s

(Prince and Felder, 2006 ; Felder and Brent, 1996 ; Dubé, 2018)

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Okay, so. So far, we have discussed how to make the process visible to students using feedback. We have introduced four essential design skills and we have illustrated how to use a three sentence and feedback to help students learn those skills. Now as a number of studies report, one specificity of projects and problem-based learning is that students can react negatively to it. Felder and Brent called this effect the bumpy road effect. The good news is that in addition to be very common this negative reaction is also transitory. The same authors acknowledge that payoffs start to emerge at the end of the project or at the end of the course. When students realize what they have achieved, they usually consider that the benefits more than compensate the difficult path. Now the key message here is that the transition from that initial negative response to the final positive perception can be accelerated. The way in which you support students can really change how they experience the project. In a sense you have the power to smooth out the bumps. In the following, we are going to look at two of the most frequent difficulties students have in projects and we will see how you can best help students.

Notes

Summary

11m 20s

"We are **lost at the beginning**, we do not have any information on how to proceed."

"Need the right **inputs**."

"Although it was not always very clear **what we were expected to do** for the project I really enjoyed having a project like this."

"The instructions were **unclear**."

Comments extracted from student feedback, 22 courses, EPFL SGM & SMT, 2015-2018

A very very frequent comment students make on courses that include projects is that they don't know how to start or where to start. You see here examples of comments that are particularly representative of the feedback students give on courses with projects at the EPFL. Generally, these comments referred to difficulties identifying what is expected from the project finding the instructions not clear enough, or reporting a lack of guidance by the teaching team.

Notes

Summary

12m 53s

Dealing with openness and ambiguity

"[...] they are uncertain about what is required from them, and as a result become **highly anxious**."

(Tan, 2003 ; Biley, 1999)

+ Lower ability to step back ("emergency reaction")
+ Lower ability to transfer

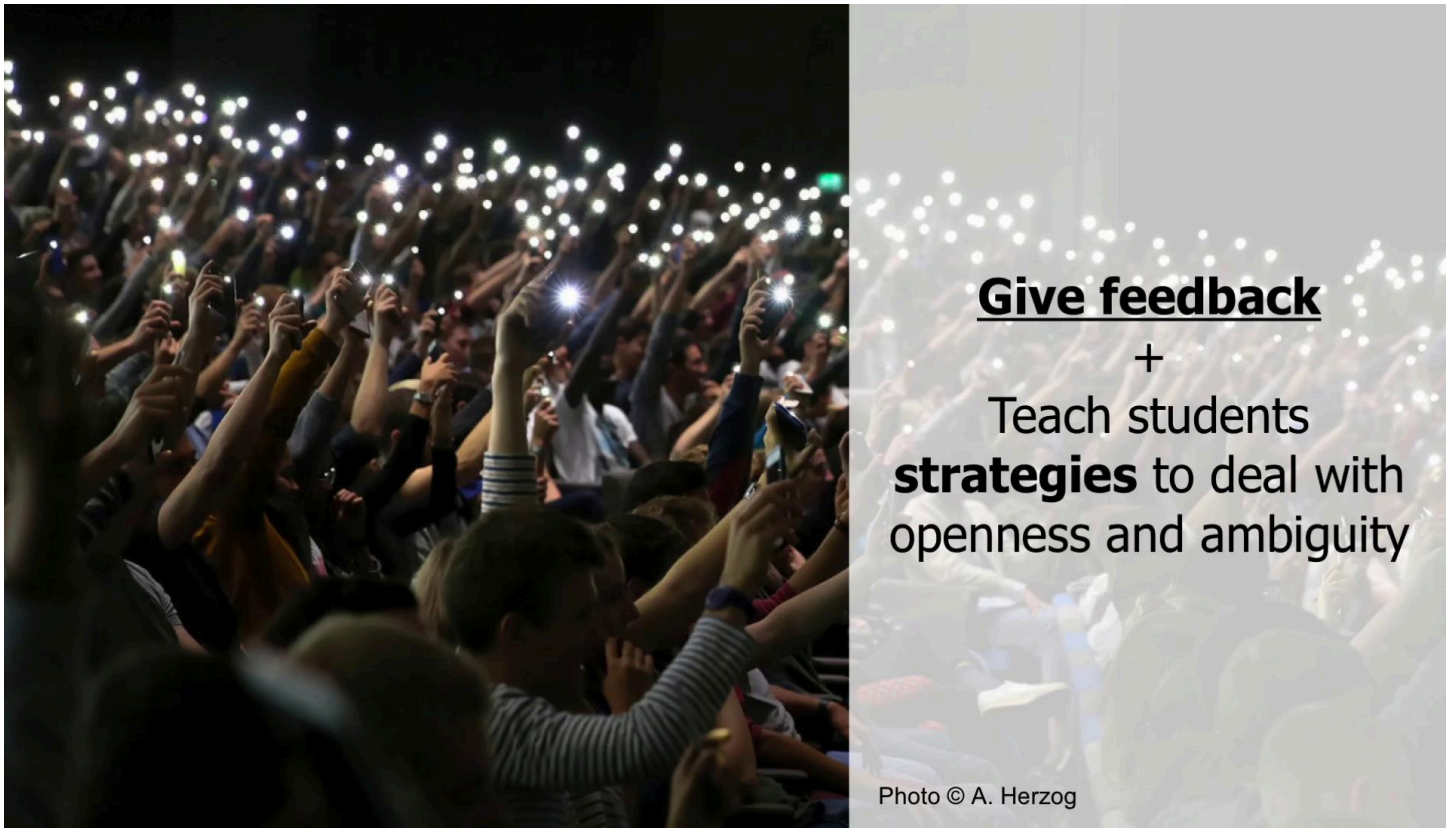
(Dörner and Funke, 2017)

As Tan explains, when students become uncertain about what is required from them, they become highly anxious. And this anxiety can hinder all the motivation they had initially of doing something practical and professional. Add to that what we already know from Dörner and Funke about how we react to complexity with a lower ability to step back, and a lower ability to transfer what we know from other contexts. It's no wonder that students can react negatively.

Notes

Summary

13m 29s



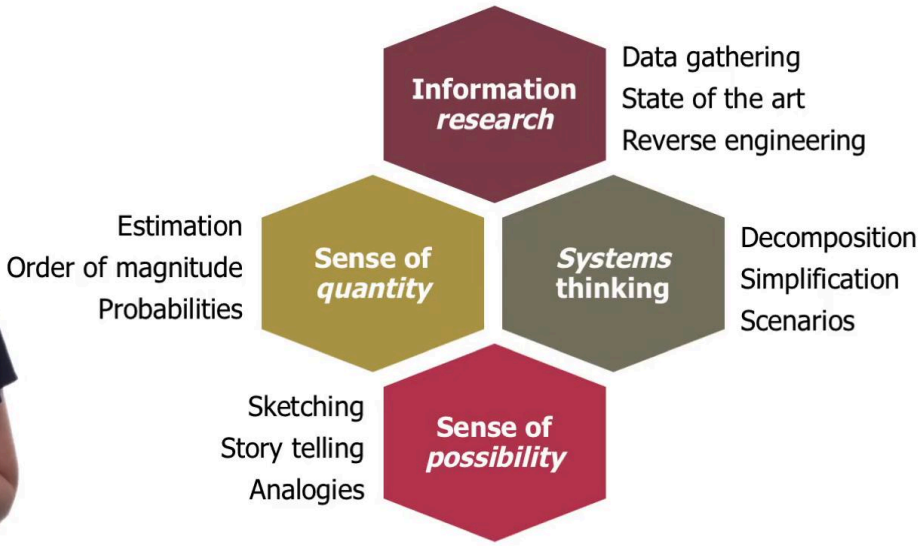
So obviously putting words on all of this is a first step to help students understand that what's happening to them, and we have seen how to do that using feedback earlier. You can refer in particular to the example feedback we have seen for those scoping skill. But another useful step is also to equip students with concrete strategies that they can use to overcome this state of fuzziness in a constructive way.

Notes

Summary

14m 04s

Thinking strategies for openness & ambiguity



(Dym et al., 2005 ; Dörner and Funke, 2017)

A variety of strategies can help in such situation. The more obvious are to look for what has been done on a similar topic somewhere else in the world, or to decompose the problem into smaller subproblems. But other strategies that are less well-known can also be very useful. For instance, 'reverse engineer an existing product to identify how it is made', 'work with estimated values for the parameters that are missing' or 'work with analogies to find a starting point'. Now, the general idea is to teach the specific strategies that engineers use, at the moment when students need them in the design process.

Notes

Summary

14m 34s

“Embedded teaching”

(Barron et al., 1998)

Teach concrete and transferable **strategies** at the time **when students need them** in the design process

Barron and her colleagues called this "embedded teaching". Of course, the goal is not to give the answer to the problem, but instead to equip the students with the appropriate tool to find it.

Notes

Summary

15m 22s

"The project was interesting but took way **too much time** and we wanted to make it good..."

"**Worth more credits** but really interesting in the scope of learning what engineering project is like."

"The course is good (interesting subject, adequate resources etc.), but the 'mini project', which is not 'mini' at all, requires a **lot of time and investment** to get done."

Comments extracted from student feedback, 22 courses, EPFL SGM & SMT, 2015-2018

Okay. What else do we know about student's difficulties. Here you see again some examples of comments that all teachers who have collaborative projects in their courses know by heart. It is highly frequent, I would say almost systematic, that students complain about the workload in project-based courses. Very often this includes asking for more credits or suggesting to increase the time allocated for the project.

Notes

Summary

15m 37s

Dealing with time and effort management

Time management is particularly challenging for students

(van der Meer et al., 2010 ;
EPFL Campus Survey, 2011)

+ Increased "potential for failure"

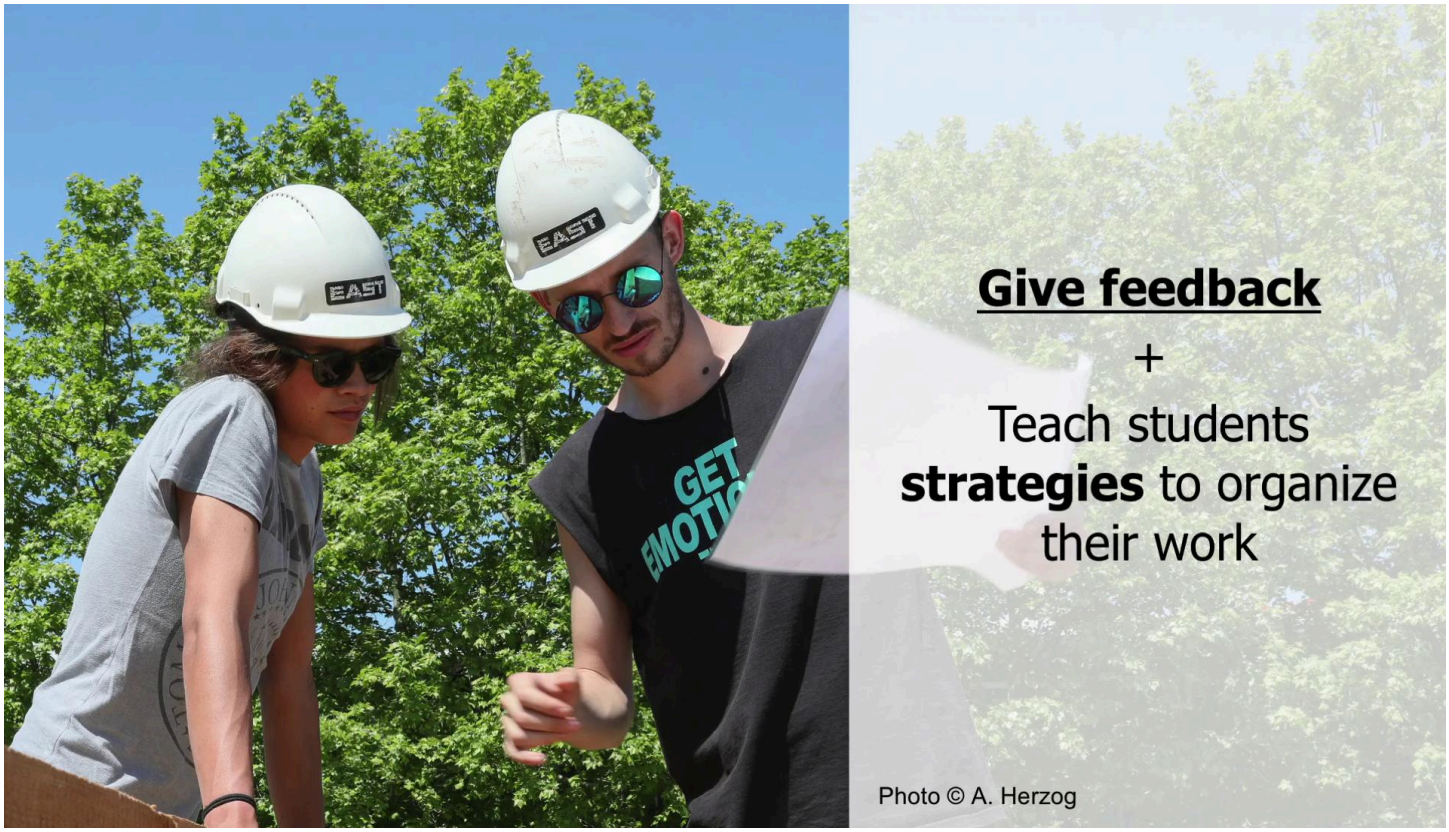
(Dörner and Funke, 2017)

These examples are typical of a major difficulty for student which is to organize their work. Many authors identify time management as both a challenge for students but also as a predictor for academic success. In a survey conducted at EPFL in 2011, the students who repeated their first year indicated that one of the main reasons for their failure was because they were unable to organize themselves. This issue with time management is particularly problematic in the context of projects because of what Dörner and Funke call the increased 'potential for failure'. As they explain, complexity makes us less rational which affects our ability to plan, to control, and to decide. So how to help students with this?

Notes

Summary

16m 09s



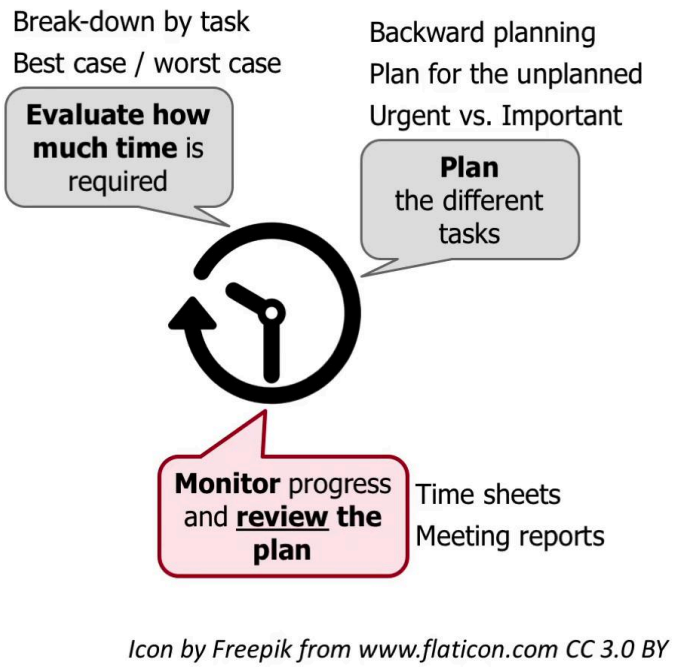
Again, you can help students in two ways first by giving them feedback. And second by teaching them strategies to organize themselves.

Notes

Summary

17m 08s

Strategies for time and effort management



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These strategies can be organized in three categories. The first step is to estimate how much time it is necessary to do something. This includes for instance estimating the time needed in the best and in the worst case. For planning, proceeding backwards and including time for unexpected events are two very useful strategies. Finally, the most important thing students have to learn, is that a plan does not need to be perfect, but it has to be reviewed regularly. Using time sheets and writing decisions in meeting reports is an important part of that process.

Notes

Summary

17m 20s

As we have said earlier these projects are often done in teams and working in teams creates a whole range of other challenges for students. We discuss this topic in another video of the Mooc.

Notes

Summary

18m 05s

Summary

Make the process visible by **giving feedback** that highlights the **4 essential design skills**

Help students to deal with openness & ambiguity and time & effort management by:

- Giving **feedback**
- **Teaching** appropriate **strategies**

Now let's recap the take-home messages of these video. First, we have seen that it is important to make the process visible to have students learn from working on a project and we have seen how to do that using feedback in a way that highlights the four essential design skills. We have also discussed how a project can be a bumpy road for students. I have illustrated this idea using two issues which make student's life difficult: first, dealing with openness and ambiguity; and second managing their time and effort. These issues are a normal part of the experience of working on a project and we have seen that the way in which you support students through these difficulties can really make a difference. Not because you make the project easier or because you remove all difficulties, but because first you teach students how to overcome the difficulties by themselves using appropriate strategies, and second because you give students feedback that helps them learn from those difficulties.

Notes

Summary

18m 20s