

Teaching Seminar
Clinical Assistant or Associate Professor in
Online Education Candidate


Shaping the Future of Online Education: A Game Design Perspective

Welcome! Please come on in
and have a seat.
This live performance is part of
the teaching demonstration.

Dr. Yaguang Zhang
May 5, 2023 | 10:30-11:30 AM EDT

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Sorry about the confusion. I always feel awkward standing in the front of the room waiting for my talk to start, so I thought it may be a good idea to do something fun this time while we wait.

Besides, the performance was more than “just for fun”. It was recorded and will be used as the raw materials for a part of the teaching demonstration that we will cover later today, tailored for the example topic, digital signal processing.

Now that we have the needed audio clip, I will stay quiet and wait for the signal to start the seminar... unless we have any questions about the song or the recording. Hopefully, more people will join us.



Good morning! I am Dr. Yaguang Zhang, a postdoc at Purdue University. Thank you very much for joining us.

Today we will have a very interesting discussion on how, we educators, may improve student involvement in online education, with the help of game design techniques.

In my opinion, attractiveness, or more aggressively, “addictiveness”, is the most important feature that is missing in today’s mainstream online courses. Adding that into the equation will definitely help students spend more time learning and developing the skills that we

want them to master. This explains a little bit about the title: Shaping the Future of Online Education: A Game Design Perspective.

- Shaping the Future of Higher Education?
Becoming a Land-grant University for Our Times



**JAMES C. SNYDER
MEMORIAL LECTURE**

FEATURING

Jay T. Akridge, Trustee Chair in Teaching and Learning
Excellence, Professor of Agricultural Economics at Purdue

Friday, April 21, 2023, 1:30 PM
Pfendler Hall, Dean's Auditorium #241

purdue.ag/snyder

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Just 2 weeks ago, while I was preparing this talk, Professor Jay Akridge gave a James Snyder Memorial Lecture at Purdue about higher education. I was lucky enough to attend the talk, and that was easily one of my most unique lecture experiences, because I never expected before: a lecture could be so encouraging and discouraging at the same time.

Why was it encouraging to me? Well, I first got the news about this in an email. The title I saw there literally gave me a shiver running up my spine: Shaping the Future of Higher Education? Becoming a Land-grant University for

Our Times.

- Shaping the Future of Higher Education?
Becoming a Land-grant University for Our Times
- Shaping the Future of Education as a
Pioneering Institute

JAMES C. SNYDER MEMORIAL LECTURE

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purdue.ag/snyder



At that time, the tentative title for this talk was: Shaping the Future of Education as a Pioneering Institute. What a coincidence! I did not even know Dr. Akridge before his lecture. But his lecture was featured at the university level, so this topic must be worth talking about!

- Shaping the Future of Higher Education?
Becoming a Land-grant University for Our Times
- Shaping the Future of Education as a
Pioneering Institute

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Encouraging 😊

○ Title

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That was very, very encouraging.

Then I went to his talk and got to know Dr. Akridge a little more. Apparently, he is a big shot. Trustee Chair in Teaching and Learning Excellence, Professor of Agricultural Economics...

- Shaping the Future of Higher Education?
Becoming a Land-grant University for Our Times
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Pioneering Institute

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Former Purdue
University Provost

Encouraging 😊
○ Title



...and former Purdue University provost!

Before he started his talk, he said bluntly, this topic is so boiling hot that he was not confident to address it properly.

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Former Purdue
University Provost

Encouraging 😊

○ Title

Discouraging 😬

○ Experience

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That was a huge discouraging moment for me.
Compared with Dr. Akridge, I am young and
inexperienced. If he feels pressure from this topic, I must
be naïve trying to address it myself?

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Becoming a Land-grant University for Our Times
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Encouraging 😊

- Title
- Challenges

Discouraging 😞

- Experience

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Fortunately, he moved on to raise the challenges faced by today's higher education. And a lot of the techniques I want to promote in this talk seem like promising solutions. So, I puffed up along the journey and felt good about myself again.

At last, when the lecture ended, I realized that Dr. Akridge pointed out high-level directions that universities could address strategically, ...

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Encouraging 😊

- Title
- Challenges

Discouraging 😞

- Experience
- **No solutions**

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... but he did not propose any actionable solutions for individual educators. To me, that was discouraging again, because I really wanted to learn about what I can do to help.



The poster is for the James C. Snyder Memorial Lecture. It features a black background on the left and a white background on the right. The title 'JAMES C. SNYDER MEMORIAL LECTURE' is in large white letters. Below it, 'FEATURING' is in a yellow box. The speaker's name, 'Jay T. Akridge', and his credentials are listed. The date and time are 'Friday, April 21, 2023, 1:30 PM' and the location is 'Pfendler Hall, Dean's Auditorium #241'. The website 'purdue.ag/snyder' is provided. On the right, a list of topics is shown: 'High-level' followed by 'Public opinions', 'College enrollment', 'Campus experience', 'Community', and '...'. The Purdue University logo is at the bottom right.

- Shaping the Future of Higher Education?
Becoming a Land-grant University for Our Times
- Shaping the Future of Education as a
Pioneering Institute

**JAMES C. SNYDER
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High-level

- Public opinions
- College enrollment
- Campus experience
- Community
- ...

Of course, that does not mean the lecture itself was not inspiring. Within only one hour, Dr. Akridge outlined the existential challenges for higher education today, covering high-level topics such as public opinions, college enrollment, campus experience, and community engagement, many of which I did not realize are playing significant roles.

With this glimpse of how broad this topic is, the first thing I did after the lecture was ...

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Becoming a Land-grant University for Our Times
- Shaping the Future of Education as a
Pioneering Institute

Shaping the Future of Online Education: A Game Design Perspective

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... change my presentation title.

So now, I'd like to follow up on Dr. Akridge's lecture, but focus on individual online educators, and limit the discussion to actionable items for us to better face today's challenges.

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Becoming a Land-grant University for Our Times
- Shaping the Future of Education as a
Pioneering Institute

Shaping the Future of Online Education: A
Game Design Perspective

Tailored Techniques → **Addictiveness** (Game Design)
→ **Student Motivation**

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More specifically, I hope to start a conversation about how to tailor existing video game design techniques, which are deliberately applied to make games addictive, so that we can better motivate students in online courses.

Many of the ideas I present today will be personal opinions as food for thought. If you like, or hate, any of the ideas, please do not hesitate to let me know. I would really, really appreciate that, because this is a very rare chance for me to unreservedly discuss this challenging topic. I will be extremely happy if we can exchange ideas and keep discussing this even after the seminar.

To encourage that, I have brought some delicious chocolate to trade for your comments. So, please interrupt me any time if you have any questions. I will be more than happy to thank you with a piece of chocolate.

By the way, I am not a native English speaker, so if you find it difficult to understand me, it's probably my fault. If that happens, please feel free to stop me and ask me to repeat or clarify.

Now, without further ado, let's continue the talk.

Topics to cover

- More about Dr. Yaguang Zhang
- Pedagogical philosophy for online education
- Tailored game design techniques
- Applications in digital ag with AGR 333 (Data Science for Agriculture)
- Institutional strategies to lead in future online education

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Here we have an overview for the talk. We will start with some unique experiences of mine, because they have motivated many of the ideas covered by this talk.

I will also introduce my pedagogical philosophy for online education, focusing on three high-level questions: what do we want our students to learn, who are we competing with as online educators, and what are we completing for.

The meat of this talk is: how to take advantage of game design techniques to develop more addictive courses, without hurting our educational goals.

As an example, we will propose some actionable items for the course Data Science for Agriculture.

And at last, we will briefly discuss what institute-level supports may be required for this strategy to work.

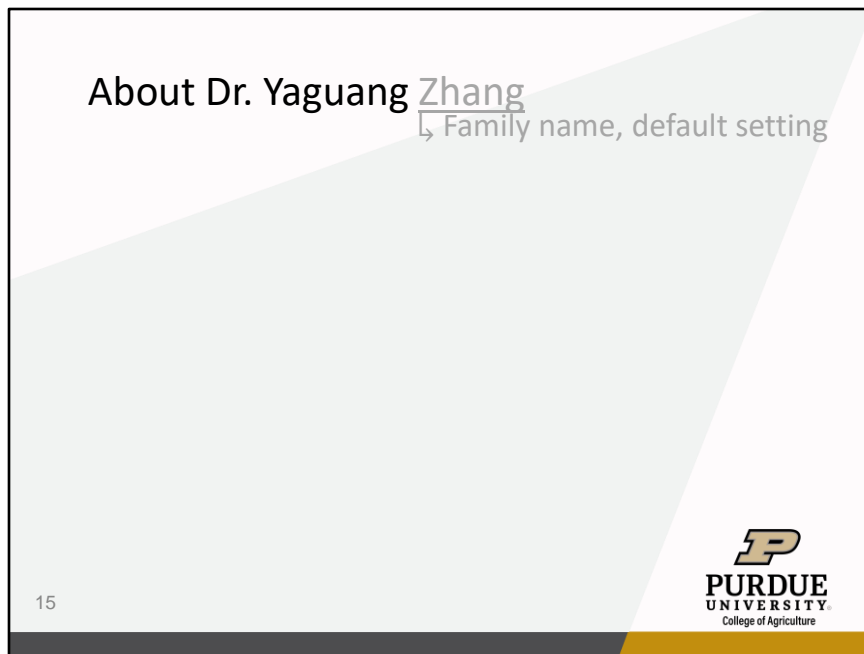
About Dr. Yaguang Zhang

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A little more about myself. This is the part where I have to go way out of my comfort zone and brag about my experiences, but everything I chose to share here is related to our discussion, so please bear with me.

The fun fact about me, that I am most proud of, is my name.



There isn't much going on for my family name, though. It just follows the default, factory setting.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-
亚
- guang
光

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But if you trace my given name back to the original Chinese version, you will find that it is composed of two characters, each can be interpreted independently.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-
亚: second (best)
- guang
光

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The first character is Ya, which means second best. So I am expected to stride for excellence, but, I suppose, not in a competitive way, because winning, according to this, should not be the goal.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-
亚: second (best)
- guang
光: light

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So, what should be the goal? Well, with some effort, that can be explained by the second character, guang, which literally means light.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-
亚: second (best)
- guang
光: light

甲 骨 文	金 文	篆 文	隶 书	楷 书	行 书	草 书	标准宋体
							
前二点三三	敬尊	今最	说文解字	光景碑	张猛龙碑	王羲之	晋书

↳ Oracle bone script
(~3000 years ago)

19



If we dig more, we can find how that same character changes as time passes by. Originally, it was just a simple drawing...

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-
亚: second (best)
- guang
光: light

甲骨文	金文	篆文	隶书	楷书
				
前三点三三	前	点	三	三

甲骨文	金文	篆文	隶书	楷书
				
前	点	三	三	三

↳ Oracle bone script
(~3000 years ago)

20



...depicting a person kneeling down on the ground while holding a long torch. We may need some imagination here, but this is the feet, this is the body, and this is the torch.

In my mind, this means this person is trying to serve others as best as he or she can, by providing light in this specific case, even if that requires kneeling down humbly.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-

亞: second (best)

- guang

光: light

} Stride for excellence to
humbly serve others

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In a word, when we put these two characters together, they could mean “stride for excellence to humbly serve others”.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-

亚: second (best)

- guang

光: light

} Stride for excellence to
humbly serve others

Far-fetched?

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Do you think this is a little far-fetched? After all, Chinese is an interesting language where the same character could be interpreted very differently.

I had the same doubts. So, I checked with my parents. And it turned out my name means something entirely different to them. Surprise, surprise.

About Dr. Yaguang Zhang

↳ Family name, default setting

- Ya-

亞: second (best)

- guang

光: light

} Stride for excellence to
humbly serve others

Far-fetched?

Still, I choose to interpret my name this way...

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But the point is, I still love this interpretation, and I have been trying my best to live my life following this.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?

Education, in the broadest of truest sense, will make an individual seek to help all people, **regardless of race, regardless of color, regardless of condition.**



GEORGE
WASHINGTON
CARVER

SETTING THE STAGE

[2021-2026 College of Agriculture Strategic Plan](#)

That ties extremely well with the opening sentence of the 2021-2026 college of agriculture strategic plan: helping others is the key, regardless of race, color, and condition.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others

Education, in the broadest of truest sense, will make an individual seek to help all people, **regardless of race, regardless of color, regardless of condition.**

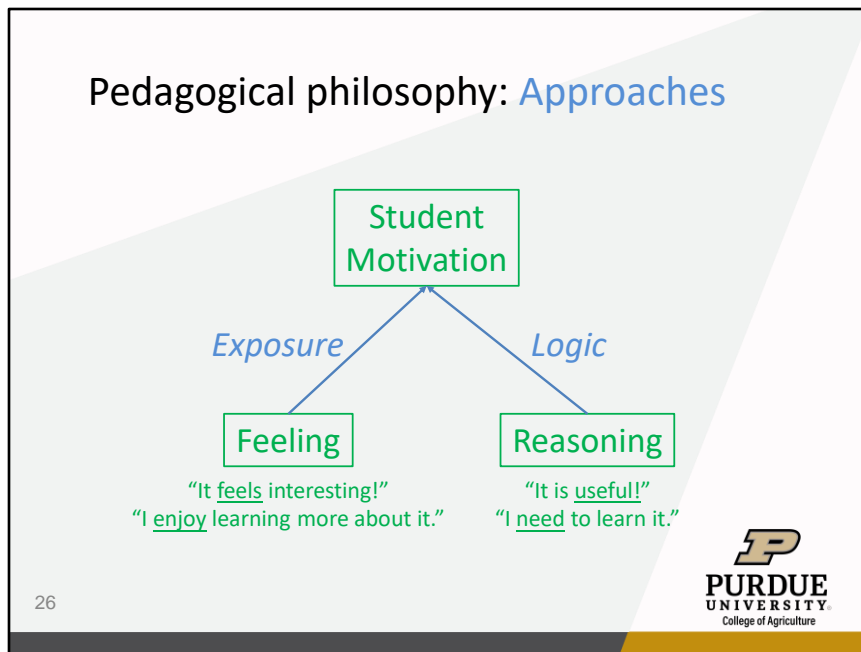


GEORGE
WASHINGTON
CARVER

*SETTING THE **STAGE***

I completely agree with this. Motivating students to serve others should be the ultimate goal. And it is a perfect answer for the question “What kind of students do we want to cultivate?”

My only complaint about this is, a high-level direction alone is not specific enough for us educators to apply this in our daily teaching. We need actionable, reproducible measures, to teach this vague life value.



This is a good time for a high-level overview over actionable approaches to motivate students.

I normally classify student motivation into two types: feeling vs reasoning. When the students comment something like, “...” or “...”, it is a good sign for the feeling type of motivation. Although not predictable at the individual level, this type of motivation is very powerful. What we can do on this side, is to expose the students to the topic of interest, preferably in a passionate and interesting manner.

On the other side we have reasoning. We could use logic to persuade the students that they would need something because it is useful, so useful that it will worth their time and effort to study hard. Let’s now have a look at a short teaching demo for the second approach: logic persuading.

Teaching demo: Optimization

- A framework for guiding/making decisions
 - Data-driven
 - Can be used to set goals for AI
 - Good for AGR 333 - Data Science for Ag

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The topic I chose is mathematical optimization, which includes a set of very powerful tools to guide or make data-driven decisions. In fact, it is a very popular option for setting goals for AI. So... this demo fits well in the data science for agriculture course.

Teaching demo: Optimization

- A framework for guiding/making decisions
- Teaching goals:
 - Optimization is useful
 - Helping others is good

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In this particular demo, I will try to embed our educational goal, motivating students to help others, in the teaching.

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\min_{x \in A} f(x)$$

↑
Action

↑
Feasible region

↑
Cost function

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First, let's quickly go through some prerequisite knowledge here, because this demo works the best after the students already have a good intuition about how optimization works.

Roughly speaking, the optimization framework can be summarized with a “minimization problem”: we have the cost function f , which we want to minimize, by changing our action x . And possible actions are limited in a set called feasible region.

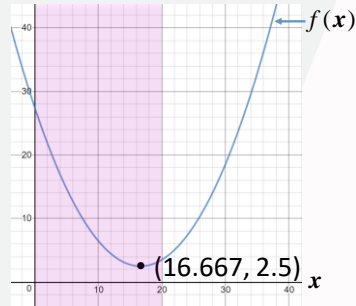
Intuitively, this formula means we want to find the minimum cost that is achievable with the actions we can take.

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\underset{x \in A}{\operatorname{arg\,min}} f(x)$$

$x \in A$ ↑ Expense - yield
↑
[0, 20]
Fertilizer amount



Example: How much nitrogen fertilizer should we apply?

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A simple application could be, how much nitrogen fertilizer should I apply in my field.

Here, we have the cost function being the expense on the fertilizer minus the yield of my field. This function is known in this example and represented by the curve on the plot. The minimization operation would then imply that we want to spend less money but get more yield.

The amount of fertilizer we can apply is limited between 0 and 20 units.

Note in this problem, the operation “min” is changed to “arg min”, because we need the best action that we can take, instead of the minimum value of the cost function.

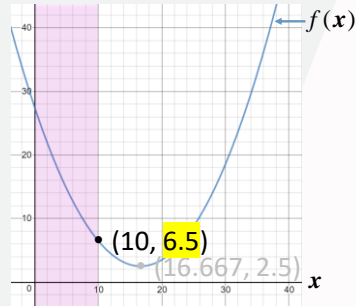
It is clear that, we just need to find the lowest point on the curve, which in this case is (16.667, 2.5). Then the optimization problem is solved. We should apply this much of fertilizer, so that the cost function is minimized at 2.5.

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\arg \min_{x \in A} f(x)$$

$x \in A$ ↑ Expense - yield
↑
[0, 10]
Fertilizer amount



Example: How much nitrogen
fertilizer should we apply?

31



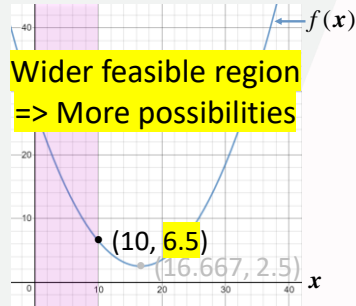
Note that the feasible region controls what action is possible. If we shrink the region from 0 to 20 to 0 to 10, then the result will be a little worse than what we got before.

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\arg \min_{x \in A} f(x)$$

$x \in A$ ↑ Expense - yield
↑
 $[0, 10]$ Fertilizer amount



Example: How much nitrogen
fertilizer should we apply?

32



This makes sense, because if we allow a wider range of actions, it will be more likely for us to find better solutions.

I know this is a lot of information. I wish we had more time. Do we have any questions?

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\arg \min_{x \in A} f(x)$$

33

Does “helping others” lead to a “better world”?

That covers all the intuitions we need, so now we are ready for the real challenge:
does helping others lead to a better world?

Teaching demo: Optimization

- A framework for guiding/making decisions

$$\text{arg min}_{x \in A} f(x)$$

$\Sigma \text{Resource} - \Sigma \text{"happiness"}$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)

34 Does "helping others" lead to a "better world"?

For example, we could define the cost function as the total resource used by all of us minus the total happiness we get. Then, a better world would refer to "less resource consumption but more happiness".

The action x will be a vector, with each element being the action one person takes. Correspondingly, the feasible region will be a high-dimensional region.

Teaching demo: Optimization

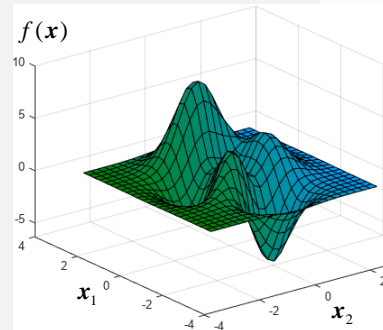
- A framework for guiding/making decisions

$$\Sigma \text{Resource} - \Sigma \text{"happiness"}$$

$$\arg \min f(x)$$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)



35 Does "helping others" lead to a "better world"?

As an illustration, this plot shows a 2-dimensional feasible region.

Teaching demo: Optimization

- A framework for guiding/making decisions

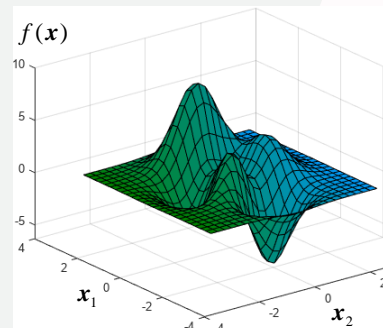
$$\Sigma \text{Resource} - \Sigma \text{"happiness"}$$

$$\arg \min f(x)$$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)

$$A_{\text{Not helping}} \subset A_{\text{Helping}}$$



36 Does “helping others” lead to a “better world”?

The key for this discussion is that, by considering helping others, we are expanding the feasible region. Consider me going through a door. If I want to help others, I will spend some effort in observing whether there is anyone following me, and if so, I will hold the door for them. On the contrary, if I am completely selfish, meaning all my actions have to directly benefit myself, holding the door for others will not be in my feasible region. I will not take that action even into consideration.

In short, considering “helping others” gives us more action options.

Teaching demo: Optimization

- A framework for guiding/making decisions

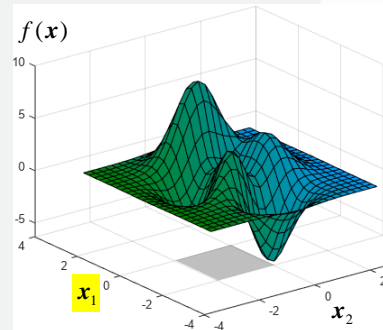
$$\Sigma \text{Resource} - \Sigma \text{"happiness"}$$

$$\arg \min f(x)$$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)

$$A_{\text{Not helping}} \subset A_{\text{Helping}}$$



37 Does "helping others" lead to a "better world"?

The best part is that, even one person's choice matters. If we manage to educate one selfish student...

Teaching demo: Optimization

- A framework for guiding/making decisions

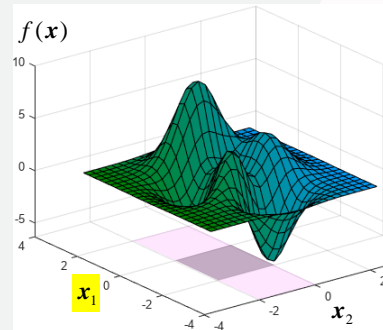
$$\Sigma \text{Resource} - \Sigma \text{"happiness"}$$

$$\arg \min f(x)$$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)

$$A_{\text{Not helping}} \subset A_{\text{Helping}}$$



38 Does "helping others" lead to a "better world"?

to become happy helping others, we are essentially expanding the feasible region along that student's axis.

Teaching demo: Optimization

- A framework for guiding/making decisions

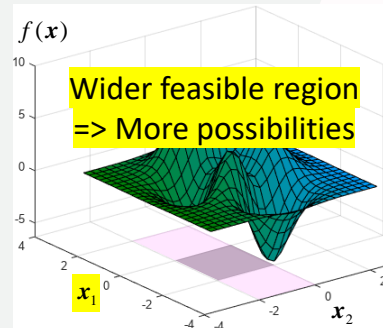
$$\Sigma \text{Resource} - \Sigma \text{"happiness"}$$

$$\arg \min f(x)$$

$x \in A$ ← A high-dimensional region

A vector (x_1, x_2, \dots)

$$A_{\text{Not helping}} \subset A_{\text{Helping}}$$



39

Does “helping others” lead to a “better world”?

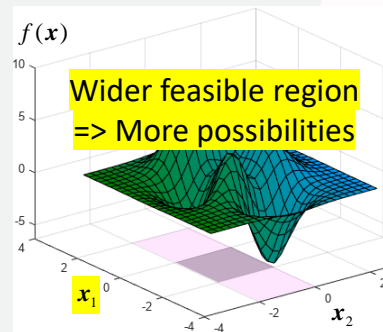
We know that a wider feasible region means more possibilities, so it will be more likely for us to reach a better optimization point, corresponding to a better world in this demo.

Teaching demo: Optimization

- A framework for guiding/making decisions

Implications

- Wider feasible region
=> Better solution
- Equality



40 Does “helping others” lead to a “better world”?

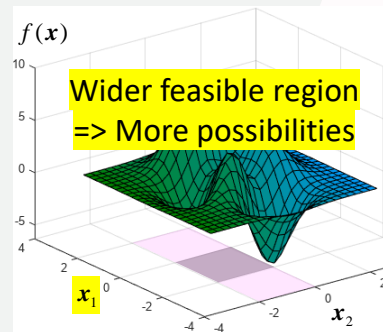
We can also deduce other implications. For example, this demo actually promotes equality, because to **guarantee** a solution **not worse** than before, we want to expand the feasible region without removing the grey “selfish” region, so that if the optimum point indeed falls in the selfish region, we can still accept that solution. This implies: “helping others” does not mean “pleasing others at all cost”; after all, we don’t have to always hold the door for others. It is better to treat any other person the same as we treat ourselves.

Teaching demo: Optimization

- A framework for guiding/making decisions

Implications

- Wider feasible region
=> Better solution
- Equality
- Example limitations
 1. Quantification
 2. Communication
 3. Computation



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Does “helping others” lead to a “better world”?

There are also disadvantages with this approach. First of all, it is very challenging to quantify metrics such as amount of resource used, and happiness. On top of that, communicating these metrics properly so that the optimizer can get all the information needed, will incur a huge amount of overhead. Last but not least, even if all of these are taken care of, solving the optimization problem in a high-dimensional space will require a tremendous amount of computational power.

That being said, we are looking for better ways to quantify feelings, we are enabling cheaper, more efficient communication, and we are creating computers that are more powerful. So, if you are an optimist as I am, it makes sense to move toward helping others for the new possibilities of a “better world”.

Any questions?

Other interesting points:

- *In a society with altruistic members, a selfish person can easily take advantage of the situation, e.g., by exaggerating their own needs.*
- *The altruism of one person can only be judged according to the action of that*

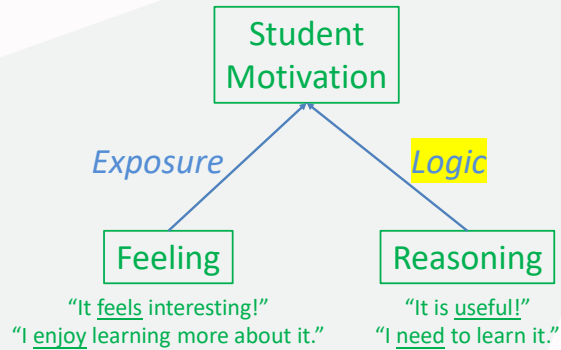
person.

- A person with selfish motivation to behave altruistically may suddenly abuse their power and hurt others'.

- Altruists may still change their mind.

- A person with action records of always being altruist, could be considered an altruist even if the motivation is selfish.

Pedagogical philosophy: Approaches



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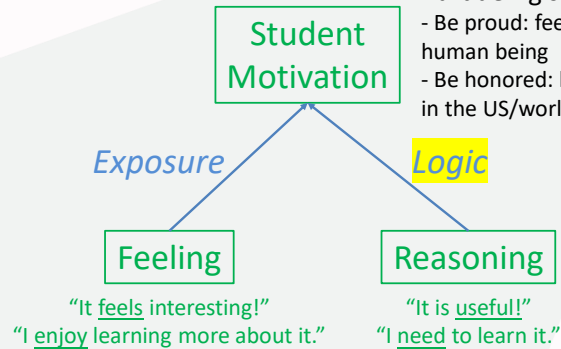


I hope that is a good demonstration for how useful logic persuasion can be, to motivate our students.

Pedagogical philosophy: Approaches

More examples for
Purdue Ag students

- Be proud: feeding the human being
- Be honored: best program in the US/world

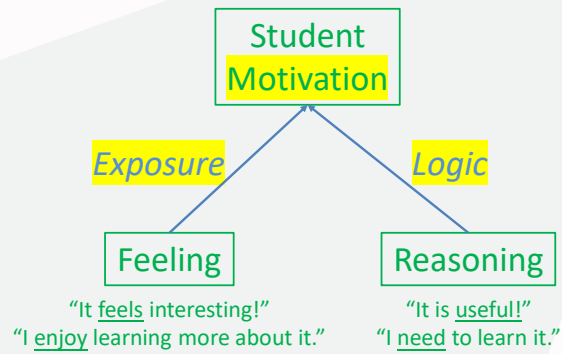


43



Just two quick examples for Purdue ag students. We can try to persuade them to be proud about their major, because they will serve the high purpose of feeding the human being, and to be honored as a member of Purdue Ag department, because they are enjoying the best Ag program in the US, and probably around the whole world.

Pedagogical philosophy: Approaches



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In fact, both approaches here, logic and exposure, are helpful beyond the purpose of motivation.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others
 2. Able to self-learn/apply new skills (Meta skills)
 3. Domain-specific knowledge and skills

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More specifically, they are critical in training students with domain-specific knowledge and skills, which our current education system is really good at, ...

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others
 2. Able to self-learn/apply new skills (Meta skills)
 3. Domain-specific knowledge and skills

46



... as well as in equipping students with meta skills, the skills for learning new skills, including the ability to fetch relevant information via tools like Google and ChatGPT, and the ability to stay focused over relatively long time periods.

This goal about meta skills is getting more and more attention now... to some degree, because ChatGPT emerges as a huge success of AI development, and that poses an existential challenge to us educators.

Note that, the three goals here are ordered in priority based on my best judgement. That is, teaching a student to be a good person is more important than equipping them with meta skills, and meta skills are more important than domain-specific knowledge.

Pedagogical philosophy: Goals

- Reality today?
 1. Focus: Domain-specific knowledge and skills
 2. Byproduct: Meta skills
 3. Slogan: Motivated to serve others

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However, in practice, the priority order is reversed. We are very good at teaching specific knowledge and skills, so that becomes our focus.

The students may pick up meta skills as a byproduct, but we seldom intentionally or explicitly teach these skills.

And high-level purposes such as helping others often only stay as slogans. Hopefully, the teaching demo we just saw has proven that, there are actions we can take to improve this situation.

Pedagogical philosophy: Goals

- Reality today?
 1. Focus: Domain-specific knowledge and skills
 2. Byproduct: Meta skills
 3. Slogan: Motivated to serve others
- The world is changing fast
 - Easier access to specific knowledge/skills.

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Anyway, is it OK to keep things as they are? Well, the reality calls for something different, because it will be easier and easier to get high-quality materials for specific knowledge and skills.

Pedagogical philosophy: Goals

- Reality today?
 1. Focus: Domain-specific knowledge and skills
 2. Byproduct: Meta skills
 3. Slogan: Motivated to serve others
- The world is changing fast
 - Easier access to specific knowledge/skills.
- Implications
 - Students with meta skills => more competitive
 - Instructions focusing on 1 may be replaced

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That has two implications. First, if our students graduate with only domain-specific knowledge and skills, their competitiveness will be very limited. The world is changing fast; future students simply need meta skills to adapt to that fact.

The second implication is that, if we human educators can only present facts as they are, we may be easily replaced.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others Human beings are the ultimate judge on life values.
 2. Able to self-learn/apply new skills (Meta skills)
 3. Domain-specific knowledge and skills

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In my list, motivation goes first. AI so far does not have the ability to set goals for human society, and even if AI was able to, it would still be hard to guarantee or prove the goals set by AI actually align with what we human beings need. Long story short, we human beings are the ultimate judge on life values. So as human educators, it is our responsibility to make sure our students will become good people.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others Human beings are the ultimate judge on life values.
 2. Able to self-learn/apply new skills (Meta skills) The world is changing fast.
 3. Domain-specific knowledge and skills

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Also, it will be better if we prioritize meta skills over domain-specific knowledge and skills, given the fast-changing world.

Pedagogical philosophy: Goals

- What kind of students do we want to produce/cultivate?
 1. Motivated to serve others Human beings are the ultimate judge on life values.
 2. Able to self-learn/apply new skills (Meta skills) The world is changing fast.
 3. Domain-specific knowledge and skills Creators and developers (vs users) of technology

52



That does not mean domain-specific knowledge and skills will become obsolete. They are for sure important, especially if we want our students to become creators and developers of new technology (instead of merely users), just we probably do not want to kill possibilities on our students' side by focusing only on this.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

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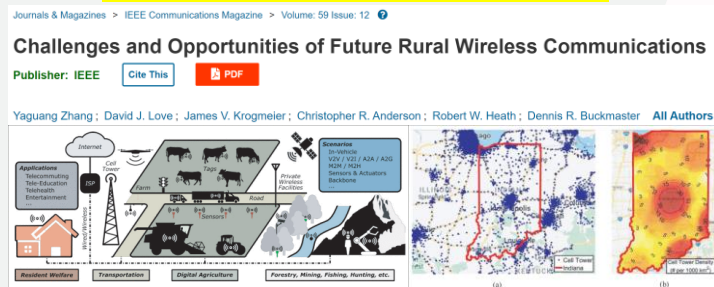
A little more about me. Again, this is me going out of my comfort zone for the sake of this talk. If you know me in person, you will notice that I am a humble, young lad who hates to talk about his achievements.

With an honest evaluation, I think I can represent “the best that can be expected ...”

First of all, I am always happy to serve others.

More about me

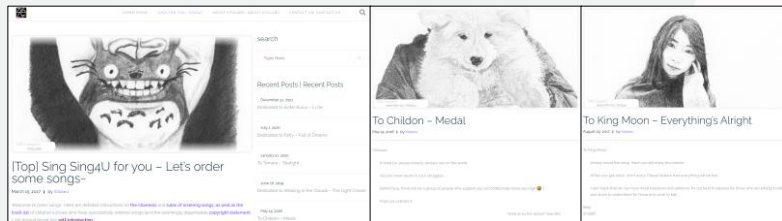
- “The best that can be expected of an average student in the modern education system.”
 1. **Motivated to serve others**
 2. Meta skills
 3. **Domain-specific knowledge and skills**



And I am especially motivated to help improve equality. One direction of my research is to help bridge the digital gap between urban and rural areas.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. **Motivated to serve others**
 2. Meta skills
 3. **Domain-specific knowledge and skills**

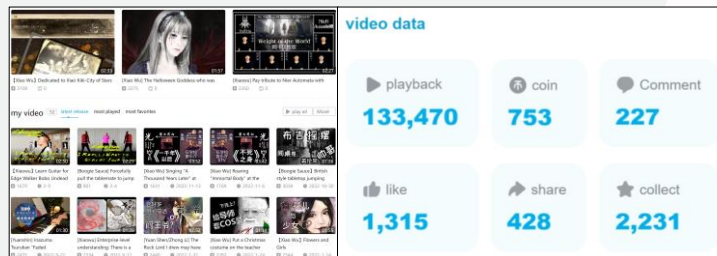


55

During my free time, I give free drawings and song covers to people online who request that, just to cheer them up.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills



I am also a hobbyist content creator. So I know a lot about audio and video editing.

More about me

- “The best that can be expected of an average student in the modern education system.”

1. Motivated to serve others
2. **Meta skills**
3. Domain-specific knowledge and skills

- | | |
|------------|-------------------|
| - Drawing | - Singing |
| - Painting | - Video editing |
| - Guitar | - Audio editing |
| - Piano | - Web development |

57



Along the way, I self-learned a series of skills. And I sincerely believe I can become anyone I want, simply because I know how to train myself. It will be great if my students can develop the same confidence provided by meta skills.

...so that they can explore and enjoy this wonderful world.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

What has made me who I am today?

How to duplicate the good characteristics?

58

So, I have been keeping asking myself, what has made me who I am today? How do I duplicate the good parts of me in my students?

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

What has made me who I am today?

- Fully trusting the instructors
 - Not brilliant, but hard-working

How to duplicate the good characteristics?

59

For the first question. The answer contains two parts. One, I fully trust the instructors, so even though I am not on the brilliant side, I always try my best to meticulously follow the instructions.

I still remember there was one math professor of mine, who said to the class: if you do not understand something I teach, just memorize it. So... that was what I did. The strategy helped, but the memorizing part was simply painful.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

What has made me who I am today?

- Fully trusting the instructors
 - Not brilliant, but hard-working

How to duplicate the good characteristics?

60

Earn the trust

You cannot expect that level of trust from all the students. So, I know when I become an instructor, I need to earn the trust, by teaching things the students feel interesting and useful, and by making it personal, showing them that I care,

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

What has made me who I am today?

- Fully trusting the instructors
 - Not brilliant, but hard-working
- Exposed to challenges and opportunities

How to duplicate the good characteristics?

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Earn the trust

Encourage students to explore

I have also been extremely lucky to have a wide range of experiences. Some of them provided the defining moments of my life. So I want to encourage my students to experience more, if they have the chance.

More about me

- “The best that can be expected of an average student in the modern education system.”
 1. Motivated to serve others
 2. Meta skills
 3. Domain-specific knowledge and skills

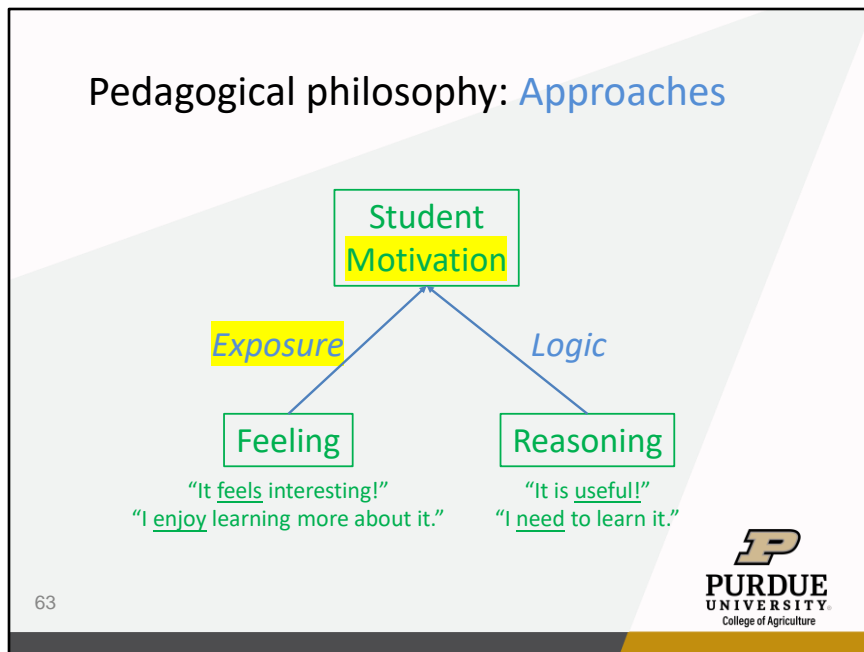
EDUCATION

Purdue University, West Lafayette, Indiana, USA PhD in Electrical and Computer Engineering	Western - US	August 2021
• Thesis Zhang, Y. , 2021. <i>Improved site-specific millimeter-wave channel modeling and simulation for suburban and rural environments</i> . Purdue University Graduate School.		
Purdue University, West Lafayette, Indiana, USA MSc in Electrical and Computer Engineering		May 2015
Tianjin University, Tianjin, P.R. China BEng in Communication Engineering	Asian	June 2013
• Thesis title <i>Design and Simulation of LTE Semi-Persistent Scheduler</i>		
University of South Australia, Adelaide, Australia Exchange Student	Western - Australia	February – July 2012

62

For example, I was privileged with the opportunity to experience three quite different education systems. At the US, as we all know, you will get enough freedom and resources to grow as high as you can reach. The Asian culture can really humble you. The Australian education system feels like a service business to me, highly professional and highly efficient.

When a student is exposed to this large portion of the world, their stereotypes about people will be challenged again, again, and again, to the point where it is probably easier to just treat everyone independently. Also, they are more likely to have friends of different backgrounds, and it is hard to discriminate strangers who appear similar to your friends.



That is why I believe exposure can help motivate a student to become a better person.

Other exposures include:

- *Role model*
- *Mentoring*
- *Services to community*

Why online education?

July 2011. **Volunteer Teacher.** Jiantang Village Elementary School, Fenghuang County, Hunan Province, China.

- *College Student Summer Service Program:* Taught at a Hope Project school and co-authored a report on local economy and education.

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Now, I'd like to share with you one piece of my experience, as a volunteer teacher in a remote village. That experience was so eye-opening, and even mind-blowing. It basically shaped my attitude toward online education.

At that time, I was a junior undergraduate student. A summer service program was recruiting volunteer teachers, so I just participated without much thinking. We were dropped off out of the village because it was in a mountainous area. The only way to enter the village was by foot. And because of the poor transportation, local economy was extremely undeveloped. There was no tap water. Only one building had electricity.

We took care of about 30 kids. Interestingly, they were from different grades. Later, we learned that the whole elementary school only had two teachers, so all the kids, no matter how old they were, almost always attended the same class. These conditions were challenging, but still acceptable to me.

Then there was this one little girl in the class, about 7 or 8 years old, holding her baby brother, who was maybe only 1 or 2 years old. The girl was so tiny herself, that her baby brother's head appeared unproportionally big. And it seemed the baby was just

hanging down in front of her, because she was too tiny to hold the baby horizontally as people normally do. That scene was so unusual to me that it will be stuck in my head for the rest of my life.

I still don't know how to handle a baby, but she was so good. The baby was behaving himself, so she must have had done that very often. It turned out that, their parents went out of the village to make money, so they were left with their grandparents in the village. We found later the whole village basically only had elderly people and kids in it.

Why online education?

July 2011. **Volunteer Teacher.** Jiantang Village Elementary School, Fenghuang County, Hunan Province, China.

- *College Student Summer Service Program:* Taught at a Hope Project school and co-authored a report on local economy and education.

- A supplement (a cheaper alternative)
- A practical remedy for undeveloped areas

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With that, let's come back to the question. Why online education? To many, online education is an alternative, cheaper option to traditional on-campus education.

To me, online education is the only practical remedy for the kids I met. They simply had too little resource to support anything else.

Pedagogical philosophy: Emerging challenges

66



Of course, that was about 15 years ago. The living condition in that village probably has been improved dramatically.

Still, if I imagine I were one of the kids there, and maybe during one visit of my parents back to the village, I got a phone as present. In that case, would I use the phone to take online courses?

Pedagogical philosophy: Emerging challenges

- Who are we (as online educators) competing with?

67



I really wish the answer is yes, but the fact is, I am a very disciplined person and I have taken many online courses myself. The majority of them only cover pieces of specific knowledge. Because of that, I frequently feel board, sometimes even fall asleep taking these course.

Pedagogical philosophy: Emerging challenges

- Who are we (as online educators) competing with?
 - Online entertainment

Deliberately designed by
experts to be addictive

68



To an average kid, TikTok and games will be way more attractive than online course. After all, they were deliberately designed to be addictive, often with the help of hundreds, if not thousands, of experts.

Pedagogical philosophy: Emerging challenges

- Who are we (as online educators) competing with?
 - Online entertainment
- What are we competing for?
 - Next generation's attention

Deliberately designed by experts to be addictive

A limited resource for keeping ideas

69



However, to actually benefit the students, we really need their intense attention over a long time. Fighting for their attention is a big deal, because whatever get the attention of the next generation, will secure its position to be preserved in future human civilization.

Pedagogical philosophy: Emerging challenges

- Who are we (as online educators) competing with?
 - Online entertainment
- What are we competing for?
 - Next generation's attention

Deliberately designed by experts to be addictive

A limited resource for keeping ideas

Useful ideas vs fun ideas

70



We educators want a bigger slice of this “limited resource” to keep ideas that we believe are useful, while online entertainment wants a bigger slice to keep ideas they are fun.

It is hard to argue which side is right, but it is crystal clear that we online educators won't win the competition if we do not change.

Rethinking “best practices” in online education

- The world is changing fast
 - Common practices today are probably not best practices in the future

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In fact, changing will be the norm for online education if we want to keep up with the fast-changing world.

Rethinking “best practices” in online education

- The world is changing fast
 - Common practices today are probably not best practices in the future
 - Proposal, implementation, evaluation, and promotion of “better practices”

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In that sense, we may not want to be too obsessed with the “best practices”; instead, we need establish procedures to streamline the proposal, implementation, evaluation, and promotion of “better practices”.

Rethinking “best practices” in online education

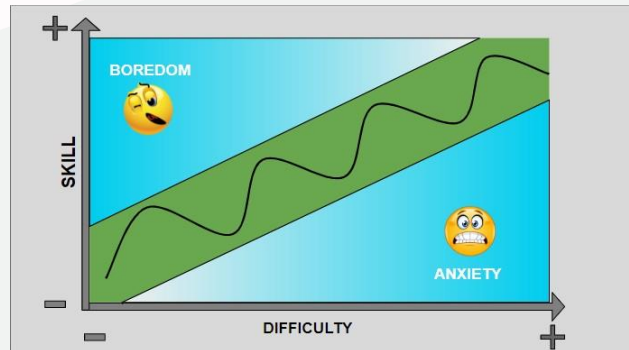
- The world is changing fast
 - Common practices today are probably not best practices in the future
 - Proposal, implementation, evaluation, and promotion of “better practices”
- Candidates for better practices?
 - Most successful training tool: games
 - Most useful education content: real-life skills

73

But first thing first, what can we propose as the candidates for better practices? Well, search no further, one of the competitors we just identified, video games, have been extremely successful in training people with complicated knowledge and amazing skills. Unfortunately, because they are **highly entertainment-focused**, **the majority of the content they teach do not directly apply in real life**. Is there a way to combine that with what we want to teach? So that the students can be addictive to learning and applying real-life skills?

Game design

- The “flow” state



<https://thinkgamedesign.com/flow-theory-game-design/>

74

Let's first step back a little bit and look at what modern “game design” can achieve. One of the key ideas is the “flow” state, as represented by the green region in this plot. We have difficulty as the x axis, and the skill level of the player as the y axis. On the one hand, if the game is too easy for the player, the player will feel bored. On the other hand, if the game is too difficult, the player will feel anxious. So we want to keep the player in the green area.

However, this is easier said than done, because the process is dynamic. As time goes by, the play will get better and better at the game. How does a game adapt to that?

What's more, there are more than one player. Each of them will start at a different skill level and will learn at different speeds. How can a game adapt to that?

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
- Intuitive visual hints
- Frequent positive feedback
 - Points/virtual currency
 - Achievements
- Real-time preformation evaluation
- The power of habits
 - Daily/weekly/monthly missions

75



The video game industry is very mature today. They have a large set of tricks or techniques to help achieve the “flow” state.

For example, intuitive visual hints, ... by points, virtual currency, and achievements. Real-..., so that you can learn almost immediately whether an action is good or not after you take it. And the power... they will train you to play the games regularly with the rewards.

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
 - Intuitive visual hints
 - Frequent positive feedback
 - Points/virtual currency
 - Achievements
 - Real-time preformation evaluation
 - The power of habits
 - Daily/weekly/monthly missions
- Huge amount of content
 - Beta tests
 - User survey
 - High-quality arts (both visual and audio)
 - Trailers/ads
 - Localization (e.g., multi-language)
 - Multi-platform
 - Community
 - Real-life events/rewards
 - Gotcha mechanism (gambling)
 - ...

76



The competition there in the game industry is extremely intense. The result is, there are actually way more techniques than highlighted here, many of them do not even follow any design principle. They just work to make the games more attractive.

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
 - Intuitive visual hints
 - Frequent positive feedback
 - Points/virtual currency
 - Achievements
 - Real-time preformation evaluation
 - The power of habits
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 - Localization (e.g., multi-language)
 - Multi-platform
 - Community
 - Real-life events/rewards
 - Gotcha mechanism (gambling)
 - ...
- "Let's be do whatever we can to make games fun!"

77

I really like this extremely pragmatic attitude. Their goal is to make games fun. For that, they will do whatever they can.

Let's be do whatever we can to help students learn more easily?

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
 - Intuitive visual hints
 - Frequent positive feedback
 - Points/virtual currency
 - Achievements
 - Real-time preformation evaluation
 - The power of habits
 - Daily/weekly/monthly missions
- Huge amount of content
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 - High-quality arts (both visual and audio)
 - Trailers/ads
 - Localization (e.g., multi-language)
 - Multi-platform
 - Community
 - Real-life events/rewards
 - Gotcha mechanism (gambling)
 - ...

“Let's be do
whatever we can to
make games fun!”

78

Should we educators do whatever we can to help students learn real-life skills more easily?

Let's be do whatever we can to help students learn more easily?

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
 - Intuitive visual hints
 - Frequent positive feedback
 - Points/virtual currency
 - Achievements
 - Real-time preformation evaluation
 - The power of habits
 - Daily/weekly/monthly missions
- Huge amount of content
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 - Trailers/ads
 - Localization (e.g., multi-language)
 - Multi-platform
 - Community
 - Real-life events/rewards
 - Gotcha mechanism (gambling)
 - ...

“Let's be do
whatever we can to
make games fun!”

79

Anyway, in this huge list, I want to first discuss the “intuitive visual hints”, which has been used intensively in this presentation.

Selected game design techniques



80

This is a screenshot from a very popular mobile game called Genshin Impact, which literally means the “impacts of original gods”.

Selected game design techniques



81

It is one of the recent “miracles” in the game industry, because this game targets **global** players who are as young as **12 years old**. And its ambition actually made a huge success: they have millions of active players and 4 billion dollars of revenue in 2 years.

Selected game design techniques



82

Their huge design team has made sure that the visual hints in the game are as intuitive as possible.

Selected game design techniques



83

For example, if you don't understand something, you can always try clicking on it to reveal hints. Key ideas are highlighted.

Selected game design techniques



84

You can click on them to get more explanations. As we can see, the rules are quite complicated, yet the game managed to teach millions of users to master the details.

These are only the **real-time hints** you can get when you are in a game.

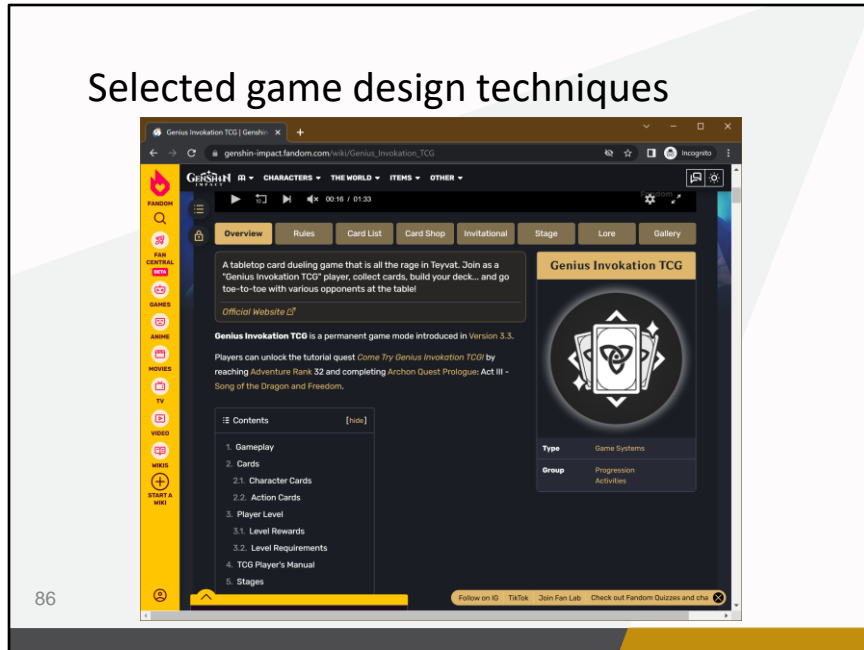
Selected game design techniques



85

They also have a built-in portal for players to learn more on their own if needed.

Selected game design techniques



What is more, they have comprehensive Wikipedia pages, where even the most advanced players can learn something new.

And all these materials are interactive with extremely intuitive visual hints.

By the way, this example clearly shows that: games accept the reality that learning requires repetition. They never assume that the players can master something with one round of learning.

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
- **Intuitive visual hints**
 - Make the learning experience effortless
 - Reduce effort/cost in fetching study materials

87



In summary, these hints make the learning experience effortless, especially because the interactive features dramatically reduce the effort required to fetch new study materials.

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
- Intuitive visual hints
 - Make the learning experience effortless
 - Reduce effort/cost in fetching study materials

Huge amount of content
for all levels with progress
control and rewards

“Let’s be do
whatever we can to
make games fun!”

88

From this example, we can see how much content is available if the player wants to learn more.

This is actually another overarching game design principle we can directly follow in online education.

We have to provide more materials than a typical student can digest, so that we will not limit how fast students can learn, or how high the students can reach. On the contrary, we want to provide rewards, either virtual or material, to encourage students to progress faster.

But the caveat is, this framework can easily overwhelm many students, so we need mechanisms to test whether the students are ready for more content, and if not, we need to intentionally limit their progress.

It also goes with the idea of achieving the “flow” state.

Let's be do whatever we can to help students learn more easily?

Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
 - Intuitive visual hints
 - Frequent positive feedback
 - Points/virtual currency
 - Achievements
 - Real-time preformation evaluation
 - The power of habits
 - Daily/weekly/monthly missions
- Huge amount of content
 - Beta tests
 - User survey
 - High-quality arts (both visual and audio)
 - Trailers/ads
 - Localization (e.g., multi-language)
 - Multi-platform
 - Community
 - Real-life events/rewards
 - Gotcha mechanism (gambling)
 - ...

“Let's be do
whatever we can to
make games fun!”

89

Now, I really want to go through all the techniques here, because a lot of them can be very inspiring, but we do not have enough time. The least I can say is, all of these techniques are widely adopted and they actually work in real life.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards

90



Next, let's move on to example actionable items for the data science for agriculture course.

I do want to discuss two techniques more carefully, because they are good candidates for better practice in online education.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content

91



Following the guidelines we saw, the first thing I would like to do for this course, is to expand the available content.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content

92

Data-driven decision-making:
Optimization



We have seen one demo for optimization, which will be good to teach data-driven decision-making.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content

Data collection & processing: Digital signal processing
Data-driven decision-making: Optimization

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Now, let's go back to the live demo of the guitar performance, and talk about digital signal processing.

Live demo for digital signal processing

- Extremely good example for intuition
 - Sensors => Microphone
 - Data => Sampled & quantized air pressure
 - Processing => In time & frequency
- Easy access + “tangible”

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This demo will be a very good low-level introduction to data science, to help students build rough ideas about where the data comes from, how to prepare the data for easier storage and processing, and what are the basic operations on data streams.

The biggest advantage is that, the equipment is easy to get, and the results are tangible. For example, (in time domain, we can see ... listen ... clip and move ...) (in frequency domain, we can ... frequency components ... filter).

That is what I mean by “tangible”. We can hear the data ourselves, which will make it easier for the students to develop intuitions. And all operations are simple enough for the students to duplicate, for example, in Python, as coding exercises.

Live demo for digital signal processing

- Extremely good example for intuition
 - Sensors => Microphone
 - Data => Sampled & quantized air pressure
 - Processing => In time & frequency
- Easy access + “tangible” + interesting
- Teach the skill first + cover the topics

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Note that this demo is not directly related to ag. I chose it anyway because I believe future education will focus on skills, instead of domain-specific knowledge. So, we may not want to limit what to teach in introductory sessions.

If we are teaching probability, gambling problems are good intro materials regardless of which major we are teaching. Similarly, audio processing has so many advantages that I feel it deserves to be covered even in an ag course.

That being said. We do want to provide a lot of agriculture examples.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content
 - Skill tree

96



That is where the skill tree can help.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Skill tree – Non-linear structure



97

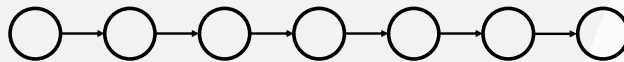
A skill tree, essentially, is a non-linear approach for organizing materials with dependency. It can provide a high-level overview of what prerequisites are needed, and what future possibilities are, for each skill of interest.

In games, the tree is typically visually pleasing and interactive. So you can click on any skill that you are interested in to get more materials.

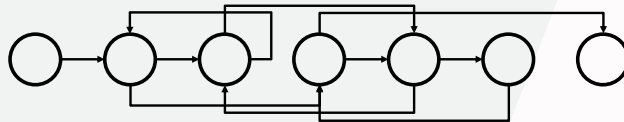
Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Skill tree – Non-linear structure
 - Why do we need a “non-linear” structure?

Traditional teaching: topics covered once are assumed to be mastered by the students.



Fact: repetition is required for learning.



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Why do we need a non-linear structure for online materials? Well, this is determined by the fact that each online student can adjust their progress based on their needs.

In traditional classroom settings, that is not practical. Instructors can not simply go back to a previous covered topic because a few students feel they want to know more about it. Instructors have to prioritize the needs of the majority.

However, the online learning experience can be tailored for each student, in the sense that they should have the freedom to explore new materials freely, or go back to review old topics as needed. Hints on the dependency of the materials can make that easier on the students' side.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Skill tree – Non-linear structure

Add a new column

	Date	Skill	Topic	Details	Quizzes and Assignments
WK 1: INTRO	Recorded		Faculty Introductions		
	Jan 10 Class		Orientation to data cycle, with an overview of all processes, FAIR concept. Volume, veracity, velocity		
	Jan 12 Lab		Beginning to work with data	Import of CSV into Excel & R with some statistical computations	
2-3: FOOD SCIENCE, FENG	Recorded		Food Science Applications		
	Jan 17 Class		Identify a research question Identify data needed		
	Jan 19 Lab		Working with Food Science data	Introduce multiple data files, including consumption, Pesticide residue, EPA RPF references	
	Jan 24 Class		Ethics of data (ownership, storage, access)		
	Jan 26 Lab		Food Science data	Conduct cumulative risk assessment of organophosphate (OP) pesticide group for this population.	

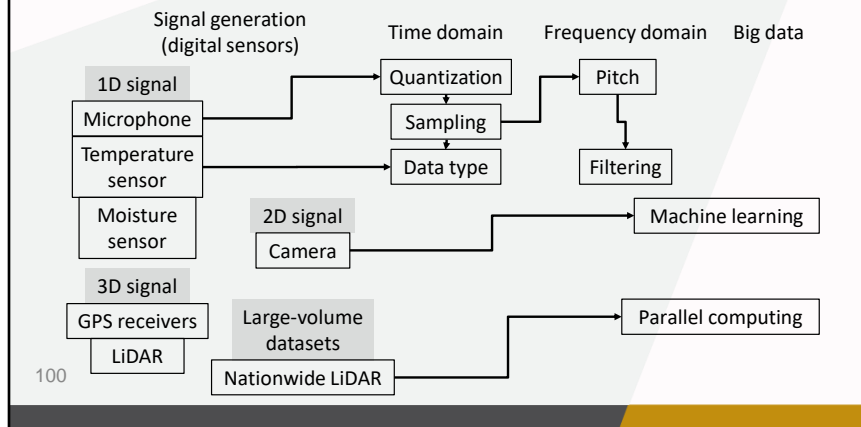
99

This idea fit education very well. The first thing I would encourage professors to do in the data science for agriculture course, is to identify the skills they want to teach, and create a skill tree accordingly.

Again, skills are what we should teach and focus on in the future. Topics are materials we use to teach the skills. Skills are the “core” of the course. Topics are the “flavor” of the course.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

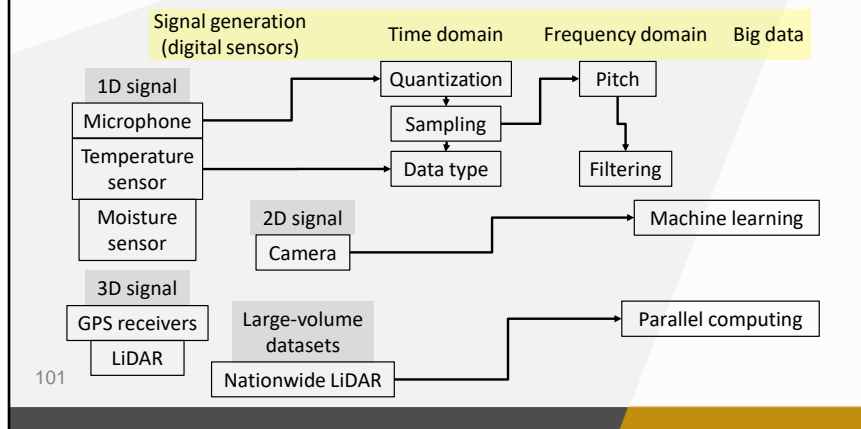
- Skill tree – Non-linear structure



For example, if we add digital signal processing into the course, we could start with a skill tree like this one for it.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

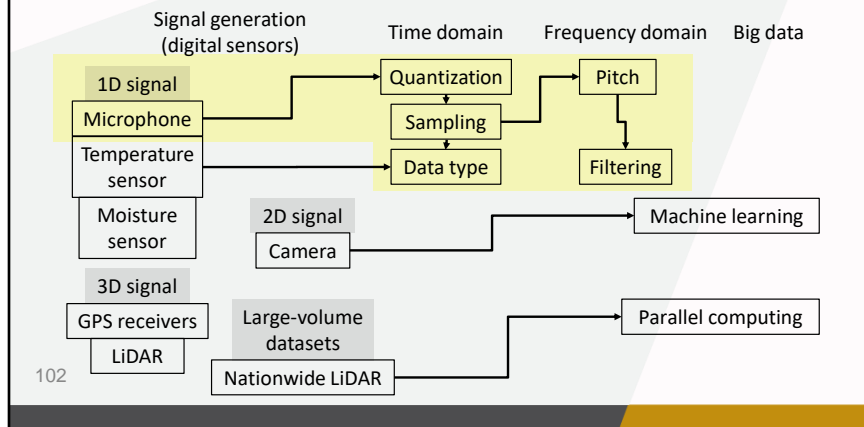
- Skill tree – Non-linear structure



We will teach signal generation, techniques in time and frequency domains, and tools for big data.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

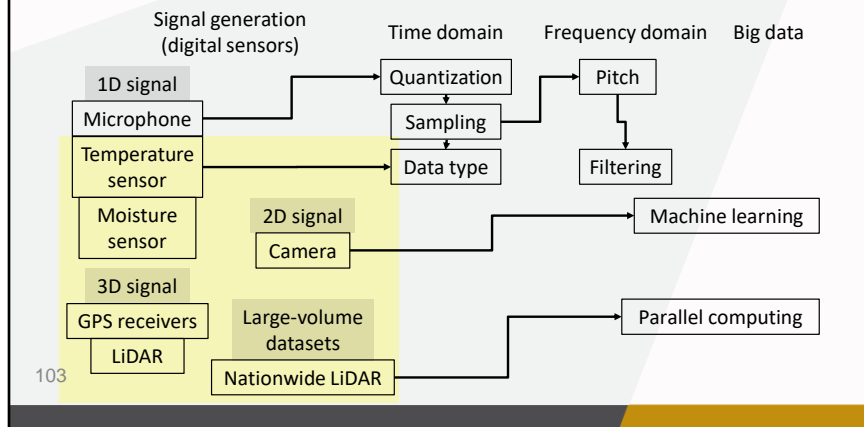
- Skill tree – Non-linear structure



Audio processing is the introductory topic for the basic ideas.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

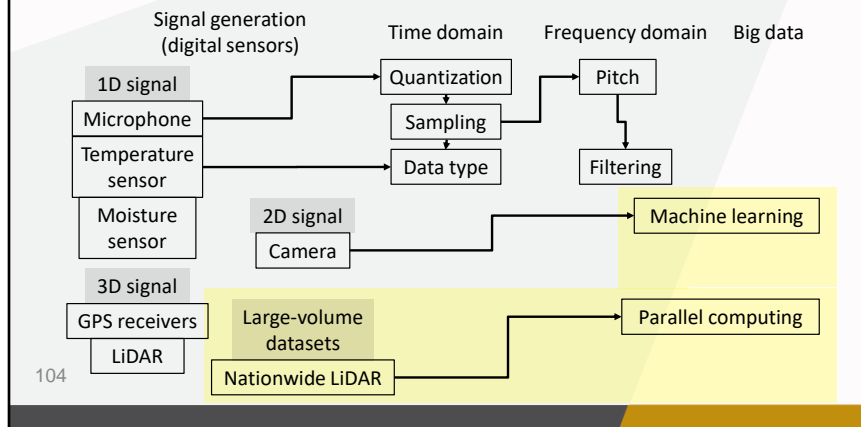
- Skill tree – Non-linear structure



Ag-related topics are covered after that, to repeatedly expose students to the same skill sets.

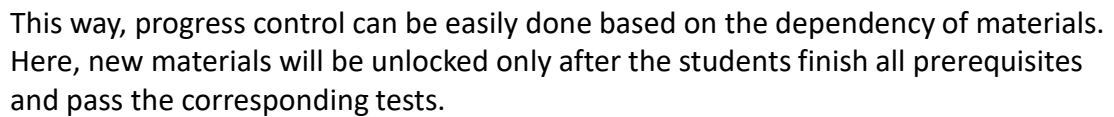
Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Skill tree – Non-linear structure



Selected state-of-the-art topics are introduced to widen the students' view.

- Skill tree – Non-linear structure



Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content
 - Skill tree
 - Point system

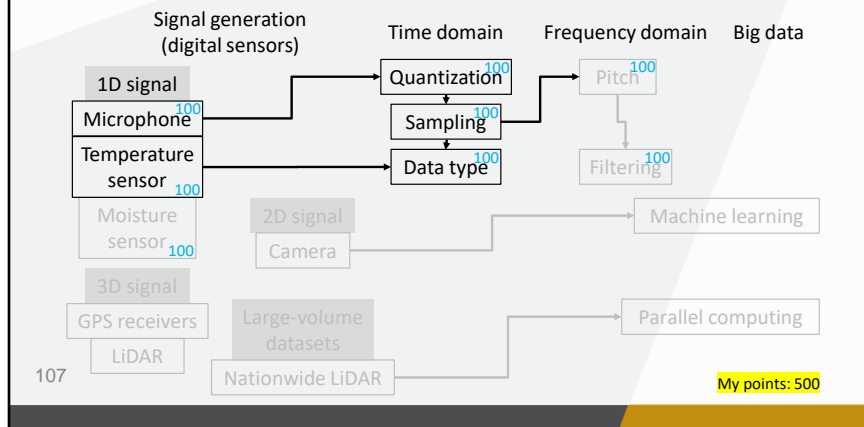
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This approach is also compatible with the point system for frequent positive rewards.

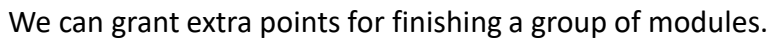
Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress



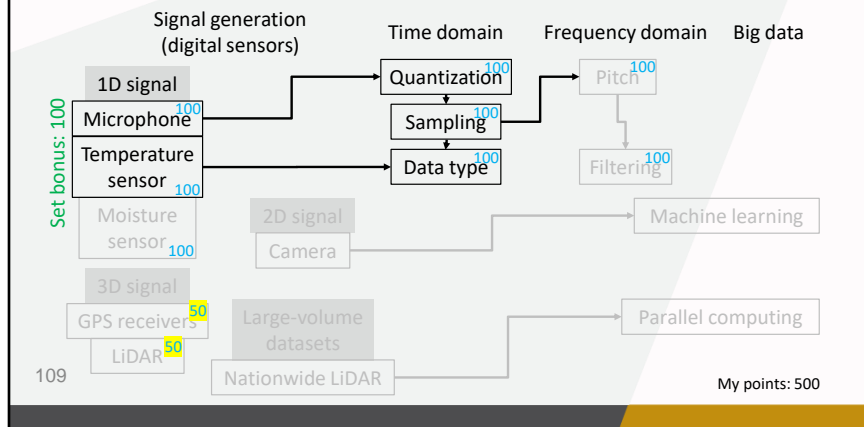
The point system is very powerful due to its flexibility. We can assign points to each module to encourage progress.

- **Point system** – Positive feedback to encourage progress



Tailoring game design techniques for AGR 333 - Data Science for Agriculture

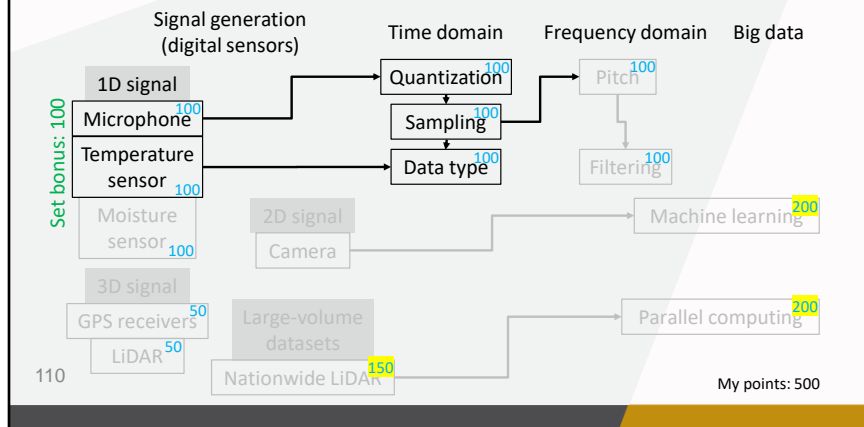
- **Point system** – Positive feedback to encourage progress



We can assign smaller amounts of points for less important or easier content.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

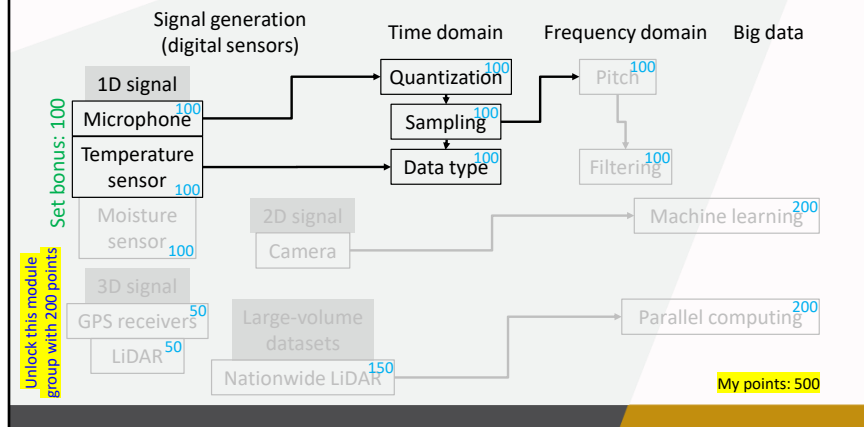
- **Point system** – Positive feedback to encourage progress



We can assign bigger amounts of points for required or challenging content.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

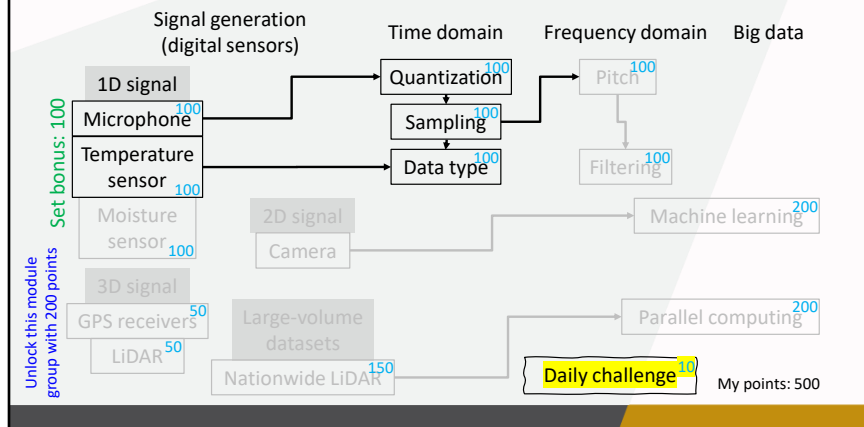
- **Point system** – Positive feedback to encourage progress



We can also use the point system for implicit progress control. Here, students have to earn enough points first before getting access to a new group of materials.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

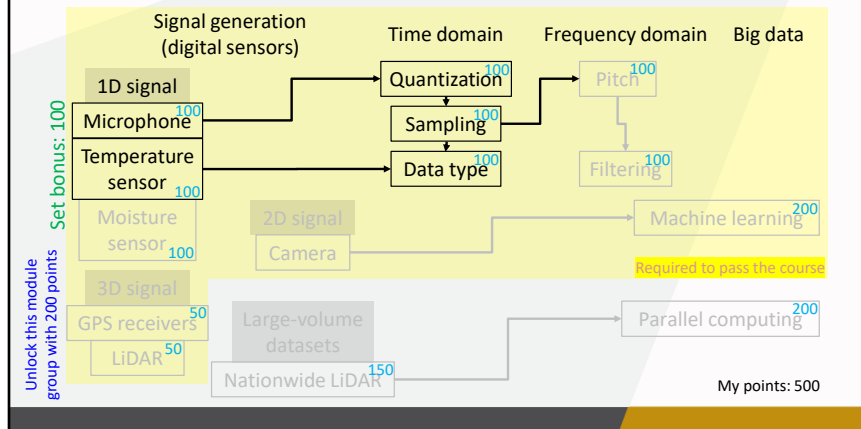
- **Point system** – Positive feedback to encourage progress



We can release daily challenges to help students develop the habit of studying everyday.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

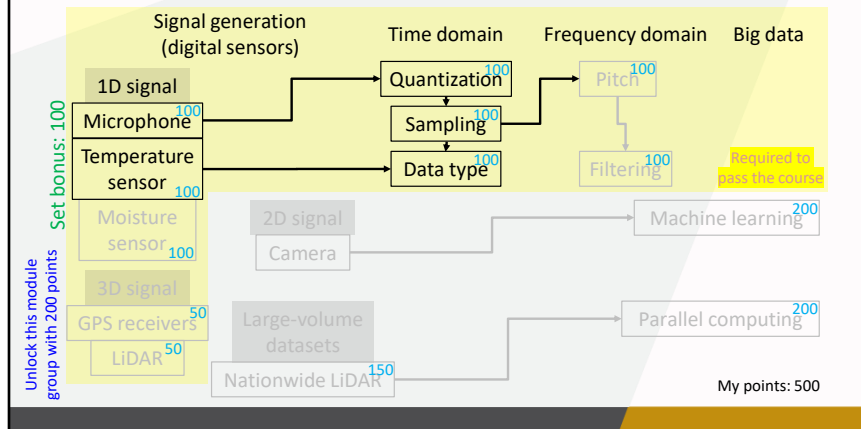
- **Point system** – Positive feedback to encourage progress



We can set some modules as “required” to pass the course, and other as “bonus” for students who want to learn more or earn more points.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress



We can easily change the boundaries, to fit the course better to the requirements of different student groups.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress
 - Competition
 - Real-time ranking: most points earned

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What's more, in this framework, we can take advantage of the students' desire to compete and win, by using leaderboards.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress
 - Competition
 - Real-time ranking: most points earned
 - Real-life awards/gifts to winners

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We can promise real-life awards to the winners.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress
 - Competition
 - Real-time ranking: most points earned
 - Real-life awards/gifts to winners
 - Virtual currency
 - Homework hints
 - One-to-one real-time tutoring

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We can treat the points as virtual currency for the students to trade for more resources, such as hints and tutoring time.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- **Point system** – Positive feedback to encourage progress
 - Competition
 - Real-time ranking: most points earned
 - Real-life awards/gifts to winners
 - Virtual currency
 - Homework hints
 - One-to-one real-time tutoring
 - Hidden challenges
 - Research ideas

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We can add bonus materials for students who progress faster, and reward those who successfully complete the content.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Point system – Positive feedback to encourage progress
 - Competition
 - Real-time ranking: most points earned
 - Real-life awards/gifts to winners
 - Virtual currency
 - Homework hints
 - One-to-one real-time tutoring
 - Hidden challenges and achievements
 - Research ideas and silly jokes

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We can frequently surprise the students with small hidden achievements to confirm their efforts, for example, if they get a task done, within a limited time or, without using hints.

I am particularly fond of this little idea. Because we instructors can come up with silly jokes for the achievements, which could be a lot of fun.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Hidden/explicit achievements



Speedrunner!

+10 points

Get a specific task done within a limited time.

“Either don’t run or... run like **crazy!**”



Mindreader!

+10 points

Get a specific task done without using any hints.

“Hints are not necessary...’cause I’m good at
reading your mind!”

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A modern game may have hundreds of small
achievements for more frequent positive feedback.

Imagine getting an achievement like these two as a student: Speedrunner ...
Mindreader ...

These are very positive feedback to reward “being concentrated” and “working independently”.

As a reference, a modern game may have hundreds of small achievements for more frequent positive feedback.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Hide hints by default

Data Science for Agriculture
AGR 333
Lab 4 - Data Collection and IoT

Goal: Understand data collection sources, limitations, and the connection to the internet of things.

Table of Contents

- Contents.....1
- Part 1: Software Setup.....1
- Installing Arduino IDE.....1
- Installing ESP Board in Arduino IDE (I).....1
- Flashing Uploader Plugin (I).....1
- Installing Libraries.....1
- Part 2: Hardware Setup.....1
- Hardware Requirements.....1
- Wiring Diagram.....1
- Part 3: Data Collection.....1
- Code Skeleton.....1
- ESP32 Code Skeleton.....1
- RTIME Code.....1
- Code Test (Pre-modification).....1
- ESP32 Code Modification.....1

Part 1: Software Setup

Installing Arduino IDE

1. Open a browser and navigate to <https://www.arduino.cc/en/Main/Software>.
2. Download and install the latest version for your operating system.
3. Open Arduino to ensure it installed correctly.

Installing ESP Board in Arduino IDE (I)

4. In your Arduino IDE, go to File > Preferences.
5. Click https://dl.espressif.com/dl/packages_esp32_index.json into the "Additional Board Manager URL:" field as shown in the figure below. Then, click the "OK" button.

Boards Manager

6. Open the Boards Manager. Go to Tools > Board > Boards Manager...

7. Search for ESP32 and install the package by Espressif Systems.

8. If the installation worked, you should now see ESP32 boards available in File > Board.

Within this framework, one lab assignment could fit as a block or one link in the details of the block. Here is an example lab from the data science for ag course.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Hide hints by default

The image shows a lab document titled "Data Science for Agriculture" with a goal to understand data collection sources and IoT connections. It includes a table of contents and a section for installing Arduino IDE. Overlaid on the document are two software windows: the "Preferences" window for Arduino IDE and the "Breadboard Manager" window. The "Breadboard Manager" window shows a list of installed packages, including ESP8266 and ESP32. A yellow highlight at the bottom of the screenshot contains the text: "The ability to follow instructions + The ability to find solutions and solve problems".

Goal: Understand data collection sources, limitations, and the connection to the internet of things.

Table of Contents

Contents

Part 1: Software Setup

Installing Arduino IDE

Installing ESP Board in Arduino IDE (1)

Flashing Uploader Plugin (2)

Installing Libraries

Part 2: Hardware Setup

Hardware Requirements

Wiring Diagram

Part 3: Data Collection

Code Skeleton

ESP32 Code Skeleton

RTIME Code

Code Test (Pre-modification)

ESP32 Code Modification

Part 1: Software Setup

Installing Arduino IDE

1. Open a browser and navigate to <https://www.arduino.cc/en/Main/Software>.

2. Download and install the latest version for your operating system.

3. Open Arduino to ensure it installed correctly.

Installing ESP Board in Arduino IDE (1)

4. In your Arduino IDE, go to File > Preferences.

5. Enter https://dl.espressif.com/dl/packages_esp8266_sdk_tools into the "Additional Board Manager URL:" field as shown in the figure below. Then, click the "OK" button.

6. Open the Breadboard Manager: Go to Tools > Board > Board Manager...

7. Search for ESP32 and install the package by Espressif Systems.

8. If the installation worked, you should now see ESP32 boards available in File > Board.

We all know about the high quality of Purdue's teaching materials, but there are a few small tricks that we can apply here to prioritize the abilities of finding solutions and solving problems, over the ability to follow instructions.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Hide hints by default

The screenshot shows a document titled "Data Science for Agriculture" with a subtitle "AGR 333" and a section "Lab 4 - Data Collection and IOT". Below this is a goal statement: "Goal: Understand data collection sources, limitations, and the connection to the internet of things." A "Table of Contents" is listed, including sections like "Part 1: Software Setup", "Installing Arduino IDE", "Installing ESP Board in Arduino IDE (1)", "Flashing Uploader Plugin (2)", "Installing Libraries", "Part 2: Hardware Setup", "Hardware Requirements", "Wiring Diagram", "Part 3: Data Collection", "Code Skeleton", "Part 4: IOT Integration", "ESP32 Code Skeleton", "RTIME Code", "Code Test (Pre-modification)", and "ESP32 Code Modification". Below the table of contents, there are two sections labeled "Hints": "Installing Arduino IDE" and "Installing ESP Board in Arduino IDE (1)". A yellow highlight is placed over the text "The ability to follow instructions + The ability to find solutions and solve problems" which is positioned over the "Hints" section.

Table of Contents

Contents

Part 1: Software Setup

Installing Arduino IDE

Installing ESP Board in Arduino IDE (1)

Flashing Uploader Plugin (2)

Installing Libraries

Part 2: Hardware Setup

Hardware Requirements

Wiring Diagram

Part 3: Data Collection

Code Skeleton

Part 4: IOT Integration

ESP32 Code Skeleton

RTIME Code

Code Test (Pre-modification)

ESP32 Code Modification

Part 1: Software Setup

Installing Arduino IDE

Hints

Installing ESP Board in Arduino IDE (1)

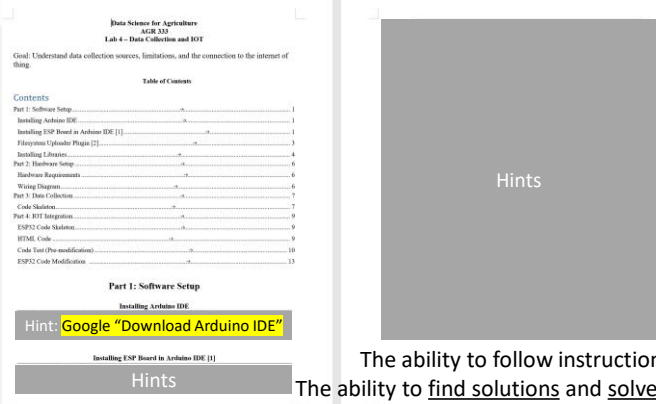
Hints

The ability to follow instructions +
The ability to find solutions and solve problems

For example, by default, we could hide all the step-by-step instructions, so that they serve as hints if the student gets stuck somewhere. The titles now will be the tasks for the students to solve on their own.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Hide hints by default



The image shows a side-by-side comparison of a lab document and a hints panel. The lab document on the left is titled "Data Science for Agriculture" and "Lab 4 - Data Collection and IOT". It includes a goal, a table of contents, and a section for "Part 1: Software Setup" with a hint to "Google 'Download Arduino IDE'". The hints panel on the right is a gray box with the word "Hints" in the center. Below the hints panel, text reads: "The ability to follow instructions + The ability to find solutions and solve problems".

Data Science for Agriculture
AGR 333
Lab 4 - Data Collection and IOT

Goal: Understand data collection sources, limitations, and the connection to the internet of things.

Table of Contents

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Wiring Diagram	6
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Part 4: IOT Integration	9
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Code Test (Pre-modification)	10
ESP32 Code Modification	13

Part 1: Software Setup

Installing Arduino IDE

Hint: Google "Download Arduino IDE"

Installing ESP Board in Arduino IDE (1)

Hints

The ability to follow instructions +
The ability to find solutions and solve problems

If necessary, we can give a simpler version of the hint for free.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Hide hints by default

My remaining points: 500

Data Science for Agriculture
week 333
Lab 4 - Data Collection and IoT

Goal: Understand data collection sources, limitations, and the connection to the internet of things.

Table of Contents

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Part 1: Software Setup	1
Installing Arduino IDE	1
Installing ESP Board in Arduino IDE (1)	1
Flashtool Uploader Plugin (2)	3
Installing Libraries	4
Part 2: Hardware Setup	6
Hardware Requirements	6
Wiring Diagram	6
Part 3: Data Collection	7
Code Skeleton	7
Part 4: IoT Integration	9
ESP32 Code Skeleton	9
RTIME Code	9
Code Test (Pre-modification)	10
ESP32 Code Modification	13

Part 1: Software Setup

Installing Arduino IDE

Unlock with 3 points Hints

Installing ESP Board in Arduino IDE (1)

Unlock with 2 points Hints

Illusional scarcity: by allowed # of hints or the point system

Unlock with 10 points Hints

The ability to follow instructions +
The ability to find solutions and solve problems

We can further encourage students to work on these tasks independently, by creating an “illusional scarcity” feeling for the hints. Here, students can use the limited amount of points they have earned to unlock more hints.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Automated performance evaluation

The screenshot displays a game interface with a 'Unlocked hints' section. Below it, a file explorer window is open, showing a directory structure. A blue box highlights a specific file, and a yellow box contains the text '(Partially) Automated check point'. To the right, another window shows a list of files with a red box highlighting a specific entry. A blue box above this window contains the text 'Checkpoint-1: Pass this check point to get 5 points.' Below the file explorer, a section titled 'Installing Libraries' is visible, with a yellow box containing the text 'Unlock with 1 points Hints'.

Another key feature we need is automated performance evaluation. In this example, we want to make sure a plugin is correctly installed. If so, the student passes the test and gets some points.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Assignments – Automated performance evaluation

Unlock hints

Checkpoint-1: Pass this check point to get 5 points.

confirm things are correct. []

Or

Run this script and copy the output below (more instructions):

Unlock with 1 points Hints

(Partially) Automated check point

Copy the output here

Submit

We could ask the student to either (i) check manually and get the point by confirming things are right, or (ii) run a check script locally and upload the results. AI may play a key role here to provide real-time feedback along with the performance evaluation results.

Tailoring game design techniques for AGR 333 - Data Science for Agriculture

- Rough guidelines
 - The “flow” state
 - Huge amount of content for all levels with progress control and rewards
- Actionable items
 - Expanding content
 - Skill tree
 - Point system

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In summary, the skill tree is an extremely natural way of progress monitoring and control. The flexibility provided by it is just beyond imagination.

We can even apply it out of a course, for example, for other things like major selection, degree requirements, even for explaining key roles of the department or university.

Institute-level support

- Procedures to streamline proposing, testing, promoting better practices
 - Student performance before and after taking different versions of the same the course
- Individual rewards for confirmed better, mimicable practices
- Expert support
 - Professors, game designers, visual artists, programmers, ...

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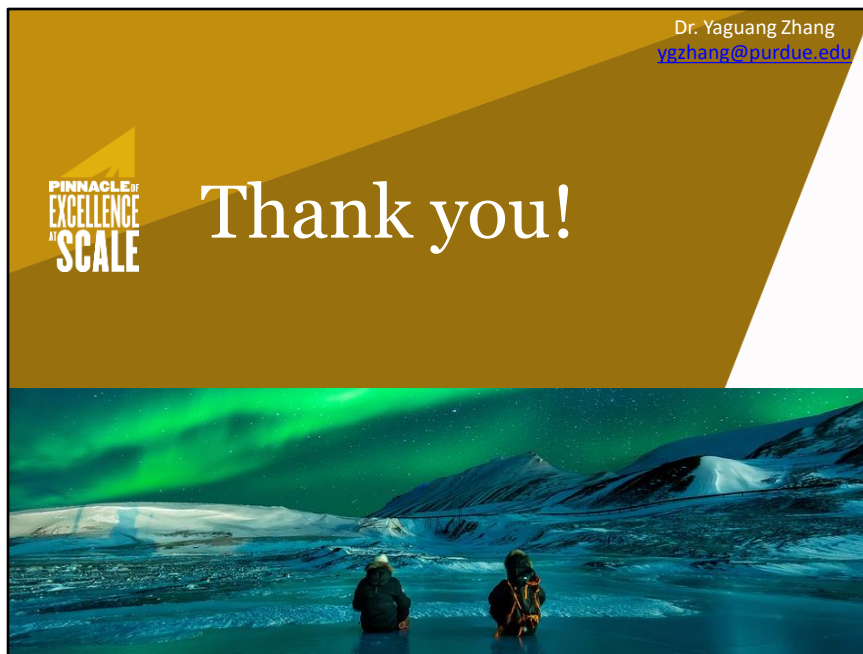
At last, as we have mentioned before, it will be great if we have procedures at the institute level to support proposing, testing, promoting better practices in online teaching.

Essentially, nobody can guarantee new techniques will work, even those proposed here. We need a strict evaluation system to objectively score the effects.

For example, we could check the long-term performance of the students. A good course should be able to improve their performance out of that course.

We also need more incentives for pioneering educators.

And as much support as possible from other experts, if we are serious about competing with online entertainment.



To me, this is the perfect time to start this conversation, because the past five years witnesses tremendous changes in education. Online education became popular about one decade ago. Then the pandemic really push it to the center of main stage, with more tools and companies appearing to support it. Last year, the sudden success of ChatGPT shows the urgency of improving online education to its next level.

I am very excited about this, because I can literally feel we are standing at the boarder or limit of the online education. In front of us, is the vast uncharted land for us to explore. But at the same time, I am a little scared, too, again because of the unknown. It almost feels like I will head into the darkness. That is why I chose the song, Hey Jude, as the live performance early today. To encourage myself, and anyone who are interested, to start the journey.

That is all I'd like to cover today. I hope you have enjoyed the seminar. Thank you very much.

The past five years witnessed... Pandemic. Online by force. ChatGPT.

What we can learn from other players in the entertainment industry, for example, freelancer content creators.

That is all we would like to cover today.

It seems we still have a few minutes left. Do we have more questions?

Tailored game design techniques in this talk

- Motivation:
 - Tell stories/Be personal
 - Take advantage of interesting topics
 - Rewards
- Training approach:
 - Repeated exposures to key ideas
 - Incremental in small steps
 - Visual hints

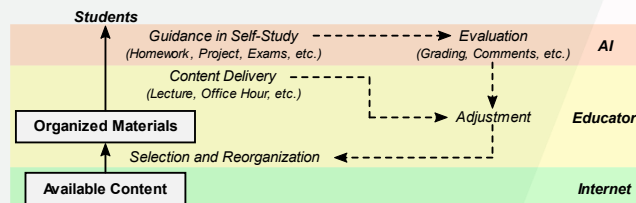
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Be different. Show the passion.

Tailoring game design techniques: Opportunities and challenges

- Reusability
 - Create high-quality content once
- Evaluation automation
 - Ideally with feedback
 - Easier for coding assignments



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Selected game design techniques

- Flow (as a rough guideline)
 - Progress control
 - Challenges
- **Intuitive visual hints**
 - Make the learning experience effortless
 - Reduce effort/cost in fetching study materials

13
3

"Let's be do
whatever we can to
make games fun!"

I would like to highlight again that modern game design is a mature industry. They use everything they know of to achieve their goal.

As a results, you can always expect to observe a mixture of techniques.

Not “gamifying” ...

More like “sugar coating”

- Provide positive feedback on the side
 - Out of the “learning” process
- Decrease the operations that may hurt the motivation
 - Reduce cost in information fetching

- Example pay-as-you-go program framework
 - For a specific program, we could pre-define a few skills we want to teach. They would serve as module (tree node) groups.
 - Then, we could add relevant online courses into each module group to teach the corresponding skill.
 - Courses can be purchased and studied individually (hence, "pay as you go").
 - The key is that, for each course, we could list alternative versions/flavors of the same course, e.g., with different years, instructors, and/or teaching materials, so that students have the opportunity to customize the program by selecting their preferred versions.
 - We could have one or two free-trial lectures in each course to facilitate the decision.
 - We could also design a course evaluation system for participating students to comment on/rate courses that they finished.

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Empty/template slide.

- Benefits of this framework
 - Motivating professors to contribute to online education
 - We could distribute part of the profit from a course to its instructor as an incentive, ideally as a percentage of the profit rather than a fixed base amount.
 - If a star professor becomes rich from their online courses, that will be a great example for us to brag about to persuade other professors to participate.
 - Granting students the option of choosing from different flavors of the same course would promote healthy competition among instructors.
 - Instructors who participate early (e.g., when their courses are essentially the only options) or who can provide higher-quality teaching (e.g., to win the market against multiple competing versions of the same course) will earn the most money.

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Empty/template slide.

- A student-oriented course evaluation system
 - The same student performance evaluations (e.g., exams) could be used in the different versions of the same course.
 - Courses with the best student performance => Potential sources for better practices in online education
 - Easy feedback from market/students (Ref: Amazon.com)
 - Most profitable courses, or highly-rated courses with positive comments => Potential versions to promote
- Motivating students to progress in courses
 - We could allow students to buy new courses with points they earn from completed courses.
 - This would increase the "illusional scarcity" of points to better motivate students to progress in purchased courses.
 - We could use other virtual currencies we come up with for this purpose, so that students are still willing to spend points for less valuable resources like hints.
 - The average amount of virtual currency a student can get needs to be carefully planned for the trade-off between student motivation and program profit.

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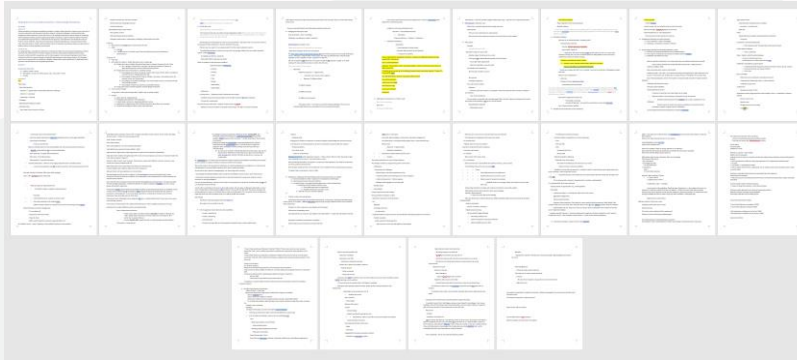
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- More flexible payment
 - (Traditional) One-time payment plan
 - Wholesale price for all required courses to get a degree/finish a program should be cheaper than other options, even with the virtual currency considered.
 - (Pay-as-you-go) Buy and take courses one by one
 - A program could enforce an "expiration date" of a course certificate if the student wants to use that for a degree/to complete that program.

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22 pages of outline



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