



Reimagining STEM Education through Beauty, Critical Thinking, and Disruptive Innovation

SPEAKERS

Tierney King, Mays Imad, Michael Rust, Barbara Jacoby

Tierney King 00:01

This is the Faculty Focus Live podcast sponsored by the Teaching Professor Online Conference, where you can join us from the comfort of your own home, and transform how you teach and how your students learn. I'm your host, Tierney King, and I'm here to bring you inspiration, energy, and creative strategies that you can utilize in your everyday teaching. As a stem educator, how can you reimagine STEM education through a humanities lens? How can you use disruptive innovation to help students think more critically? And how can you teach critical reflection skills in an engineering or math course? In this episode, we'll address all of these questions and more. To start Mays Imad explains how using a teaching journal and student journal made her realize that her students want to see the beauty of what her course had to offer.

Mays Imad 00:54

And so I teach a series of STEM courses. And in my teaching, I do a lot of reflective learning. And so I do a lot of journaling. And the journaling is both for the students and for the teacher. And so what I mean by that is the journaling, so I give the students reflective learning, so they follow a rubric. And I ask the students to keep a learning journal to document their learning experience. And the students follow a rubric. And so I read their journals, and it's going to be online. So I will read their online journals. And in addition, I have a teaching journal that I post online, and the students students can read my teaching journals, and what I'm trying to convey to the students is that learning is done not in a vacuum, we want to integrate, we want to incorporate we want to explore what we know and connect it what we want to know and what we've learned before. And so I do a lot of that modeling through my teaching, by having a look at a teaching journal. And then I ask the students to share their their learning journals. I want to show you examples of what students wrote in their learning journal. Now, keep in mind that those learning journals are meant to be about the topic that we're studying. And what I found over the years, there's this theme of being disenchanted, if you will, whereas the student that wrote in her learning journal, "I wish we could talk about the news in the classroom." When I spoke with the student, the students said, "You know, it just feels that we're asked to leave everything behind when we walk into the classrooms. And I'm sitting in the classroom, and I keep thinking about what happened last night, and things that impact my community. And I can't concentrate." Another student wrote, "I feel I am attending school for robotic education. It feels suffocating and so far removed from the real world, there is no spontaneity nor beauty." Now, when I took the second quote, I saw a lot about it, I reflected

on it. And I asked one of my colleagues actually in the break room, and I said, "Do your students want to learn about beauty? And do they want spontaneity?" There was that reflexive reply that, "No, they just want an A." And I would do actually a research where I would asked students about certain things, and I asked faculty to see how aligned they were. And the fact of the matter is, they were not aligned, right? And so there was that reflexive that students want to get an A and go to medical school and get a job, as if it was mutually exclusive, as if that didn't mean that they also want to learn about beauty and the world around them. And here's the third quote, where the student says, "Life can be how hard. Life can be on on you some days, and how drab and dull the world feels without passion. I wish my teachers knew just how badly some people struggle with the weight of the work and the world as they try to wiggle their way through the tight and unrelenting cookie cutter format of the educational system." And again, this left me thinking about passion and how often do we impart passion for the subject from the profession to our students. So the questions that I was left with is what do I think students want from their education? And what do I hope that they want from their education? And the most important question is really what do they actually want? That is, how can I ensure that my perception of what students want out of their education aligns with what students actually want?

Tierney King 05:29

So we touched on reimagining STEM education through a humanities lens, but what about integrating students skills such as critical reflection into your STEM course? In this program, Barbara Jacoby explains how you can use four basic modes of reflection and integrate it into any STEM related course.

Barbara Jacoby 05:48

So as we look a little deeper at critical reflection in STEM, in the next few minutes, I'd like for you to keep this reflection question in mind: So what is a missed opportunity for student learning that has occurred in the course of teaching one or more of your courses? What is it that students just didn't get? So there are four basic modes of reflection. There's telling or speaking, the oral modes, writing, activities, and media. Let's look a little bit closer at those. So telling/speaking can take many forms, things like focus groups, structured dialogues, the obvious class discussions and presentations. But for presentations, I'll give you an example from the course that I teach. I have my students each teach a class. So each student provides a thought leadership for a particular topic. So they really take ownership of that topic. And I give them a set of reflection questions by which they consider what are the key elements of whatever their particular topic is that they are going to present. So there's the teaching a class, preparing real or mock testimony, engaging in debate or deliberation, debate is arguing as as we know, to defeat your opponent, you present your best thinking, you you attack your opponent's arguments, and the goal is to win in deliberation, we submit our best thinking to improve it, we try to seek a common ground and together to come to the best solution. But the both of these are terrific forms of reflection, oral reflection, and work very, very well in the STEM disciplines. Writing is often the most common means of reflection in the context of academic courses, journals and logs, certainly very effective in STEM, problem analysis, case study, portfolios, essays, press releases, drafting real or mock legislation, and writing letters to politicians or letters to the editor, letters to oneself, sometimes can be really excellent examples of reflection, that can sometimes also lead to civic action. Let me give you two examples of how writing can play out in math, a STEM discipline that faculty colleagues both on my campus and others say, this really isn't part of math, is it? Well, it can be. So in a math course, let's say students learn the mathematics of how the lottery works, why it's nearly

impossible to win. And then they can draft a letter to the editor or to a politician, if gambling as it is in my state is on the ballot coming right up. And then what is the economic damage that that gambling can cause. And again, that goes back to the mathematics it brings the mathematics alive, and puts it into a social context, it makes it relevant for students. Reflection also can be done in inside the class activities. Students can work in teams and problem based learning, which is sort of the more intellectual cousin of case study. So here's an example that students could grapple with in a range of disciplines as far as in a situation of problem based learning. How should sustainability and economic development be balanced in developing countries, so students can work in teams to address the issue. They would figure out what information they have, what information they need in order to deal with the issue, and where they can obtain high quality information that would lead to coming up with potential solutions. Certainly things like interviews. And then I'll give you a couple of examples that I often use is roleplays. A former simulation students are given a scenario in which individuals have different perspectives on the situation. Here's an example from engineering, which would be terrific preparation before students would actually get into the process in this case of designing a playground for a neighborhood. So students in the roleplay, who would be about to embark on this enterprise, the players might be children, parents, older neighbors, elected official school personnel, police officers, owners, those local businesses. And so the students would enact the roleplay. And afterwards, they would critique how well the situation was handled, again, in preparation for going into a neighborhood to actually design and build a playground. Then there's the forced choice exercise, which is one of my favorites. I'll give you an example from an IT coursework. So we take a controversial statement in the field, all of our fields have them. So here's one from IT: the ability of the availability of information justifies its use. The availability of information justifies its use. So in a forced choice exercise, the students would have to stand up, get out of their chairs, they would move to one side of the room, if they agree with that statement, and move to the other side if they disagree. Of course, they want to stay in the middle, but you won't let them. And then each side formulates their arguments as to why they selected the side of the issue that they did. And they choose a spokesperson or spokespersons, they then try to convince the students on the other side across the room and join their group. So you can do this iteratively a couple of times, and then the students can eventually, you know be rooted in their positions. And they can reflect on the process of going through the deliberation and the persuasion, again, skills that are very useful for professionals in STEM fields.

Tierney King 12:04

In addition to these critical reflection skills, Michael Rust explains how a disruptive innovation assignment can help students think more critically, and how students can apply these tools to their future jobs.

Michael Rust 12:16

When we think about the way that we train our students, we want them to be connecting with customers, we want them to be able to understand what customer's needs really are, so that when they develop solutions, those solutions can be impactful, not just novel. So disruptive innovation is one way that we can go about doing that. First a little bit of terminology. What do we mean by disruptive innovations, disruptive solutions. I think oftentimes, disruptive innovation is used as a buzzword, and it might be overused. But when used correctly, it can be a very powerful term and influence in our

economy. A disruptive product is usually a solution that's cheaper, almost as good as existing solutions, and serves a group of customers that perhaps larger companies have ignored over time.

Tierney King 13:01

Here, Rust explains how the assignment works, and specific assignments you can use with your students in the form of a deliverable.

Michael Rust 13:09

The goal of this activity that I'm about to have you go through is to really think about how you can now apply them to a product or service or industry to disrupt it. And this is something that I often do with my students. And so I'd like you to try this out now. So the idea here is to pick a product or service or an industry that you would like to disrupt, I'll give you a few starters. And you can also come up with your own and it's sort of a wildcard format. So you could choose to disrupt the example I just mentioned of a smartphone, you could try to disrupt beauty salons or maybe emergency medicine in ambulances, or maybe medical imaging centers. Could you disrupt the automotive industry or college university degrees, or again, disrupt something that you're passionate about from your own work. So start by picking your product or service or industry that you'd like to disrupt. You'll see that there's an opportunity to identify different customer types, look at their specific features and needs, and then start brainstorming for solutions to disrupt this product, industry or service. You can then choose from among those different prototypes or solutions to ultimately pick one that you'd like to move forward with that could form the backbone of a startup company or a new product that could be launched. The way that I use that is with my students is to often give them a lecture on disruptive innovation, so that they have a little bit of an idea of, you know, historical examples of disruption, as well as some of the language and terminology that's used here. And then I use that handout to guide the students through this activity where they develop ideas. Maybe they start from scratch, or maybe this is part of an ongoing project in which this allows them to just sort of think through different customer types before moving into actual prototyping. And then you can think about how you might want to wrap this up with your students in the form of a deliverable, right because they have an elevator pitch competition in which they actually pitch back to the class, here are the different ideas that we came up with, and then you can have the class vote and crowdsource the solution to see who actually won the competition. Or maybe you can have your students work on a technical report where they communicate back the ideas that you've developed. And again, maybe you have enough time to actually move forward and develop these projects. Maybe this is just a one off activity in a class. It could actually be the front end for design projects if you have that in your teaching portfolio.

Tierney King 15:26

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