TRANSCRIPT

Hello, and welcome to Designing STEAM Activities. My name is Matt Gottilla. I have taught STEAM in Morris Plains, New Jersey for the last three years where I was fortunate enough to develop the curriculum, and all of the lessons, and activities for that program.

I currently live in San Diego, California, and I'll be teaching at High Tech Middle Mesa beginning in August, something I'm really excited about. You can reach me at matt@gamifyeducation.com, or follow me on Twitter @mrgottilla to see some STEAM in action. A quick note that I wanted to make is that during this presentation, whenever I talk about a class period, I'm referring to a 40 minute block of time.

I thought it would make sense to start out by defining STEAM. I realize that most people that signed up for this conference probably know what it stands for, but I wanted to go beyond that acronym a little bit into some of the deeper meaning behind STEAM. STEAM, to me, is an instructional philosophy, and it's really categorized by discovery, creativity, experimentation, and a lot of cross-curricular application of knowledge.

I found a quote by author Brian Aspinall that I think sums up the spirit of STEAM quite nicely. He says, 'I no longer cover curriculum, but prefer to have students uncover it through authentic tasks.' I think that's really the goal of STEAM in general.

So, what does authentic STEAM look like? I think it's easiest to understand if we can compare, and contrast it with what I would consider to be inauthentic STEAM. So in authentic STEAM, students will engineer unique solutions to challenges through an iterative design process, meaning that they'll brainstorm, they'll come up with a plan, and then through testing, and refinement, they'll continue to improve that solution.

By the end of the STEAM activity, all of your students will likely have something that looks at least a little bit different from their classmates, if not, is a completely unique, and individual creation. In an inauthentic STEAM activity, students will assemble a product, or a solution through some sort of a step-by-step guide, or by using a very limited number of materials, and all of the products will end up looking essentially the same, because there really wasn't much student innovation involved.

Authentic STEAM requires students to apply knowledge, and skills from across different disciplines to solve whatever the challenge is that they're being presented with. In inauthentic STEAM, again, there's really not much of a challenge for the students, and not much of a chance for them to apply their innovation, their creativity, and the design process. They're more, or less assembling something that is fairly trivial, rather than applying deeper knowledge, and understanding.

In authentic STEAM activities, the real focus is on the process. What do you want your students to get from this activity, and how are they going to get there? You want to really make sure that the experience they're getting, the knowledge that they are learning, and then applying, and the skills that they're using are those things that you're targeting.

In inauthentic STEAM, the focus is often just on the final product, and almost to a point where sometimes final products that are a little bit more showy are given preference over products that would require students to apply, and learn more skills. So, the authentic STEAM, again, would focus more on that process, while the inauthentic STEAM would really be focused solely on the product.

One other difference between authentic, and inauthentic STEAM is that in a real STEAM activity, students are going to use evidence-based thinking, and create their designs, and solutions based on data, on testing, on improvements that they come up with on research, and understanding of the concepts that they're applying.

In inauthentic STEAM however, oftentimes it'll be sort of a fly by the seat of their pants operation. They'll randomly choose a design, or they won't have a rationale that they can express to you in terms of evidence-based thinking. So, why incorporate STEAM activities at all? Here are three good reasons that I came up with.

The first is that it's going to provide your students with a meaningful way to incorporate, and transfer knowledge beyond its original context. Here's an example of a group that is applying knowledge about electricity, and circuit building to create an intruder alarm. In the video clip you're about to see, they're using their knowledge of electricity to display a pressure plate intruder alarm built into a model room that they've designed. [inaudible 00:05:42]

Another good reason to incorporate STEAM activities is that they boost student engagement, and enthusiasm. And the clip I'm going to show you next, students had been designing their own mortar after doing a material analysis. They then use that mortar to build walls, and we were testing how strong their mortar mixture, and construction was by hitting their walls with a wrecking ball. [inaudible 00:06:24]

And the third reason I think that you should incorporate STEAM activities into your class is that they're going to help students learn a lot of important skills, sometimes called 'Soft Skills' like problem solving, collaboration, conflict resolution, critical thinking, and project management.

Here are two students showing off their bridge design that they'd been working hard on, and they actually achieved a remarkably strong bridge using very simple materials, such as note cards, and scotch tape.

So, when you're ready to get started with your STEAM activity, I have a little bit of advice to help you figure out what you'd like to do. The first thing you'll need to decide is what lesson, or topic you are designing this activity for.

You can use a top down approach, or a bottom up approach. Maybe you've got a great project, and you're figuring out ways that you can build some of the concepts into that project that you're trying to incorporate, or the other way around. If you have some really awesome concepts that you're excited to teach your students about, you can take those concepts, and build up to a project from there.

A few resources that I've found to be helpful in my time teaching STEAM include: Teachengineering.org, and Eie.org. The first has a lot of lesson plans that they've already put together that are aligned to standards, and Eie.org, which stands for Engineering is Elementary, not only has lesson plans that are standards aligned, but they also have complete STEAM units that you can use.

They even sell the materials for all of those along with a story that goes along with each project, and a great teachers guide to help you along. Lastly, I frequently will just do a Google search for the topic I want, STEM, or STEAM, and see if I can get some inspiration from what comes up, just searching on the internet, and that can be a great way to get some new project ideas.

I've also included a couple of books that I've found to be really helpful. The first one is the Big Book of Makerspace Projects, and the second is STEM Labs for Middle Grades. I'll talk a little bit more about those at the end of this presentation in the resource roundup, and I'll include a link to the Amazon.com page for each of those books.

So when you're designing your activity, I think it's best to begin with a problem, or challenge that you are going to provide to the students, and this problem, or challenge should require them to apply the knowledge, or the content that is the goal for your STEAM activity. So, let me share a few of those problems, and challenges that I use with my students.

One of the examples from my classes, again, with the grade that is focused a lot on electricity, and electrical engineering is to construct a working flashlight with a switch using household items.

So, there are a few different aspects to that challenge, and in putting together that flashlight, they have to demonstrate that they have an understanding of how circuits work, the ways that a switch is able to open, and close a circuit, and they have to be pretty innovative in applying items that wouldn't normally be part of a flashlight based on whether they're conductors, or insulators to come up with their own version of a homemade flashlight.

Another challenge that I use with my students is, I have them develop a table entirely out of newspaper that can hold the weight of at least one textbook, and we've had a lot of success with this challenge. It does require students to attach thing at the proper angles, include supports, and use their materials wisely.

We've actually had students hold upwards of 20 textbooks on a newspaper table with as few as 15 sheets of newspaper. Another challenge, and this one is directly from the Engineering is Elementary website is, can you design a lighting system to illuminate the hieroglyphs in a model tomb?

And this one really helps students understand how light travels, the angles at which it reflects, and refracts, and it has them work through the engineering design process to create their own lighting system to illuminate those hieroglyphs.

Another one that I use is a Wiggle Bot challenge. A Wiggle Bot is a little tiny robot that is powered by a motor, and an off balance gear, and the hardest part of this challenge is they have to get their Wiggle Bot to move in a more, or less straight path, and we race them down a one meter course.

Go! [inaudible 00:11:56] So, the next thing I'd like to talk to you about is the engineering design process. This is really the structure that I use to form all of my STEAM activities. I find it to be not only helpful in guiding the students through their creations, their solutions, but also in structuring my classes for these activities.

So, the version, or the definition of the engineering design process that I like to use best really has seven different steps to it, and one thing I'll say ahead of time is, this is an iterative process, and it does not have to be linear. It does not have to go in order all the time.

So, often you will go back to previous steps, you'll go through the entire process again, but these steps each will help you in understanding what students are working on at various parts of the process. So, we start out with ask.

In the ask step, they're going to do some research, make sure they fully understand the problem at hand, and do any experiments they might need to do to have a better understanding of the knowledge that will help them solve the challenge.

In the imagine stage, that's when students will start to brainstorm. You'll try, and have them come up with as many ideas as possible. I often have them brainstorm individually, and then come together with their group to discuss their different ideas, and they try to learn from each idea, compare them, figure out maybe ways that some are better than others, or ways they can be combined to make an even better idea.

After they imagine, they plan. At this stage, they're going to create a labeled diagram of their plan. I also often will have them record any measurements, and material lists for the solution that they're going to build. Once they have that plan, and only once they have that plan, you'll have them create.

So, this is where they're going to take what they've come up with, and make it real, they'll gather their materials, and they will build it. After they create, it's time to test their solution, and when they're testing, it's really important that they record their results, and they analyze their solution after the testing, especially if they've tested to failure.

This is a great way to figure out the weaknesses of their design, and hone in on some areas for the next step of the engineering design process, which is improve. At this point, they will come up with an improved design. Usually this will mean getting new materials, as they may have destroyed, or weakened their original design in testing, and they're going to try to make a better solution to the challenge.

Once they've come up with a solution that they are fully satisfied with, it is time for them to share with their peers. So, I end every single STEAM activity that I do with a presentation from all of the groups to their classmates where they'll reflect on their process, and they'll share not only the results, but what they learned, and the different parts of their process with their classmates.

So, once you have your STEAM activity in mind, there are a few things that you'll want to check to make sure that you are on the right track to have a successful STEAM activity. The first, and a very important one is to check to make sure you are including the knowledge that you want students to be gaining, or applying in the STEAM activity.

Be really intentional with this. If there's something that you want them to get out of it, make sure that you are asking them about that, providing them with opportunities to record information about it, and to apply that.

You also want to check to make sure you have all the materials necessary, and in fact, I would definitely recommend having more than the amount of materials you will need, because materials tend to get lost, or break, and you don't want to have a hiccup in your STEAM challenge, because you don't have enough rubber bands left, since too many of them broke during your first class.

Also make sure that you have any necessary safety gear if they're going to be doing something that might be dangerous, or require safety gear, make sure you take care of that ahead of time. Another thing that you'll want to think about are the constraints on your project.

I recommend having a wide range of materials for students to use during these STEAM activities. That will allow them to be really creative, and innovative, but oftentimes you will have to have some sort of constraint on that project, and I've given you a few different ones to consider here, and they're each good in their own way.

So, one that I really enjoy doing is budgetary constraints. I will often set up a little STEAM shop, I will lay out all the materials, I'll have a price list, and they are restricted by how much money they can spend, and oftentimes you can factor that into the scoring of their solution where a lower cost will help them achieve a higher score on the solution that they've come up with.

Another type of constraint would be a same materials constraint. This one works best for a flash STEAM activity, maybe a one class activity. This might be where you have six brown paper bags, and you fill them all up with the same exact materials, pass them out to the students at the beginning of class, and you give them a challenge to achieve with those materials, and you see what they can come up with.

Another one is a material number constraint. So, if you are building a STEAM activity based on the ability to lift a certain amount of weight for example, and one of your materials is really strong, you might want to limit the amount of that material students can use, so they have to be a little bit more creative in their engineering to meet the goal.

Another constraint that you might consider is a weight constraint. So, recently I did a great Teachergeek.com STEAM activity called 'Hydraulic Judo Bots', and in this activity, we then had the hydraulic judo bots battle it out against each other in the judo bot arena, and there was a weight constraint on that challenge.

This is to prevent students from just adding a tremendous amount of weight to their box, so that they can never be knocked over, or moved out of the arena. A similar constraint might be a size constraint. You could have either a minimum, or a maximum size depending on the challenge.

For that newspaper challenge, I had a minimum height for the newspaper table, but you can certainly have that constraint on either, or both ends of the size, and finally, if you want to really encourage creativity, try a challenge with no constraints within reason, and give students really free rein of the materials that they would like to use for your STEAM activity.

So, now that you've completely planned out your STEAM activity, when you're ready to start, one thing that's truly important is, you want to make sure that you're defining the problem very clearly for the students, as well as giving them the criteria for success.

Definitely start them off with a firm understanding of what they're trying to achieve, that will set everybody up for the best possible results. One thing that I'll mention here, and talk a little bit more about later is that the criteria for success for their solution isn't necessarily the only thing that you are grading them on.

There's a lot of other things in the process that they can also be graded on, and I'll go into a little more detail about that later. Before you start your STEAM activity, sometimes it may be necessary to teach some preliminary lessons if there's certain foundational knowledge, or skills that your students will need, and then you'll also want to figure out the groupings.

Most STEAM activities really do work best in a collaborative setting. I've found that for a lot of these team activities, the ideal size is between two, and four students, and you'll want to use some different grouping strategies throughout the year so that students have a chance to work with different peers on different activities.

I know that I mentioned the engineering design process earlier, so I won't go as all the details again, but this is really how I structure the classes for the activity. Day one, we'll often work on that ask part of the engineering design process, and students will usually get a chance to start brainstorming some ideas for solutions.

During the next class, they will plan out the design that they are going to be building. I usually require them to provide me with a labeled diagram before they are able to start creating.

One thing I will do is put out the materials so that they can at least go look at them, see how they might work together, maybe make any measurements they need to make, but I will ask that they don't actually start building with those materials until they've shown me their completed plan, and then after they do have that completed plan, it is time for them to start making.

The create phase can take anywhere from a single class period, to potentially up to a week, or more depending on your activity. That is usually the largest amount of time they're spending on the activity, so you'll want to plan accordingly for that.

Once they have finished creating their solution, it's time for them to test it out, make sure they're recording data about their testing, and they're being really intentional in what they're trying to observe, and figure out from it, and then they'll reflect on their testing, and come up with a way to improve their design.

Oftentimes, I mentioned earlier, they'll get some new materials, make another labeled plan, and create a better version of their solution, and then the most meaningful part of the STEAM activities in my class is always their sharing with their classmates, and peers. So, every STEAM activity I do, for the most part, at least, ends with a presentation from each group to their classmates about what they've accomplished.

Some of the information that I ask them to include is their design, and materials, any problems they faced along the way, solutions that they had to those problems, or improvements that they made, their testing, and results, and what they learned.

Sometimes, I'll ask them additional questions like, 'If you could do this over, what might you do differently?' That's really up to you to figure out what information you would like them to share with their classmates. So, a few tips and tricks that I'd like to leave you with.

The first one is that you can turn a good STEAM challenge into a great STEAM challenge by providing your students with a powerful why, give them meaningful context. I want to talk a little bit about a class challenge I recently did with my sixth graders.

For this activity, some of the electrical understanding they had to demonstrate included, creating a vault that was powered by an electromagnet, and wiring up the doors, to the Borough Bank with an intruder alarm, so that it would go off if someone came in after hours, and it was really rewarding for everyone involved, and that powerful context, and that real challenge helped motivate them to push themselves a lot farther than just putting together a snap circuit.

Another tip that I will give you is that you really want to make sure you give your students the freedom to fail. I think this is so important when you're doing STEAM activities. You want to create an environment where your students are willing to take risks, to be creative, to not know what the outcome is going to be, and to enjoy this whole experience, and discovery.

[inaudible 00:24:28] And finally, I want you to go for it. It doesn't matter if you are not an engineering, or computer science expert. I've learned about most of the activities that I do by watching videos, reading tutorials, and mostly just trying them out for myself.

I think that if you look at it as an opportunity to enjoy learning along with your students, you're going to have a blast. You're going to do some incredible things, and I just want you to take that first step, and dive right in with some STEAM activities.

A couple of resources that I discussed earlier in the presentation: Teachengineering.org, Engineeringiselementary.org. The two books: The Big Book of Makerspace Projects, and Stem Labs for Middle Grades. The links are included in this presentation, which I'll share with you in one moment, and finally, me.

You can access this presentation at any time by going to bit.ly/designingsteam. You can always shoot me an email, Matt@gamifyeducation.com, and you can follow me on Twitter @mrgottilla to see some of STEAM activities in action.

Thank you very much for watching. Your time is valuable, and I really appreciate you for joining for this PD opportunity. I hope that you leave here excited to try some cool things with your students, and I'd love to hear about them. So please, please send me an email, let me know what you're doing. Thank you. Bye.