STEM & STEAM EDUCATION

Facilitator: Heni Gesztelyi-Nagy

Introductions/Housekeeping

- Schedule:
  - Monday, Tuesday, Wednesday, Thursday, Friday
- 1 or 2 breaks a day
- Safe, fun, open learning environment for everybody!
- Wifi Password:

Learning STEM Objectives:

- Identify the key features of STEM and STEAM;
- Define learning objectives that integrate STEM and Art & Design subjects to increase student engagement in learning;
- Connect and relate different subjects through creative STEAM activities, based on real-life and concrete experiences;
- Build an authentic STEAM lesson;
- Trust the importance of play, fun, and engagement in learning;
- Incorporate art and design-related skills into the general learning environment and curriculum.

Know-Wonder-Learn

Discussion Question: *What do you know about STEM and STEAM learning?*

- **Know**: What do you **know** about this topic?
- **Wonder**: What do you **wonder** about this topic?
- **Learn**: What have you **learned** about this topic? (final reflection question)

gnheni@gmail.com

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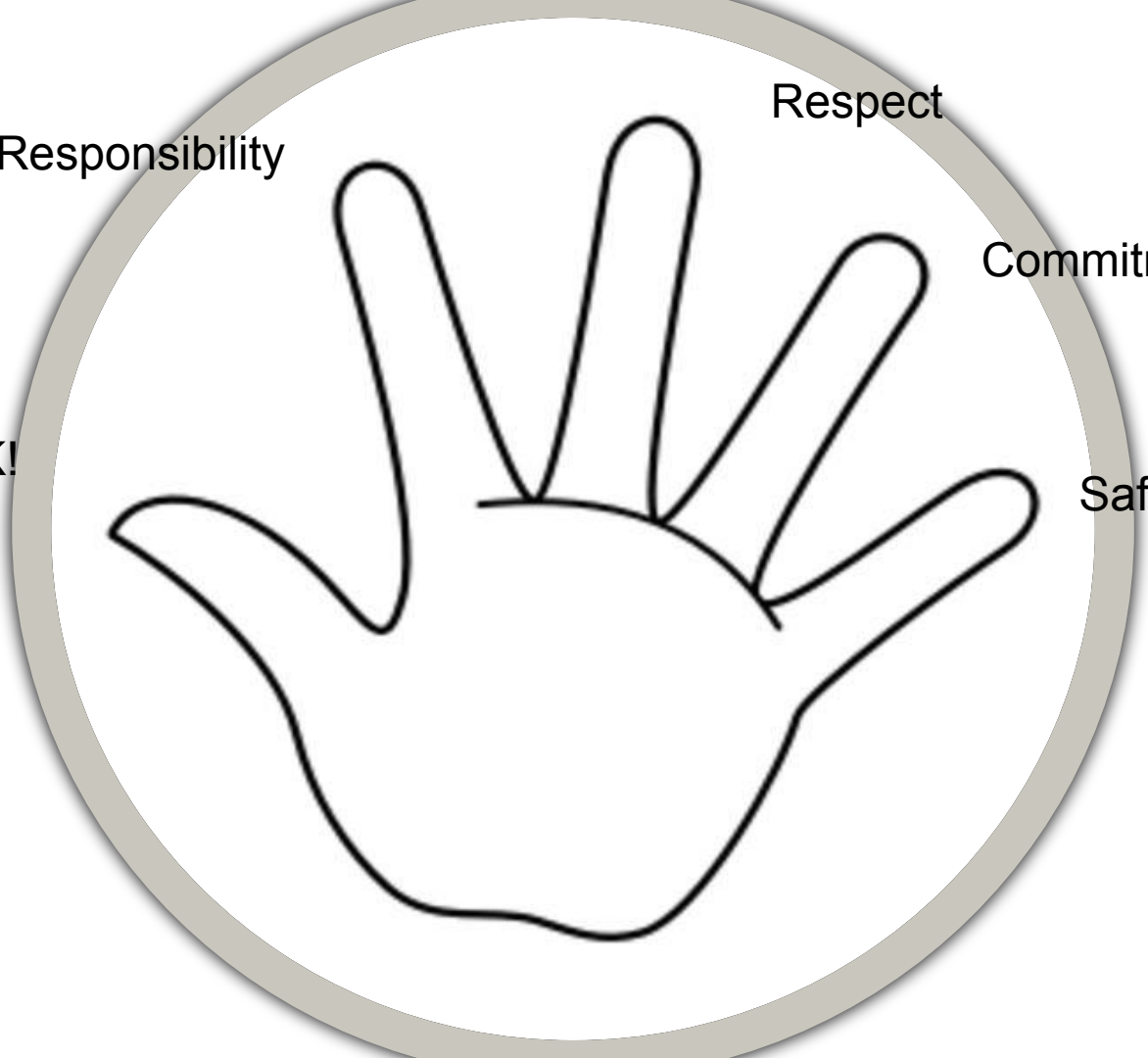

21st Century Educational Skills

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1 Collaborative Problem Solving

- Students learn through solving problems. A great way to learn is by effectively working as a team to solve problems as a cohesive, collaborative unit. Working together toward a common goal is a hallmark of human society. One Stanford study found that participants primed to work collaboratively kept working on a task 64% longer than those working alone. A 21st-century curriculum emphasizes team-based projects in which groups draw on each individual's strengths to solve problems. This model exposes students to new ideas and opposing viewpoints, while demonstrating the power of the collective mind.

2 Creativity

- A 21st-century education affords students opportunities to flex their creative muscles beyond the traditionally creative classes. Whether they work to find a new solution to an old problem or find a different way to explain an everyday occurrence, students are constantly finding their own approaches to problems and projects.

Whatever the next chapter in life brings, creativity is an essential tool to get young minds thinking across disciplines and beyond what's been done before. In fact, one study found that 78% of college-educated professionals say creativity is very important to their career.

3 Hands-On Learning

- Students in a 21st-century skills classroom are not afraid to get their hands dirty. They thrive on translating textbook material into real-life scenarios in which teachers encourage creativity, experimentation, and trial-and-error. A 21st-century curriculum takes hands-on learning beyond the art studio and science lab.

In the middle school English class, students create sock puppets and put on a performance of the short story, Tobermory. A European History class decorates T-shirts to illustrate the narrative of the French Revolution. Hands-on learning brings coursework into the here and now through active, project-based activities.

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4 Cultural Competency

- In our diverse, ever-changing world, it's essential that the 21st-century classroom emphasize cultural competency skills, beyond an appreciation for other cultures. The U.S. Census projects that by 2044, the minority population will increase to more than 50%, and the U.S. population will become majority-minority. In a 21st-century skills classroom, all individuals have the opportunity to interact with students from other backgrounds and participate in culturally immersive experiences. These skills will be critical as students fuel future growth on a global scale.

5 Effective Written and Oral Communication

- Students learn to listen actively, organize and articulate a discussion, present information, and argue points respectfully. Communication skills are not seen as a "given." Effective communication, when speaking and writing, is encouraged and cultivated through activities that challenge students to think beyond their knee-jerk reactions or preconceptions about a topic or problem. Expressing ideas clearly and effectively is essential for success, as one study that shows over 73% of employers look for candidates with strong communication skills.

6 Ethical Decision Making

- You make about 35,000 decisions every day, from the most simple to more complicated choices. A 21st-century curriculum teaches students how to navigate their own decision-making process by considering ethical factors, such as respect, fairness, equality, and kindness. Students explore how seemingly small decisions they make each day have far-reaching effects on others. Character building is a cornerstone of the 21st-century skills classroom.

7 Information and Media Literacy

- Our world is saturated with information. In a 21st-century classroom, students learn how to interpret facts and figures and question the credibility of information published online. A Stanford Graduate School of Education study found that the majority of students in middle school, high school, and college struggle to think critically about online media, including what constitutes fake news. Media and information literacy skills are interdisciplinary in nature and essential for students to learn across all subjects.

8 Leadership

- Today's world needs strong leaders. A 21st-century skills classroom focuses on developing leadership skills related to listening, building consensus, organizing, and motivating a group to action. Students learn what it means to have a responsibility for something beyond themselves. Considering that 47% of managers stepped into their positions without any training, developing leadership skills will pay off significantly as students enter college and the wider world.

9 Critical Thinking

- The 21st-century skills classroom focuses on asking questions to encourage critical thinking, inquiry, and reasoning. In all courses, students evaluate, synthesize, and translate ideas to solve problems and complete projects. Teachers also encourage students to hone their reasoning and inquiry skills. Well-developed thoughts and approaching problems from multiple angles is expected. Students question and analyze information — an increasingly crucial skill — rather than simply memorizing facts and figures.

10 Personal Responsibility and Initiative

- Students in a 21st-century classroom are challenged to take ownership of their learning and dive headfirst into projects on their own. Staying flexible in the face of ever-changing circumstances is a critical skill for success. When an assignment or activity does not go as planned, students are encouraged to demonstrate humility and react to obstacles in a positive, productive way. In our fast-paced society, the ability to adapt to change will always be in high demand.

STEM LEARNING: Definition

A: Science, Technology, Engineering and Maths

B:

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STEM LEARNING: Definition

A: Science, Technology, Engineering and Maths

B: STEM is already in itself an **interdisciplinary way to teach scientific subjects**: instead of having students learn about science, maths and technology **separately**, STEM activities involve them in **complex projects that require the application of skills and knowledge from all of them at once**, which is closer to how they will one day use their abilities in their **real jobs**.

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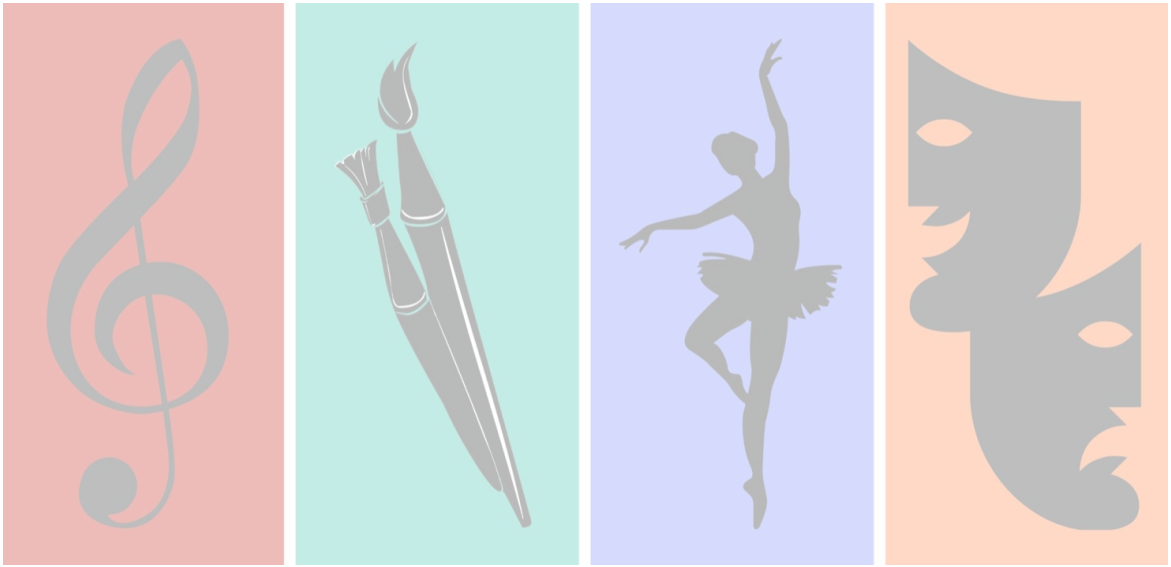
STEM and… STEAM?

“STEAM” represents STEM plus the arts – humanities, language arts, dance, drama, music, visual arts, design and new media. The main difference between STEM and STEAM is **STEM explicitly focuses on scientific concepts**.



REFLECTION:
- Why are the arts important? How could the Arts be used to help facilitate further learning in the other STEM categories?

Reflection:

> "Design is not just what it looks like and feels like. Design is how it works."

Steve Jobs
Former CEO Of Apple, Inc.

WATCH HERE

6 Phases of STEAM

(1) FOCUS

- In this step, we're selecting an essential question to answer or problem to solve. It's important to have a clear focus on both how this question or problem relates to the STEM and the Arts content areas you've chosen.

6 Phases of STEAM

(2) DETAIL

- During the detail phase, you're looking for the elements that are contributing to the problem or question. When you're observing the correlations to other areas or why the problem exists, you begin to unearth a lot of key background information, skills or processes that students already have to address the question.

6 Phases of STEAM

(3) DISCOVERY

- Discovery is all about active research and **intentional teaching**. In this step, students are researching current solutions, as well as what ISN'T working based on the solutions that already exist. As a teacher, you can use this stage to both analyze the gaps your students may have in a skill or process and to teach those skills or processes explicitly.

6 Phases of STEAM

(4) APPLICATION

- This is where the fun happens! After students have dived deep into a problem or question and have analyzed current solutions as well as what still needs addressed, they can begin to create their own solution or composition to the problem. This is where they use the skills, processes and knowledge that were taught in the discovery stage and put them to work.

6 Phases of STEAM

(5) PRESENTATION

- Once students have created their solution or composition, it's time to share it. It's important that the work is presented for feedback and as a way for expression based on a student's own perspective surrounding the question or problem at hand. This is also an important opportunity to facilitate feedback and help students learn how to give and receive input.

6 Phases of STEAM

(6) LINK

- This step is what closes the loop. Students have a chance to reflect on the feedback that was shared and on their own process and skills. Based on that reflection, students are able to revise their work as needed and to produce an even better solution.

6 Phases of STEAM

1 FOCUS

2 DETAIL

3 DISCOVERY

4 APPLICATION

5 PRESENTATION

6 LINK

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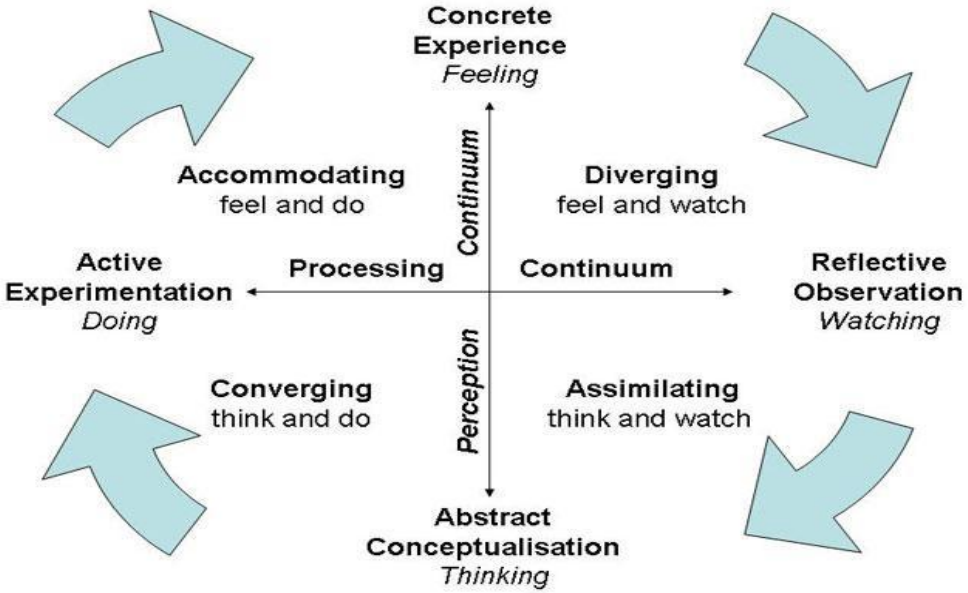
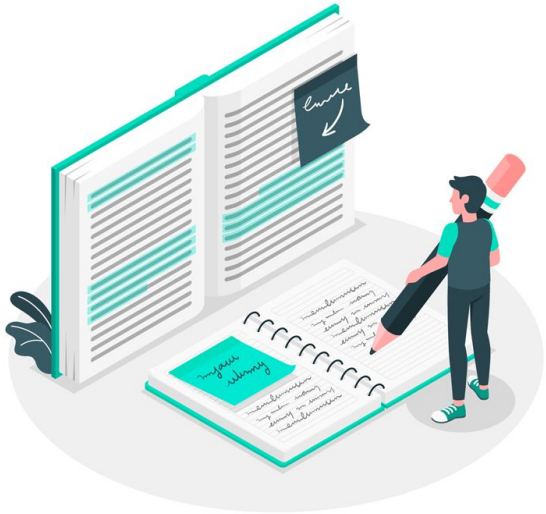
Kolb's Learning Cycle



Design a STEAM Class

1. Reflect on a previous class
2. Take each of the STEAM phases and elaborate how you could apply the STEAM approach, taking Kolb's Learning Cícle into Consideration
3. Reflect, then we will share in the group

Today's summary:



Reflect on the following:

- What's something you've learned today?
- How can you apply it to your classroom?
- Summarize today in one word.

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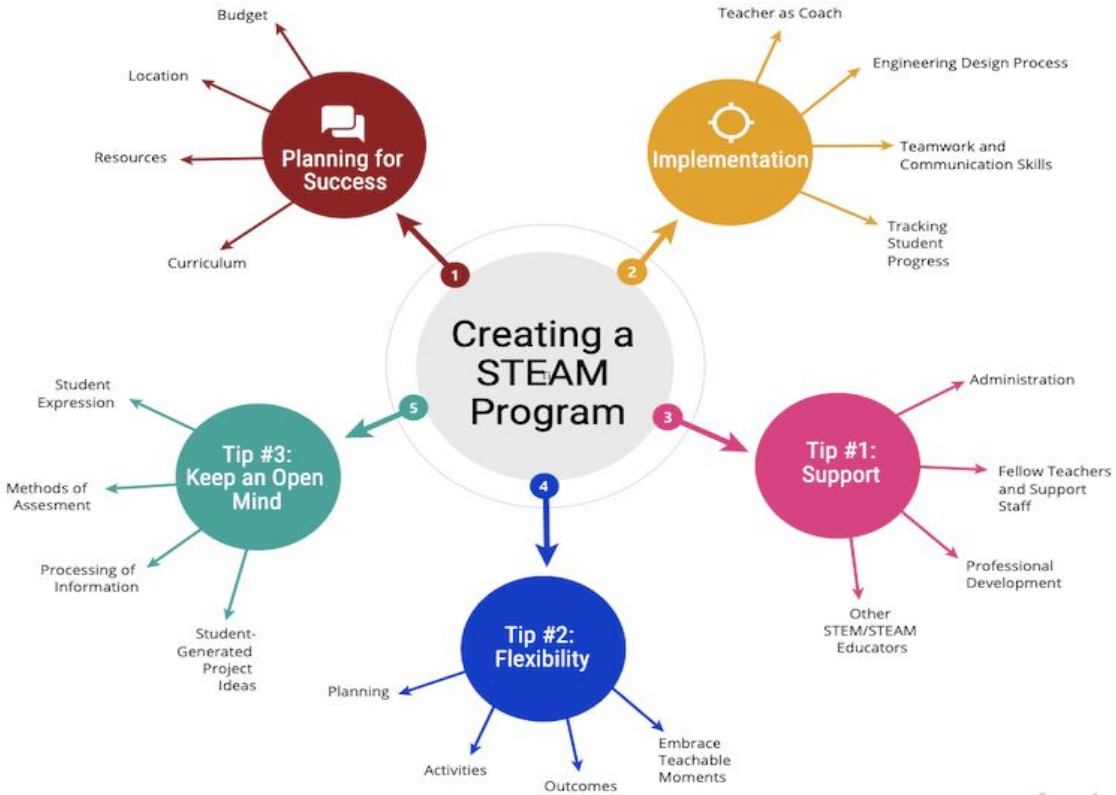
Elements of Program Implementation



Elements of Program Implementation

- In terms of Program planning, what are some practical classroom/school elements to consider?
  - Think of at least 5

- In what areas could teachers keep an open mind and embrace flexibility?
  - Again, think of at least 5.

REFLECTION:
- First, reflect individually. Then we will share our reflections in a workshop-wide discussion.

Video: What does STEAM look like?

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REFLECTION

- How could you imagine implementing similar strategies into your classroom?
- What are some similarities you notice between your school and Mountain View School?
- List some differences, as well.

STEAM OUTCOMES

A comprehensive list

STEAM has a slightly different focus, and intention with arts integration. The following are the STEAM outcomes:

- Intentional Connections
- Inquiry based
- Integrity

STEAM OUTCOMES

Intentional Connections

- Similar to arts integration, the best quality STEAM lessons intentionally connect 2 aligned standards. The first two components of this list break this down a bit.

- We want to make sure we purposefully select standards, content areas and topics that make sense together. The easiest way to do this is through seeking similar verbs across standards.

STEAM OUTCOMES

Inquiry Based

- Any good STEAM lesson is grounded in inquiry, problem-solving and process-based learning. In fact, this is one of the distinguishing characteristics between Arts Integration and STEAM.

- So when viewing STEAM in the classroom, you want to pay close attention to the essential question and the process surrounding its exploration.

STEAM OUTCOMES

Integrity

- Whenever a STEAM lesson is being used, it's imperative that the arts content has been selected purposefully and that it's being taught with integrity and not in service of the other content. This is a non-negotiable.

- Many times, we'll see lessons where students are creating a craft at the end of the lesson and educators call it "STEAM".

Practical Application:

DESIGN YOUR OWN STEAM/STEM CLASS!

- Objective of the lesson / Driving Question
- Explanation
- Materials needed
- Order of steps to complete the activity
- Evaluation
- Follow-up Activity (explain why you chose this one!)

** Each group will represent one of the three STEAM outcomes.

REMINDER:

OUTCOMES

- Intentional Connections
- Inquiry Based
- Integrity

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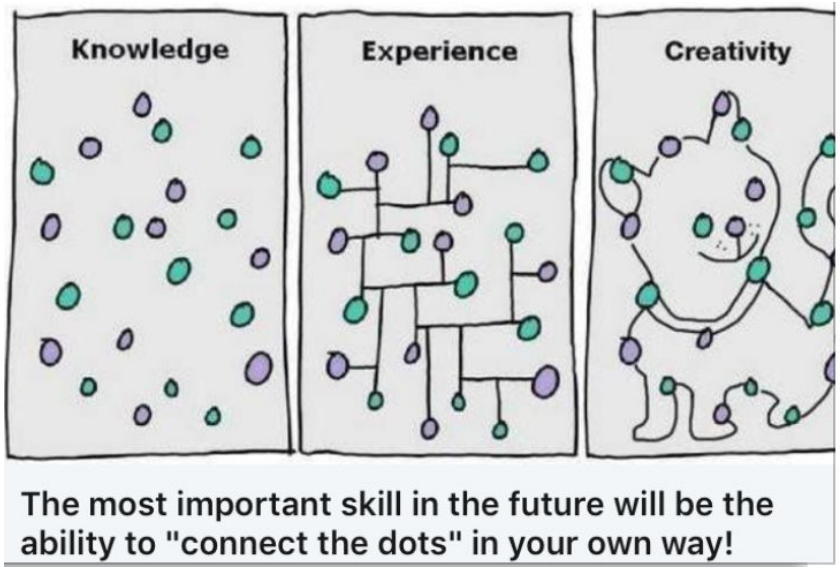
STEAM: Reflections



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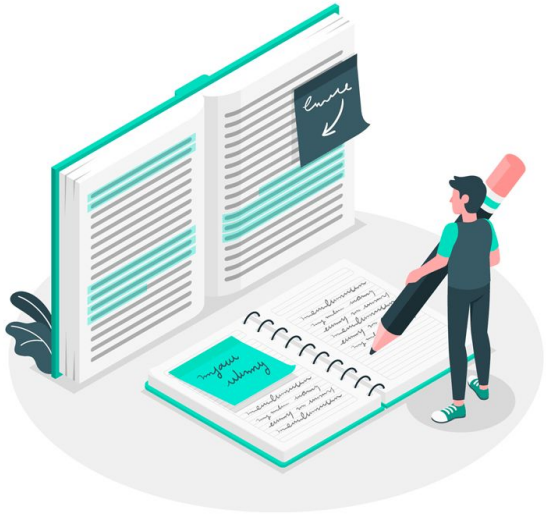

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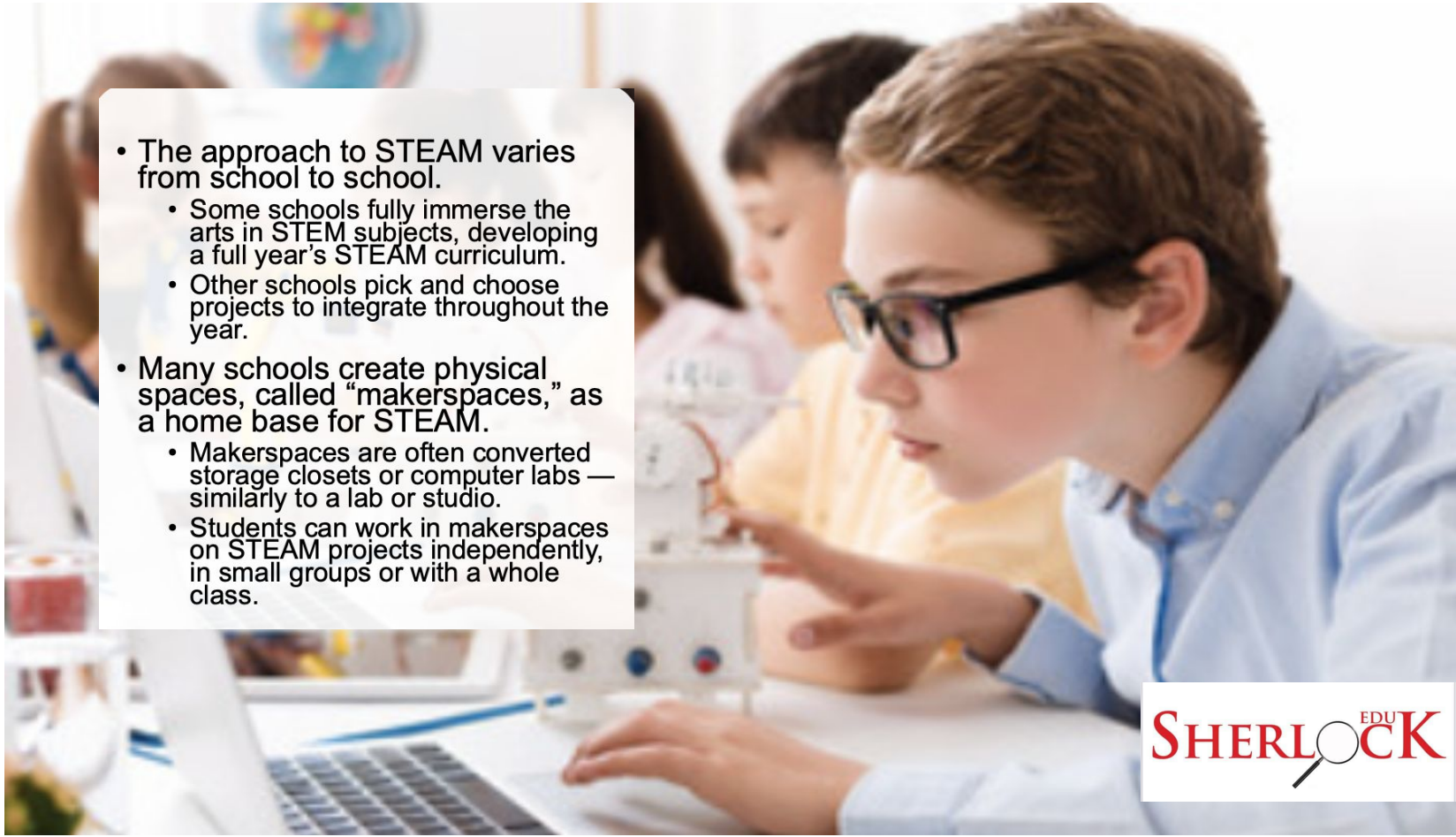
Journey to Planet ORG-567

STEAM: Reflections



- The approach to STEAM varies from school to school.
  - Some schools fully immerse the arts in STEM subjects, developing a full year's STEAM curriculum.
  - Other schools pick and choose projects to integrate throughout the year.
- Many schools create physical spaces, called "makerspaces," as a home base for STEAM.
  - Makerspaces are often converted storage closets or computer labs — similarly to a lab or studio.
  - Students can work in makerspaces on STEAM projects independently, in small groups or with a whole class.

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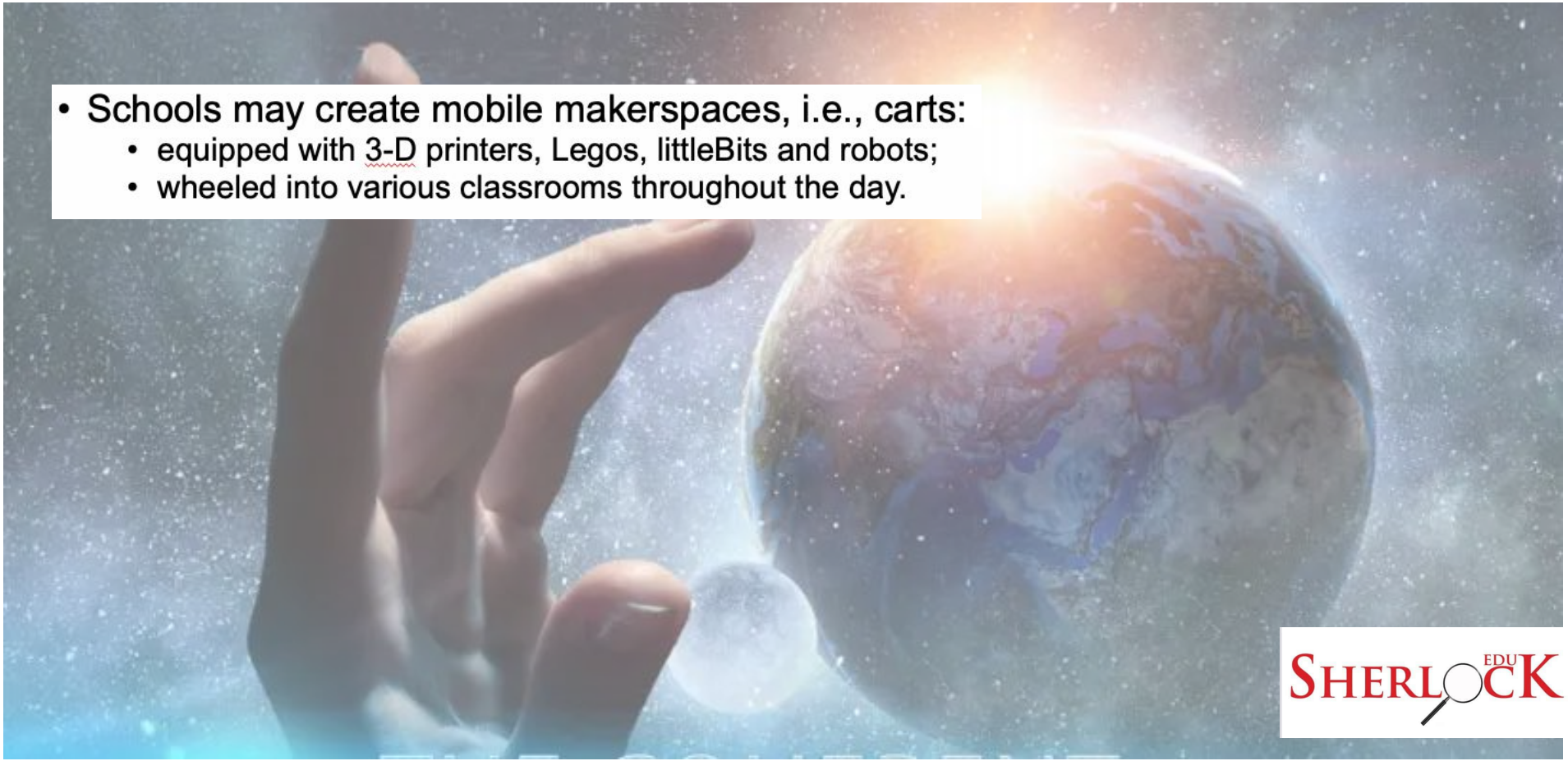
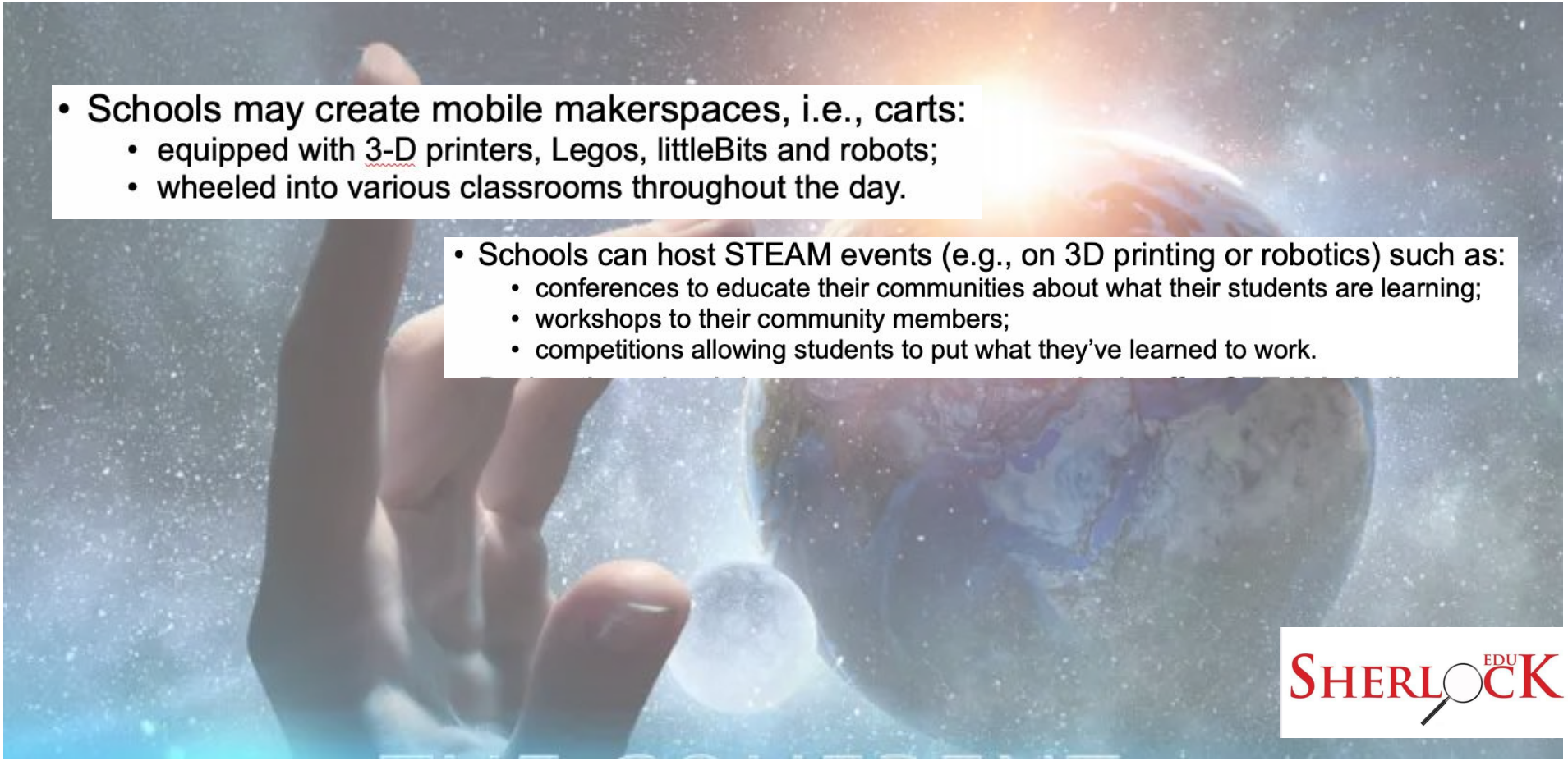
STEAM: Reflections



- Schools may create mobile makerspaces, i.e., carts:
  - equipped with 3-D printers, Legos, littleBits and robots;
  - wheeled into various classrooms throughout the day.

STEAM: Reflections



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- Schools can host STEAM events (e.g., on 3D printing or robotics) such as:
  - conferences to educate their communities about what their students are learning;
  - workshops to their community members;
  - competitions allowing students to put what they've learned to work.

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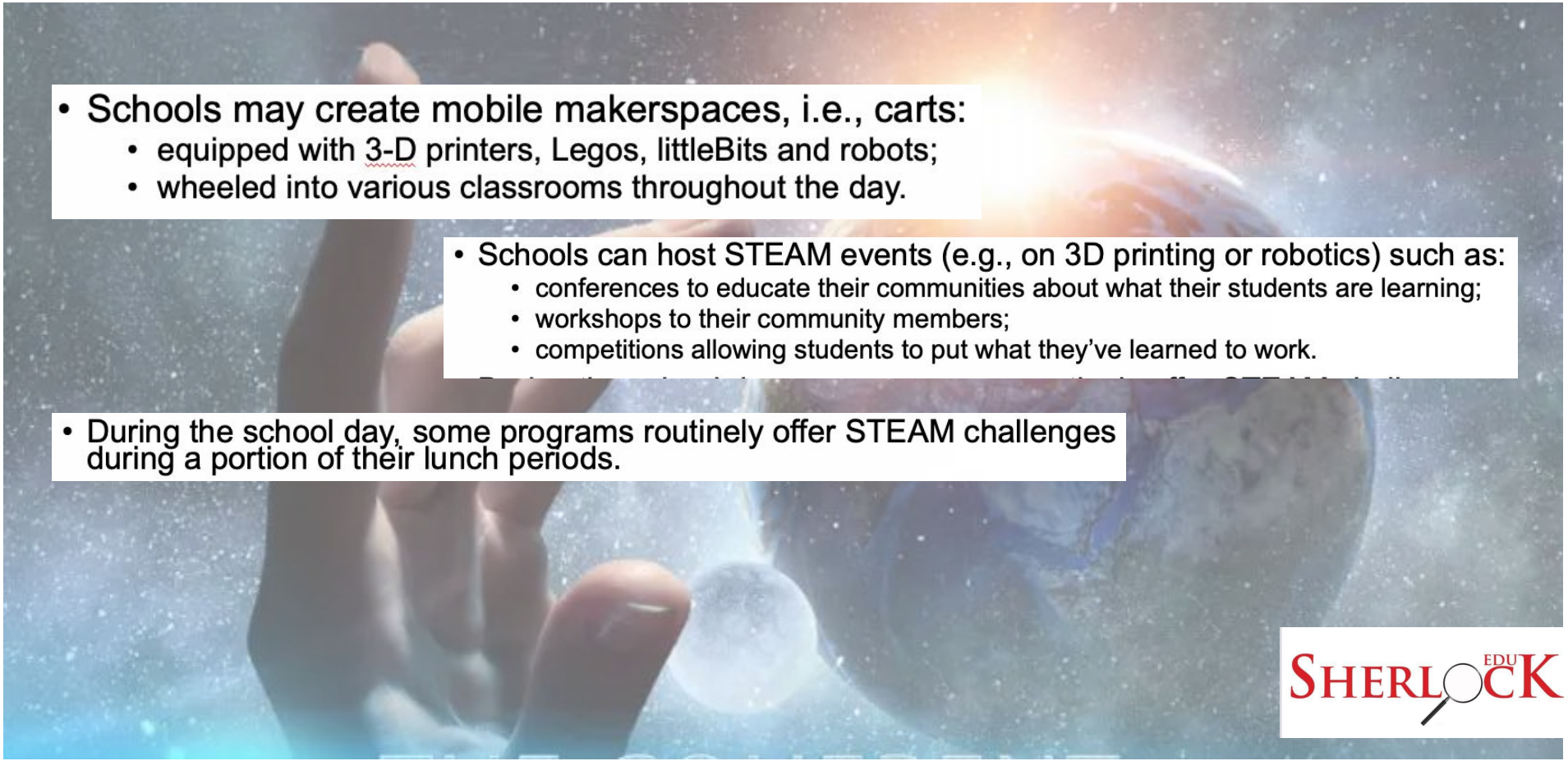

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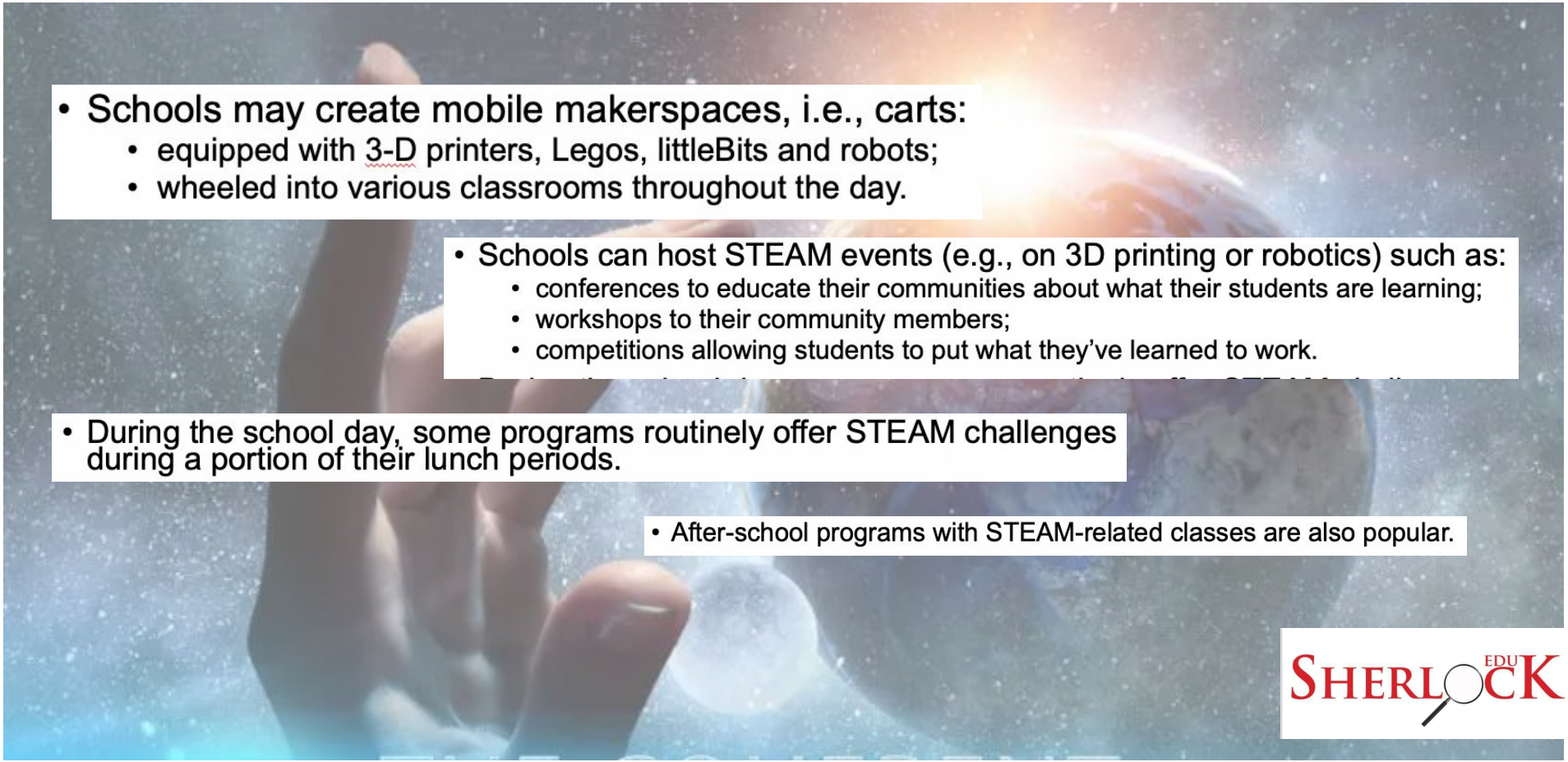
- During the school day, some programs routinely offer STEAM challenges during a portion of their lunch periods.

STEAM: Reflections



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- After-school programs with STEAM-related classes are also popular.

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CREATING the world of STEAM

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- After-school programs with STEAM-related classes are also popular.

- Much depends on:
  - the level of buy-in from teachers the amount of funding available and the level of support from district administrators.

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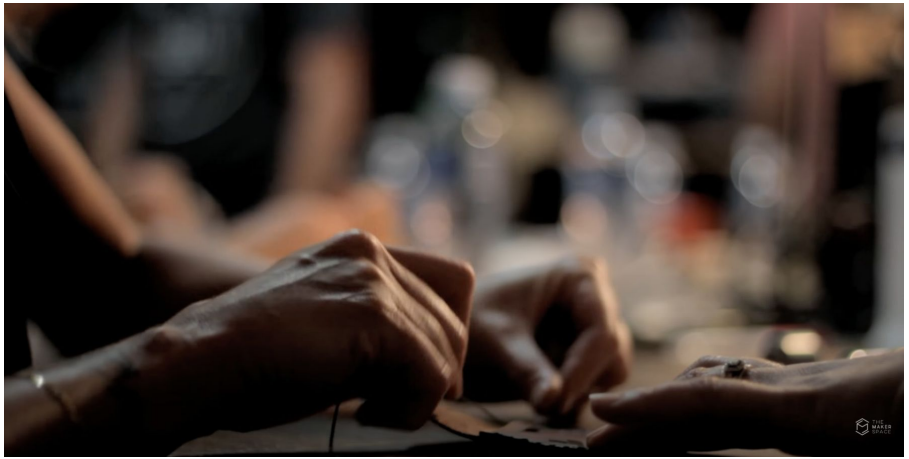
Video: MAKERSPACE



WATCH HERE

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MAKERSPACE

Let's talk MAKERSPACE – A definition:

"A makerspace will be broadly defined as an area that provides materials and tools to encourage individuals or groups to make things, to create new knowledge, or to solve problems" (Bevan, 2017; Martin, 2015; Martinez & Stager, 2013, 2019; Vossoughi & Bevan, 2014). In Mersand, 2020.

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"Makerspaces are places where participants may work together to create and co-create knowledge and physical or digital products. A making environment provides the potential for cross-curricular connections, collaboration, creativity, innovation, and learning" (Martinez & Stager, 2013, 2019)

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REFLECTION

- How might a MAKERSPACE compliment a STEAM approach to learning?
- Reflect on any educational experiences you may have had in a MAKERSPACE – what worked, what didn't work, etc...

YOU HAVE 10 MINUTES TO FREE-WRITE INDIVIDUALLY, THEN WE WILL SHARE!

MAKERSPACE

What does it look like?

First, let's take a look at a more traditional classroom…

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MAKERSPACE

What does it look like?

Now, let's take a look at a MAKERSPACE…

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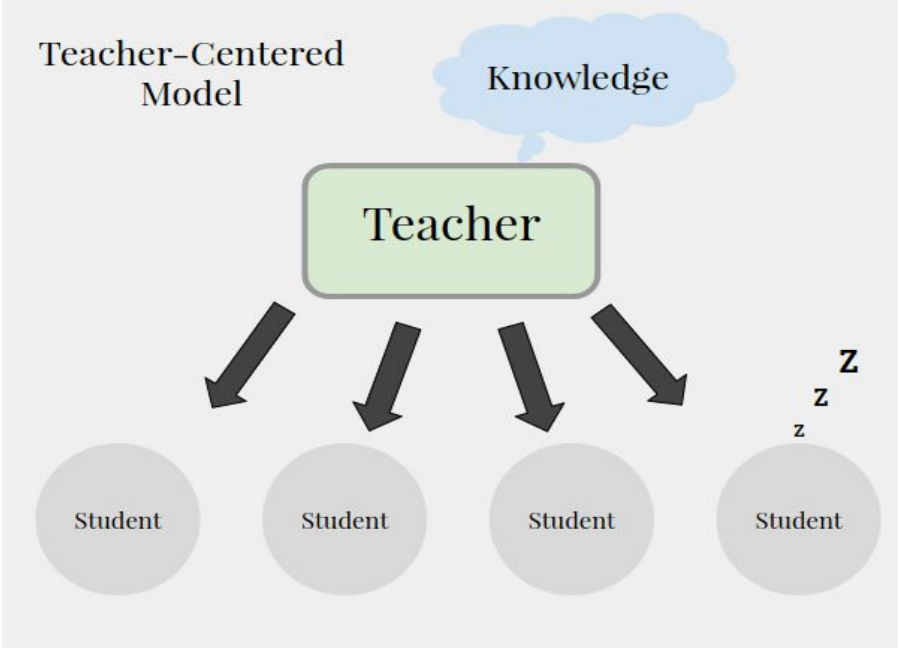
Classroom implementation

We want this...

Not this...



Classroom implementation

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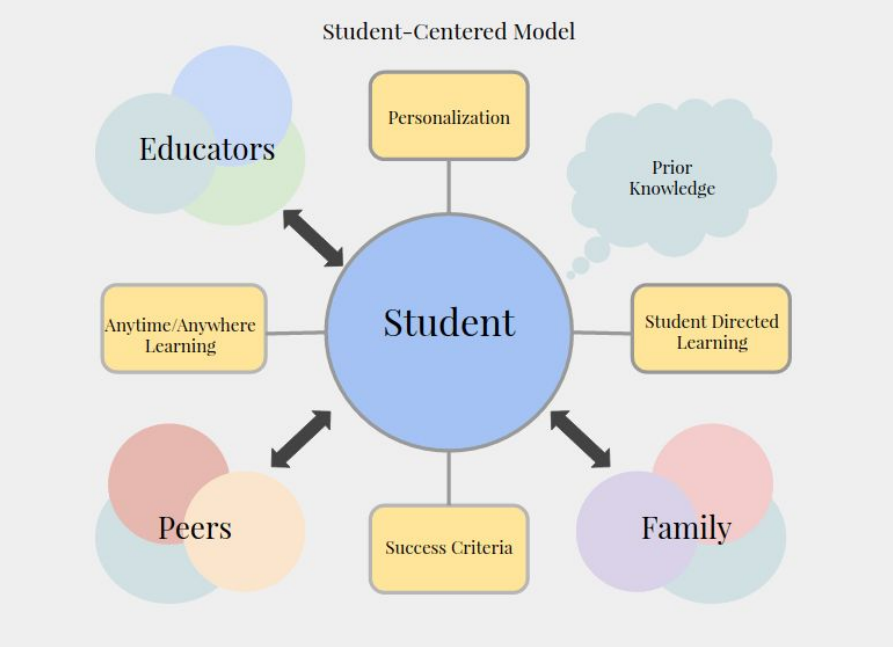
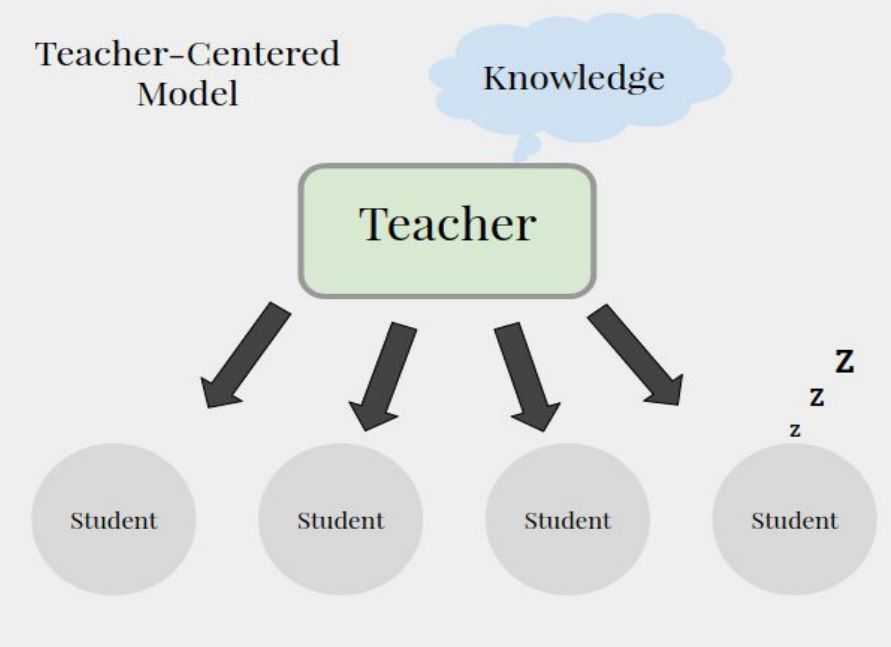


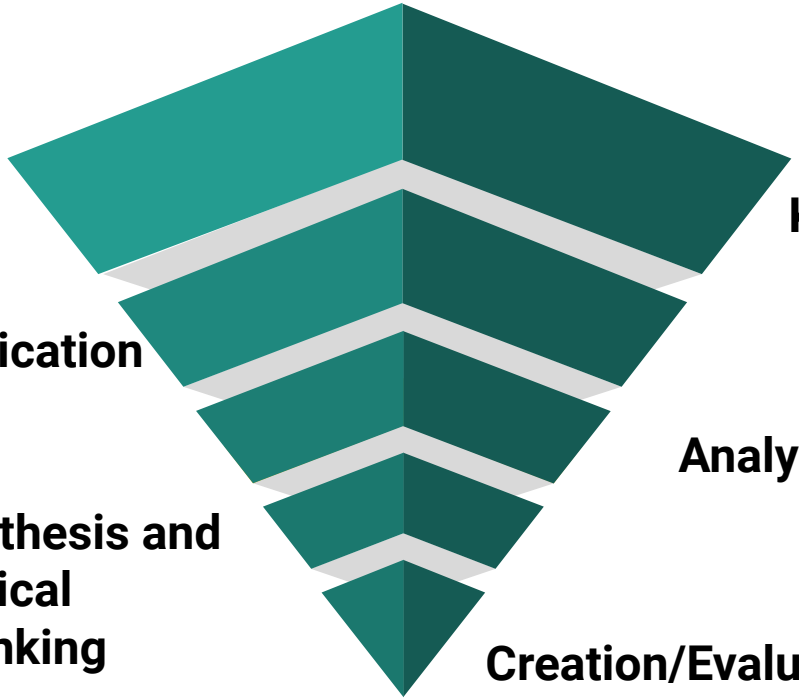
Not this...



Bloom's Taxonomy

Changing Classwork: The Flipped Classroom

Homework



Knowledge/Understading

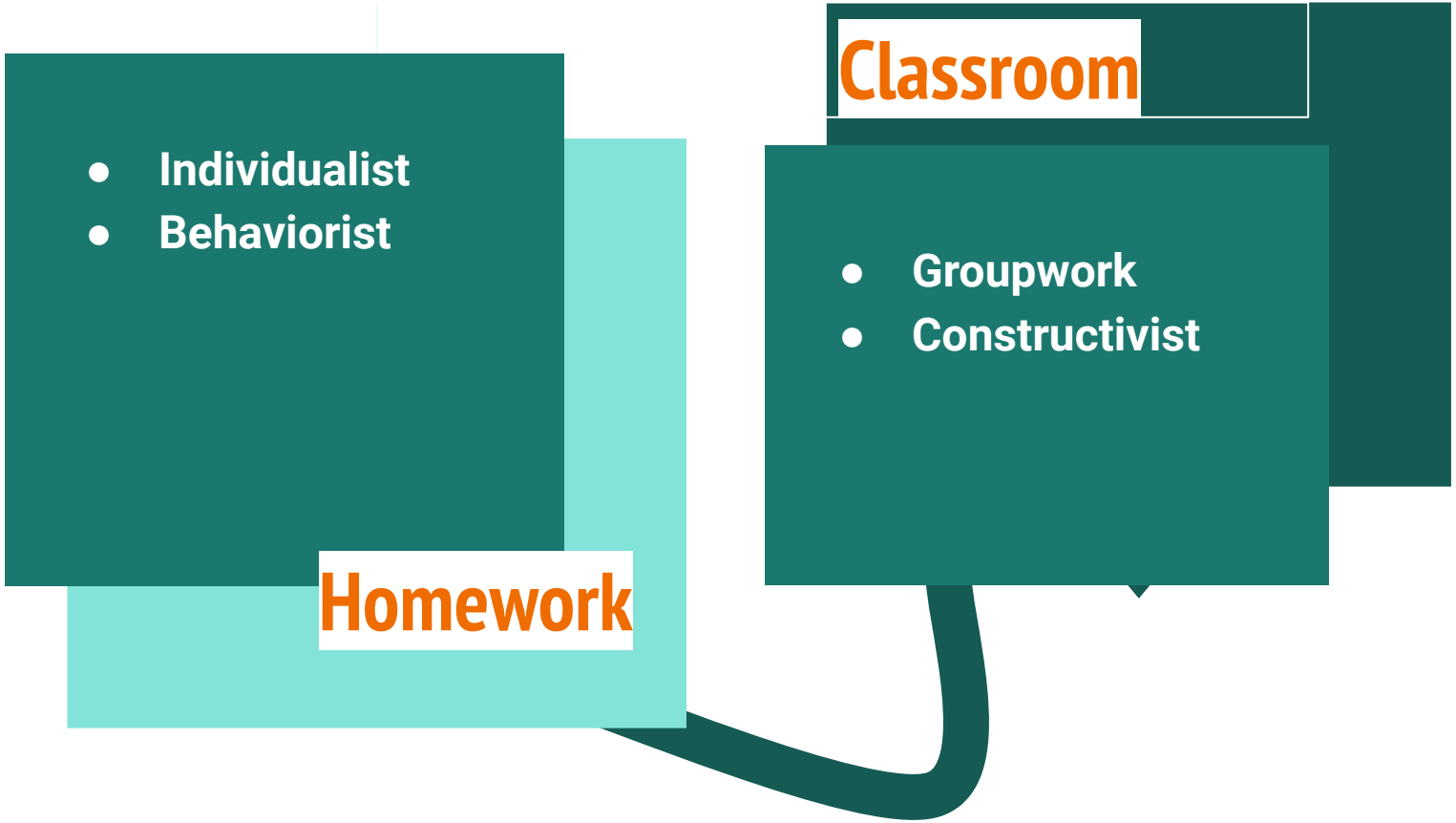
Application

Analysis

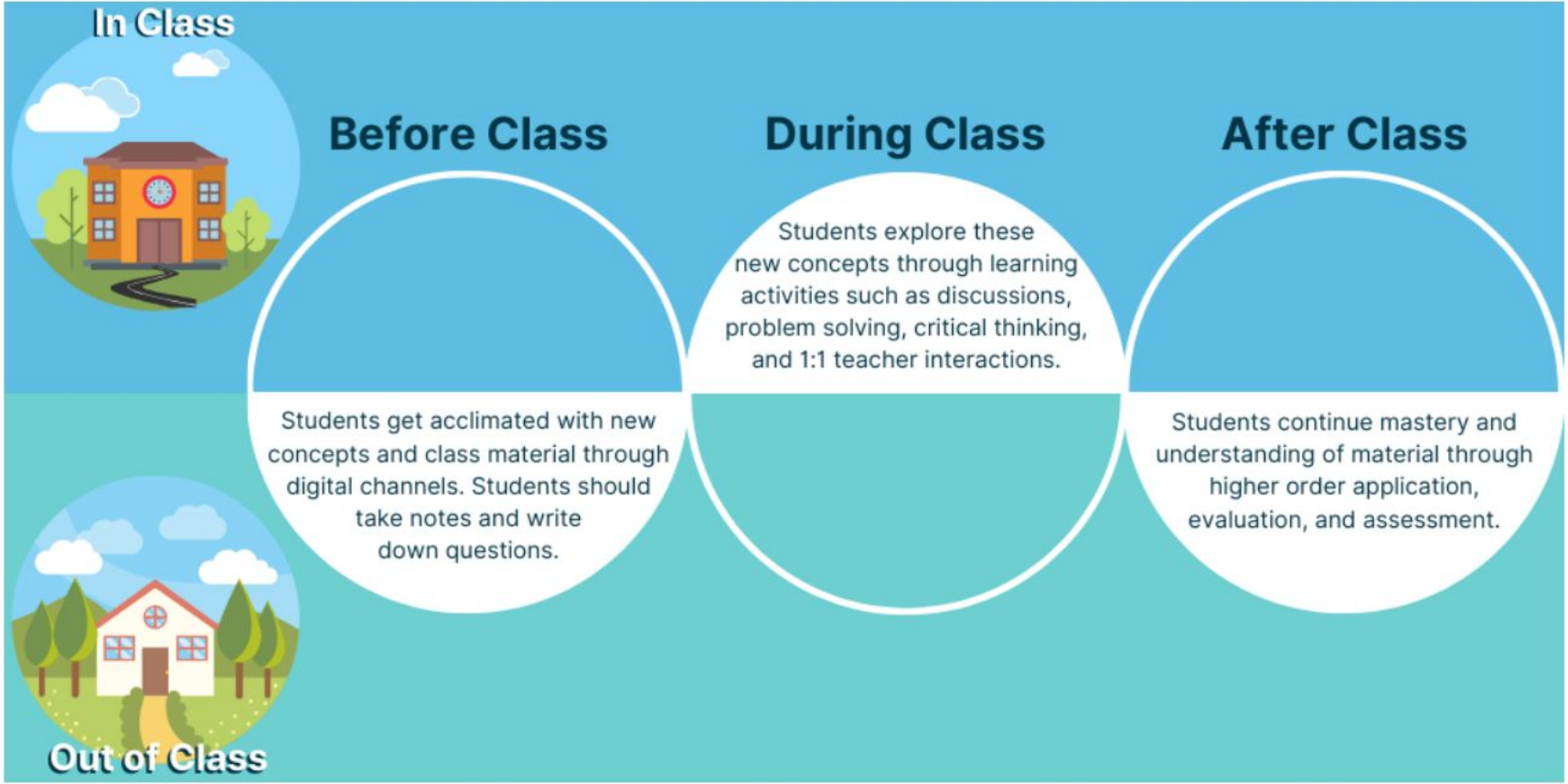
Synthesis and Critical Thinking

Creation/Evaluation

Groupwork, interaction, etc.


Classroom
Groupwork
Constructivist
Homework
Individualist
Behaviorist

Flipped Classroom: What does it look like?



Flipped Classroom: What does it look like?

1. Create flipped lessons for at-home learning

Flipped classroom models can contain many forms of flipped lessons. Teachers can provide students with a video or text to learn a new piece of content, and then complete an assessment following that lesson. Alternatively, teachers can provide more interactive lessons such as a HyperDoc that requires students to engage with the material more by completing activities while consuming the content.

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2. Decide which engagement models to use in the classroom

One of the most important and effective parts of the flipped classroom model is the fact that inherently classroom engagement increases. Although this is a byproduct of the flipped classroom model, teachers should decide what structured engagement models they will choose to use for specific content in the classroom. Some models to consider are project-based learning, game-based learning, understanding by design, makerspaces, and design thinking.

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3. Reflection, management, and evaluation

The flipped classroom model can be challenging because it requires students to complete and learn material on their own time. It can be difficult to ensure that students are completing learning prior to class time, and not falling behind. So, it's critical to reflect on flipped lessons and engagement activities to make sure learning is being maximized in and outside of the classroom. Managing the flipped classroom is different than managing traditional structure because there is more variability and autonomy in student engagement. Giving students more freedom can create distractions and getting off-task, so having an evaluation process in place

Flipped Classroom: Tools for support

Tools to support the flipped classroom model

There are many tools that can help make flipped lessons outside the classroom and engagement during class time most effective for students and teachers. During this time of remote learning, teachers have had the opportunity to dive deeper into technology and tools they can utilize for a flipped classroom model next year. A 2018 Edutopia article by Bethany Petty outlined three tools to get your flipped classroom model started.

- **Google Classroom**: Teachers can use Google Classroom to distribute and assess learning materials to students as well as communicate with students outside of the classroom to provide feedback and instruction. Teachers can outline goals, learning objectives, and assessments to help students complete flipped lessons at home.
- **Edpuzzle**: Rather than just distributing class content, video is one of the most effective ways for teachers to conduct flipped lessons outside of class time. Not only can teachers create and distribute instructional video with Edpuzzle, but they can also embed formative assessments to make sure students are completing lessons.
- **Padlet**: Learning the content is one thing, but practicing and reflecting on what students learned is just as important. Teachers can use Padlet to help students engage with their peers while reflecting on content when reviewing for assessments.

REFLECTION

- What are some pros to teaching through MAKERSPACE?
- What are some cons that you can envision?
- How could an educator prepare for the “con” elements of MAKERSPACES?

YOU HAVE 10 MINUTES TO FREE-WRITE INDIVIDUALLY, THEN WE WILL SHARE!

MAKERSPACE

What makes it a good pedagogical tool?

Can be organized and re-organized to fit the intended activity.

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Learning within them means knowing the multidisciplinary of things in the world.

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MAKERSPACE

What makes it a good pedagogical tool?

Can be organized and re-organized to fit the intended activity.

Can provide high level of Inclusion.

Support collective and/or individual work.

Facilitate differential instruction.

Learning within them means knowing the multidisciplinary of things in the world.

Support formative & Summative assessment

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MAKERSPACE

What makes it a good pedagogical tool?

Can be organized and re-organized to fit the intended activity.

Can provide high level of Inclusion.

Support collective and/or individual work.

Link school knowledge to that present outside of it [work]

Facilitate differential instruction.

Learning within them means knowing the multidisciplinary of things in the world.

Support formative & Summative assessment

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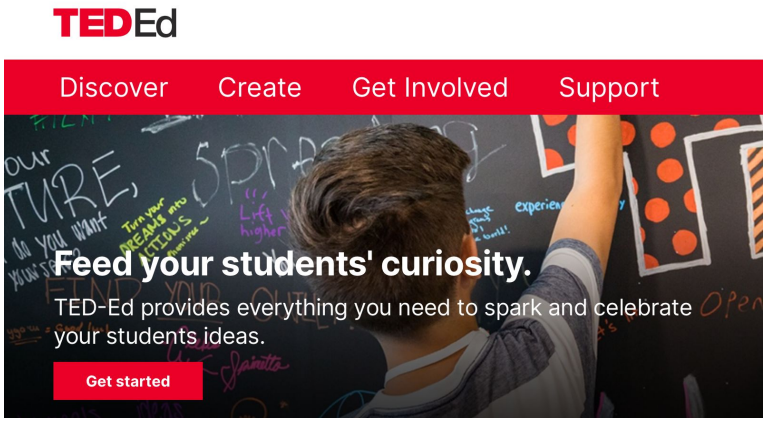
REFLECTION

- Would you add any elements to the question “What makes a good pedagogical tool”?

YOU HAVE 10 MINUTES TO FREE-WRITE INDIVIDUALLY, THEN WE WILL SHARE!

TEDEd



Video Explanation

Website

- Gamified educational app to create actionable video games

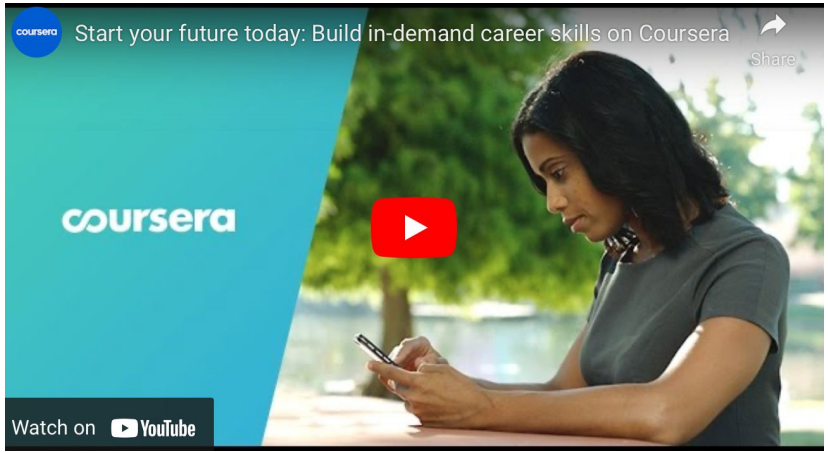
Khan Academy

Video Explanation

Website

- Gamified educational app to learn anything for free, forever

Coursera

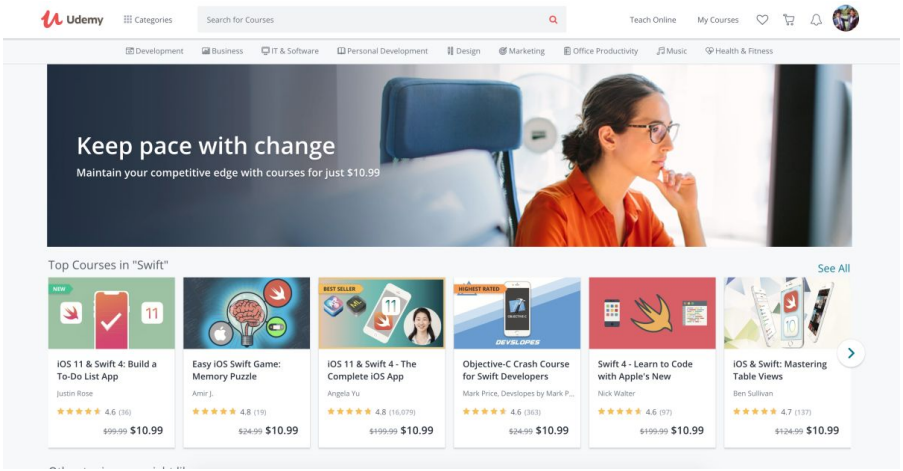


Video Explanation

Website

- Gamified educational app to get Ivy-League education from your own home

Udemy



[Website]

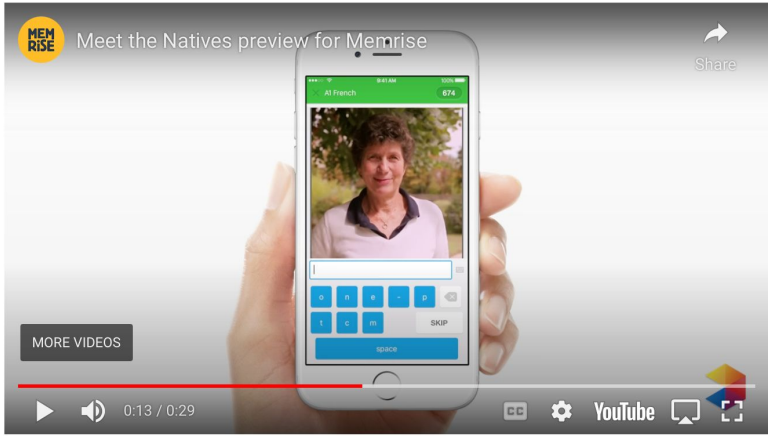
- Gamified educational app for user-generated learning

SoloLearn

Website

- Gamified educational app to learn how to code

Memrise



Video Explanation

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Practical Application:

DESIGN YOUR OWN GAMIFICATION CLASS, USING ONE OF THE APPS WE EXPLORED!

- Objective of the lesson
- How will you prepare the students to use the app?
- Materials needed
- What other activities will be involved? (Aside from the app)
- Evaluation
- Follow-up Activity (explain why you chose this one!)

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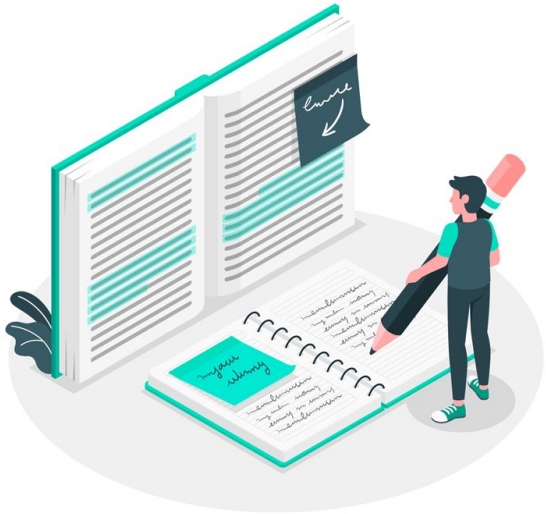
Today's summary:



Reflect on the following:

- What's something you've learned today?
- How can you apply it to your classroom?
- Summarize today in one word.

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REFLECTION

- Reflect on some of your reading/literacy classes:
  - What is different from the STEAM approach?
  - What is the same?
  - How could you apply this to your classroom, while still maintaining your academic curriculum standards?

Video: STEAM for Social Transformation

WATCH HERE

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Post-video discussion:

After having watched the video, let's discuss the following points:

- **What points did you agree with?**
- **Which elements of the discussion would you like further research to elaborate on?**
- **Did you disagree with anything that was said in the video?**

STEAM EDUCATION IDEAS

Classroom Application

- How would you use this idea in the classroom?
- How would you track the students' learning?
- What would be your method of evaluation?

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STEAM EDUCATION IDEAS

Classroom Application

- How would you use this idea in the classroom?
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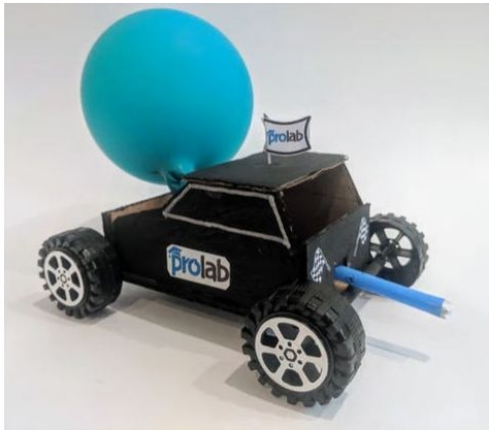
STEAM EDUCATION IDEAS

Classroom Application

1. Drive a balloon-powered car



- How would you use this idea in the classroom?
- How would you track the students' learning?
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STEAM EDUCATION IDEAS

Classroom Application

- How would you use this idea in the classroom?
- How would you track the students' learning?
- What would be your method of evaluation?

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STEAM EDUCATION IDEAS

Classroom Application

6. Construct a geodesic dome

- How would you use this idea in the classroom?
- How would you track the students' learning?
- What would be your method of evaluation?

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STEAM EDUCATION IDEAS

Classroom Application

- How would you use this idea in the classroom?
- How would you track the students' learning?
- What would be your method of evaluation?

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STEAM EDUCATION IDEAS

Classroom Application

21. Explore how sugary drinks affect teeth

- How would you use this idea in the classroom?
- How would you track the students' learning?
- What would be your method of evaluation?

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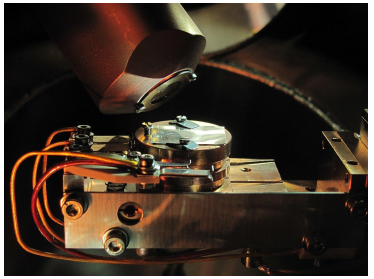
STEAM EDUCATION IDEAS

Classroom Application

Smartphone spectrometer



Students construct a spectroscope using card, DVD and a smartphone camera. Club leaders can prepare the dvd in advance and cut and clean etc. to reduce risk to students. **Suggested Materials:** Blank dvdr; template printed on black card; cutting board; craft knife; black electrical tape; scissors; sticky tape/glue; phone or tablet; clean soft cloth; ethanol/methylated spirits; cotton wool.

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STEAM EDUCATION IDEAS

Classroom Application

Can we rid the world of disease?

Students investigate disease control through a vaccination simulation. By analysing their data they will attempt to conclude what percentage of a population must be vaccinated in order to protect the majority of a community. **Suggested Materials:** Laptop/tablet with internet access; Large sheets of paper; pens/ pencils.

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Your Turn!

Exploring different STEAM options:

- In partners, research some STEAM classroom ideas.
- Choose one of your favourite class ideas and present the following for the following criteria:

AGE:

  - Learning objectives
  - How will the activity be introduced?
  - How will the learning be evaluated?
  - Consider a follow-up activity

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Reflection

- What have you learned from this course?
- How will you apply it to your classroom?