Preparing STEM Students with Problem Solving Skills

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Innovation and Creativity

➢ Creativity is based on 2 things:
   1. Your knowledge base and/or experiences relative to the group
   2. Your ability to combine concepts from uncommonly associated concepts/disciplines/industries

➢ Few innovations are made in a vacuum
   ▪ Baby steps built on the body of knowledge of a field of study
   ▪ Adaptations from an entirely isolated industry

➢ A group of people with shared experiences, skill sets, and conceptual capabilities may not seem creative together, but when dispersed into other groups will shine with creativity and innovation.
Engineering is the use of scientific principles from all fields to solve a technical problem.

- Design focuses on creating a solution that works as best as possible.
- Redesign focuses on improving upon existing designs.

The practice of problem solving lays the foundation for excellent engineers.

Each discipline of engineering has a slightly different focus, but problem solving is at the foundation of all degrees.
Closed and Open Ended Problem Solving

➢ Closed Form Solutions
- There is only one solution, and the student is either right or wrong.
- This is the traditional method of problem solving taught in schools for knowledge-based curriculum.
- Easy to evaluate.

➢ Open Ended Solutions
- There are many approaches, and potentially infinite solutions.
- This is what most people face in the real-world and is also the focus of design-based courses.
- Many instructors are hesitant to give open-ended problems because they will have to either understand all of the possible fields or the students perform poorly.
Group Activity

Please have a paper and pencil/pen ready
30 Second Brain Building Activity

➢ List challenges are a simple activity to begin forcing the brain to create new neural pathways and connections.

➢ Even though the goal is to write down the most items in 30 seconds, the educational objective is to see the students transition from route memory to memory exploration/evaluation.

➢ This can be used with prizes and you are limited to the number of categories you can imagine.
   - Use students to suggest categories so that they are not excluded.
   - Should be general enough for students to have ~15 seconds worth of route memory listing.
   - Do not overdo it, even though this seems like a simple activity it is quite taxing on the brain and will wear students out quickly.
Additional Strategies

➢ Keep track of your ideas in a journal
  ▪ Some people make sure to have a journal nearby when they are in a “no-mind” state like when sleeping, showering, exercising, mowing, etc...

➢ Make a list of random fields and pull one from a hat to learn about on the internet for the week

➢ Purposely take different paths and try new ways of doing daily routines

➢ Take strange community education classes or join local craft clubs

➢ Active listening and attention to detail

➢ Stop and focus on one thing at random and ask “Why?”

➢ Read as much as you can, listen to intriguing podcasts, and be ok with failure.
The Design Process has many forms depending on the intended use or who is teaching it.

At its core, Design is about using scientific knowledge to make big leaps that have a reasonable possibility of success, test to see if performance is achieved, and iterate the design as needed based on what was learned.
Open-Ended Problem Solving Loop

➢ Define the problem
  ▪ Be explicit. If you do not have a rule restricting breaking the intent of the activity, then it is a creative solution.
  ▪ Do not leave it too open. Bounds make it easier to focus. So does a time limit.

➢ Provide some examples of preferred (optimal) ways to solve the problem.

➢ After sharing the best way(s) to solve the problem, remove that as an option and start the timer for other solutions.

➢ After time is up review the solutions with the class and talk thru variations on the solution attempted.

➢ Allow students time to formulate a different version of the problem for the next class.
Problems with getting the solutions flowing

➢ Students may be reluctant to participate or be intimidated
  ▪ First... really important, there is nothing wrong with finding a way not to do something. It is valuable to learn ways not to do things and it takes courage to try something that may seem silly.
  ▪ Provide a structured strengths/weaknesses chat of different key items and/or aspects of what is needed to solve the problem.
  ▪ Provide each student with a “secret skill card” that shows them an idea or provide them with some training
    ➢ You could also pair this activity by doing a skills based small group activity before and then break each of the specialized groups into diversified groups for the problem solving

➢ Show many different solutions and move onto a different setup or problem

➢ Set up the problem on a Friday to do on Monday
Junk Drawer Problem Solving

➢ Most people have a junk drawer of random items
  ▪ If you do not, talk to a coworker or parent.

➢ There are typically going to be many office supplies in a junk drawer
  ▪ There will also be random items from past projects
  ▪ Junk drawer challenges are inherently unique because everyone’s junk drawer is different
  ▪ Year over year, items can change either by cleaning, use, or curation
Hanging Light

➢ Tie a string to two chairs and tape a flashlight to a coat hanger.
  ▪ You may need to add weight to the chairs (books)

➢ Place a target on the floor off center from the chairs
  ▪ Could be tape, a coaster, a frisbee, ...

➢ Goal is to hang the light on the string and somehow get it to shine on the target using an object or technique

➢ Once that object or technique is used, document and remove it from future solutions

➢ It is up to you to decide if items can be manipulated...

➢ At the end of the activity have them come up with 3 common items to put in the box for next year and how to solve it with said items
There are a lot of physics experiments with rolling spheres and streams of water.

Could be used with tracks as well

Depending on how many books are used to prop up the board, the slope will be different and cause very different solutions.

Again, random items can be used to keep the sphere above a line when dropped or in place when released.

Depending on the rules that you define, students could:

- Remove books
- Add books
- Reposition board
- Use Magnets and magnetic wire or steel ball

There are many variations on balls in goal area activities that can generate some true Rube Goldberg designs.
Video games

➢ Study how free video games are designed and simulate classroom activities based on those concepts.

➢ Have the students recreate their favorite games with a random assortment of items in a set time window.

➢ There are many ball rolling games and water flow games that could be replicated in a classroom.

➢ The use of a Raspberry pie and light sensors/emitters could be used to simulate the popular game Portals.
KiwiCo
- If a parent, alumni, or donor want to provide resources to increase the STEM offerings in a program for relatively cheap, KiwiCo has some very unique kits.

Arduino
- Robotics is not for everyone, but there are a lot of really good resources that have projects already put together or close to the desired outcome.

Taskmaster – British TV show
- Very funny show that has activities from the simple to complex for ideas.

3D Printing Assemblies
- Thingiverse has many assemblies ready to go and if teachers are demonstrating the use of CAD, a print-modify-print approach may be interesting.

Matchstick puzzles
- This gets into Mensa games and could be used with craft sticks as well

Reach out to an industry professional or tradesperson.
Contact me. We can schedule some time to talk thru some ideas.
Questions?

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