



Strategies for Students to Reflect on and Learn from Mistakes

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In This Session....

- ▶ Discussion of mistakes and failures
- ▶ Connections to some relevant literature
- ▶ Examples of two potentially useful course strategies
 - ▶ One that's been used for over 20 years in many courses
 - ▶ One that started a couple of years ago
- ▶ Lots of discussion!

Can We Relate to This Situation?

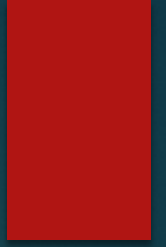


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What Happens Next?



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Mistakes

- ▶ How do your students think about mistakes in your class?
- ▶ How do you want them to think about mistakes in your class?
Beyond your class?

Mistakes and Failure....According to Some Famous People

- ▶ “Experience is simply the name we give our mistakes.” – Oscar Wilde
- ▶ “You build on your mistakes. You use them as stepping stones.” – Johnny Cash
- ▶ “If you’re not making mistakes, then you’re not doing anything. I’m positive that a doer makes mistakes.” – John Wooden
- ▶ “Do not fear mistakes. You will know failure. Continue to reach out.” – Benjamin Franklin
- ▶ “You can be discouraged by failure, or you can learn from it. So go ahead and make mistakes, make all you can. Because, remember that’s where you’ll find success – on the far side of failure.” – Thomas J. Watson

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- ▶ “I have not failed. I’ve just found 10,000 ways that won’t work.” – Thomas Edison
 - ▶ “Creativity is allowing yourself to make mistakes. Art is knowing which ones to keep.” – Scott Adams
 - ▶ “Failure is simply the opportunity to begin again, this time more intelligently.” – Henry Ford
 - ▶ “Success consists of moving from failure to failure without loss of enthusiasm.” – Winston Churchill
 - ▶ “It’s fine to celebrate success, but it is more important to heed the lessons of failure.” – Bill Gates

Mistakes

- ▶ What can we do to help students think productively about mistakes?
- ▶ In particular, what about
 - ▶ students who don't believe they will ever make a mistake?
 - ▶ students who make one mistake and think they can never succeed?

Formative Assessment

- ▶ Feedback (and the student processing of it) is the most important part of the learning process.
- ▶ Formative assessment practices have more impact than other types of educational innovations.

[Black & William, "Inside the Black Box: Raising Standards Through Classroom Assessment," *Phi Delta Kappan* 80, 139-148 (1998).]

Formative Assessment



- ▶ What do/can we do to provide students with formative feedback?
- ▶ When do we have the best opportunity to get their attention?

Midterm Exams – a Background Study

- ▶ Students were not using exams as a learning tool.
- ▶ Survey given to 285 freshman engineering majors.
- ▶ Only about 25% of the students reported trying to learn from their mistakes while fresh in their minds.
- ▶ Over half of the students put the test away, many of them apparently never to look at it again.

Exam Corrections

BASIC PROCESS:

- ▶ Don't go over exam when it's handed back
- ▶ Students are given assignment to correct/explain errors on exam within a few days
- ▶ Turned in, graded largely for effort
- ▶ Review exam with class after corrections

GOALS:

- ▶ Help students use exams in a formative way
- ▶ Treat "Post Exam Syndrome" so students can move on with new material

Effectiveness?

- ▶ Several mini-studies at 4 different institutions
 - ▶ Junior E&M
 - ▶ Introductory E&M
 - ▶ Freshman honors mechanics and E&M
 - ▶ Introductory non-majors astronomy
 - ▶ Freshman seminar on problem solving
- ▶ Nothing conclusive, but every study points to learning gains as a result of exam corrections.

Some Questions....

- ▶ Is making a mistake the same thing as failure?
- ▶ Would your students answer this question the same way as you did?
- ▶ How do we want our students to handle perceived failures?

A Quote About Failure

- ▶ “Here’s the problem. It’s the word ‘failure.’ It means a VERY specific thing in schools. The big red F is serious. In school, failure is NOT a cheery message to ‘try, try again!’ , it’s a dead-end with serious consequences.”

[Martinez & Stager, 2013]

Growth Mindset

- ▶ How students perceive their abilities impacts their ability to learn.
- ▶ Students who believe intelligence/ability can be developed outperform those who think these qualities are fixed.
- ▶ Having students focus on processes that lead to learning fosters a growth mindset.

[Dweck, Education Week, September 23, 2015.]

Growth Mindset

A growth mindset isn't just about effort.

What not to say

- ▶ "Don't worry, you'll get it if you keep trying."
- ▶ "Great effort! You tried your best!"

What to say

- ▶ "That feeling of physics being hard is the feeling of your brain growing."
- ▶ "The point isn't to get it all right away. The point is to grow your understanding step by step. What can you try next?"

[Dweck, Education Week, September 23, 2015.]

About the Growth Mindset



“The growth mindset...is about telling the truth about a student’s current achievement and then, together, doing something about it.”

- Carol Dweck

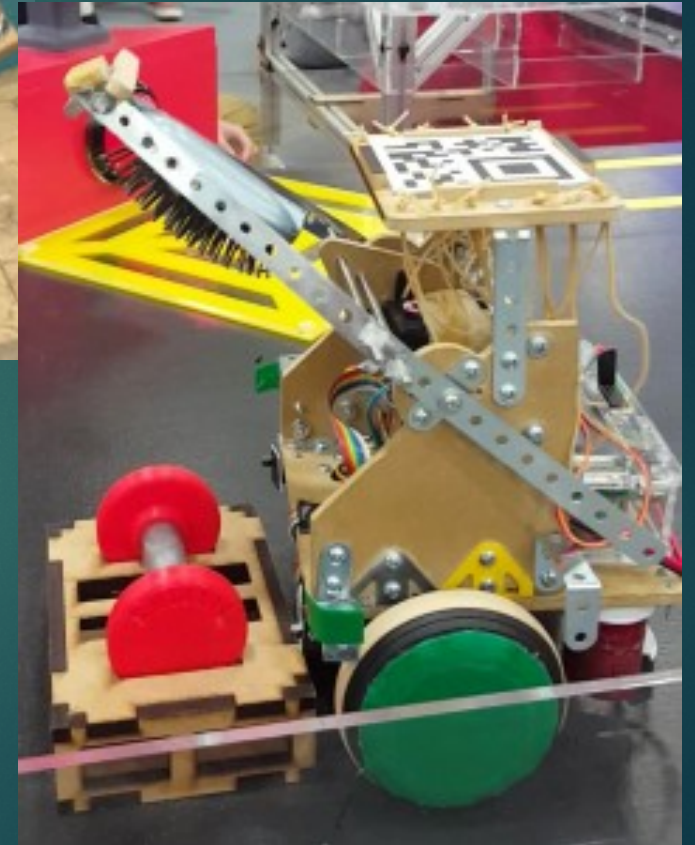
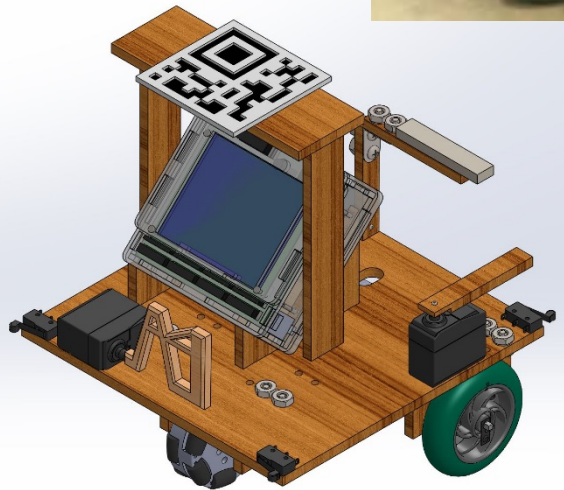
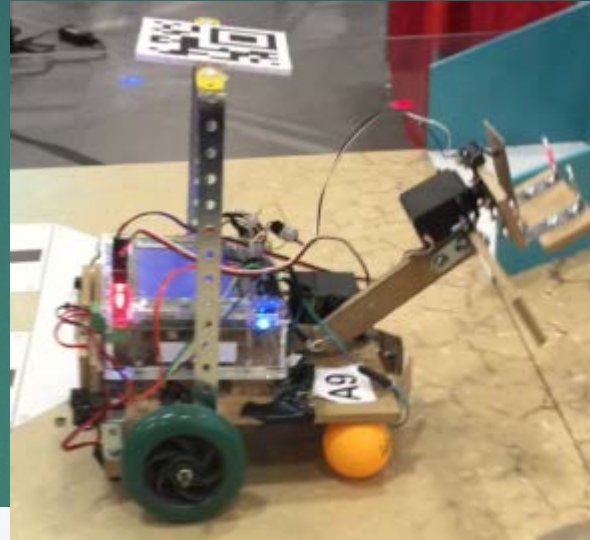
Real-world Failure

- ▶ “Practicing engineers acknowledge failure as a normal and expected outcome as a part of the iterative nature of designing solutions to problems, although the end goal is that the solution (hereafter, the ‘design’) is not intended to fail.”

- Lottero-Perdue & Parry, JPEER, 2017

- ▶ Note: iteration is not just blind trial and error.

Introducing Failure Analysis to a Design Course



Context

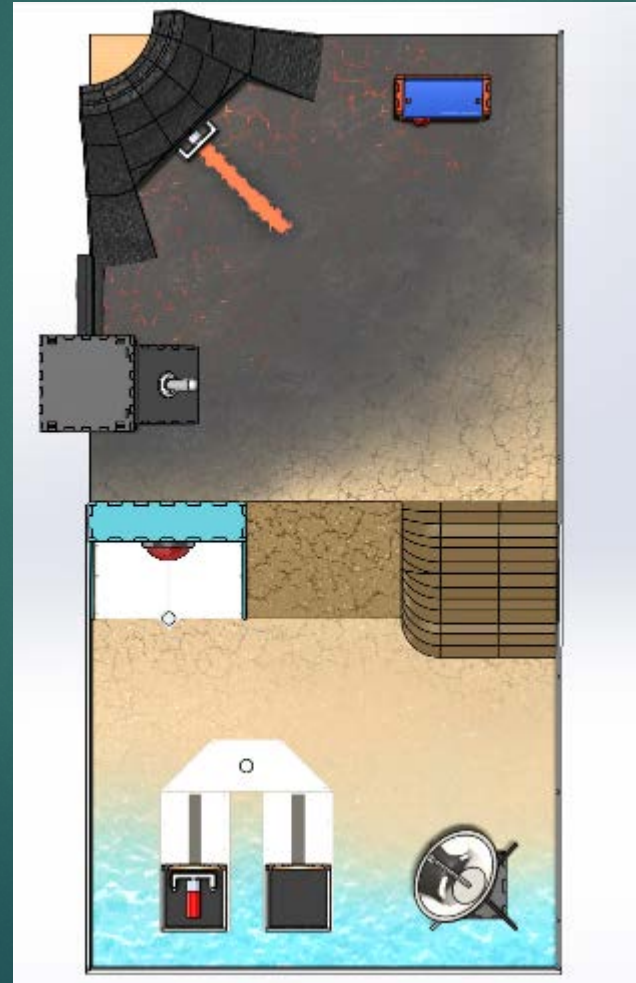


- ▶ Design schedule includes regular performance tests, an individual competition, and a head-to-head competition.
- ▶ Every task is addressed by the performance tests.

Post-Performance Test Assignment

- ▶ Required for teams attaining 50% or less on the performance test
- ▶ A 1/2 page paper or 2-3 minute video addressing
 - ▶ Problems/difficulties during the performance test
 - ▶ Plan to ensure future success
- ▶ Teams scoring above 50% automatically receive credit for the assignment

An Example: 2017 Performance Test 3 (Core Extraction and Deposit)



Student Responses

Problem Area	# of Teams Reporting
Time Management	19
Hardware	18
Software	16
Navigation	15
Testing	9
Team Issues	9
Making Major Change	5
Design	3
Interrelation	3
External Factors	3
Hubris	3
Equipment	2

Solution Area	# of Teams Reporting
Software	11
Hardware	10
Time Management	10
Team Issues	9
Navigation	7
Design Modification	6
Strategy Modification	5
Equipment	1
Design Change	1

Was This an Effective Educational Experience?

- ▶ We don't know yet.
- ▶ 2017 was probably our most successful year ever in terms of robot performance, but we made other improvements.
- ▶ Student responses about the failure analysis were mixed.

Why It Was Helpful

- ▶ “it helped to reference these when writing the [final] report”
- ▶ “helped us look at the problems that occurred and analyze them more carefully”
- ▶ “allowed us to centralize the team’s thinking”
- ▶ “it forces you to think about what went wrong, both with the bot and with the team”
- ▶ “made me realize that bull****ing the code was not the way to go”
- ▶ “It made our performance on the following performance test the best of the four.”

Why It Was Helpful

- ▶ “After we performed poorly on the third performance test, we found that talking through new ideas was very helpful. The reflection helped to facilitate that conversation.”
- ▶ “Although we mostly knew what went wrong...the reflection probably helped us verbalize exactly what our issue was and how we could fix it. It wasn't necessary, as we knew what went wrong, but it was a good assignment to make sure our team was on the same page.”

Why It Was Not Helpful


- ▶ "...my teammate did it"
- ▶ "...it was a mechanical error that caused the issue for the most part."
- ▶ "...we already know what went wrong and what we wanted to fix."
- ▶ "...we were really close and just needed another hour to complete the task."
- ▶ "...for our failure it was because of the store not our team. The store didn't have an essential part we needed so we were unable to fully test for PT3."

Why It Was Not Helpful

- ▶ “We already knew what the issue was and how we were going to try to fix it. It did not add anything to the development of the robot. It may have been beneficial to my understanding of how engineering works in the real world but it didn't help what was happening in the class.”
- ▶ “The reflection was not necessarily helpful since the issues of the robot could not be clearly identified.”

What About 2018? 2019?

- ▶ We had almost no teams score below 75% on any of the performance tests.
- ▶ We believe that most of our teams would substantially benefit from being prompted to reflect on opportunities for improvement.
- ▶ Starting this year, all teams will submit a reflection after each performance test, regardless of score.

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- ▶ What are some ways you might be able to incorporate elements from today's presentation and discussion into your own classes?

A Parting Thought

- ▶ “Resilient responses to design failure include an optimistic mindset that the problem can indeed be solved or that the failure can be overcome.”
- Lottero-Perdue & Parry

Thanks for coming!

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