Learning by Design: How Design Tech High School Uses Research

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As they prepared for the 2016-2017 school year, administrators and teachers at Design Tech High School ("d.tech"), a public charter school in Northern California, decided they needed a deeper understanding of how students learn. According to Nicole Cerra, Director of Learning, "Obviously you need to get to know students academically, but also personally, culturally, and cognitively. We felt we didn't know the adolescent brain well enough."

However, the team didn't want to simply learn more about the adolescent brain; they wanted to apply this knowledge in concrete ways across their unique curriculum, which is organized around an engineering-based, design thinking process. Students learn how to first understand a problem and end-user, then brainstorm solutions, create prototypes, analyze data, and finally, engage in multiple design iterations. Students take a four-year design lab course, and by senior year, are able to "go out and find their own problems to solve, and actually turn their ideas into action," said Ken Montgomery, Executive Director of the school.

The team decided to partner with researcher Melina Uncapher, a neuroscientist at the University of California, San Francisco, and CEO of the Institute for Applied Neuroscience, to help them apply research findings in ways that work best in their environment. Uncapher first presented training sessions to share principles from the learning sciences that could inform their thinking about how to best support students. Then the d.tech team worked closely with Uncapher to undertake their own design-thinking process about how to best integrate learning science principles into their daily work — at both the school and classroom levels.

In this report, we share the story of d.tech's journey, which provides useful ideas for other schools seeking to integrate research into their own culture and context.

How d.tech Administrators Use the Science of Learning

With Uncapher's help, the administrative team made the science of learning an emphasis in faculty professional development in the fall of 2016. In an initial teacher training session, Uncapher defined principles from the learning sciences including *social learning*, and effective learning strategies such as *retrieval practice, spacing, practice testing, and interleaving*.

Uncapher also spent time debunking common myths about education research, and addressing educators' skepticism on the value of applying research findings from studies conducted at other schools. Uncapher says their skepticism is warranted, as researchers "are not very good at communicating how the actual findings might be applied to their classroom." However, she works with several schools like d.tech to create a "bidirectional dialogue" between educators and researchers, which benefits schools and the research that's being done. She says, "I recognize and appreciate that they're [educators] the ones who really study how people learn in the real world. And as researchers...it's really important for us to refine our research questions based on what they know."

Using the design-thinking process, Uncapher worked with d.tech faculty to generate and test ideas for how the learning sciences can be used in the classroom. "We realized the synergy around design thinking and science of learning, and the technology they use to personalize the learning process into a larger conversation around what we're calling learning engineering...Using the problem solving processes of engineering to start to take the science and engineering solutions to problems of practice," she said. Teachers worked together in "design sprints" to

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prototype solutions to challenges they had in the classroom, and crafted approaches for testing these solutions in the academic year.

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Teachers were grateful for the opportunity to dig into the learning sciences. Henry Lonnemann, Government and Politics teacher, said, "I think in the past we always try to differentiate and personalize for students, but it's more about who they are socially and personally, and not so much about how their brains work... It was a shift for me to have been teaching for so long to think about learning in a different way, so I really like that."

Lonnemann's reaction mirrors those of educators Uncapher has worked with at other districts. She said, "Almost all of the educators I speak with are really looking for guiding principles, and evidence-based principles to help them do their job in a more effective way... that really supports the kids they're there to serve."

This year, Montgomery and his team plan to return to the learning sciences principles in additional workshops and discussions, and will share the results of "early adopter" teachers who have already implemented research in their classrooms as a way to spark other teachers' interest. They also plan to partner with researchers at nearby Stanford University to analyze data and determine whether the changes are improving student learning. Cerra added, "We knew all along we needed to have a follow-on plan throughout the school year for professional development with the staff, so that it wasn't just one-and-done."

Montgomery says the learning sciences and design thinking now form the foundation of his school's change management process, where the entire team "has this mindset that whatever we're doing at d.tech is focused on the end users, which are the students... so we can adapt quickly to give them what they need." He added, "We're trying to help our teachers become learning engineers, and engineers take the research and turn it into something they can use in the classroom."

How d.tech Teachers Use the Science of Learning in the Classroom

Nathan Pierce, an English teacher at d.tech, is one of the "early adopters" who is testing strategies for implementing learning sciences research in his teaching. After the training, he says he began to think of himself as not just an educator, but as an "engineer of the learning process." And, he says, it follows that, "If I want to be an engineer, I have to use the classroom like a lab, and see what works."

Pierce found Uncapher's presentation on rewarding students to be particularly useful, especially research on the importance of building students' intrinsic motivation to learn, rather than using all external rewards. For this reason, Pierce values d.tech's practice of allowing students to do "extension passion projects" where he says "there is no outside reward, just the freedom and the resources to take the projects on." Additionally, he wants to experiment with research principles from game theory to help students design a game they can play to improve their skills and compete against other classes — while improving their intrinsic motivation for learning.

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Cerra said after the training, several d.tech teachers began using regular, low-stakes practice tests to improve students' retention of information. She also shared the story of biology teacher Neal Addicott, who implemented research on interleaving into his teaching. Interleaved practice refers to alternating practice of different skills within the same block of time (e.g. "abcabcabc"), as compared to blocked practice in which subtopics are studied one after another (e.g. "aaabbbccc"). Addicott found software that would help him create flashcards, and then a sequence that would show students different material at spaced intervals of time. Cerra described, "It was sort of pre-set, or a way to space out the questions so that there was an appropriate time for students to forget their learning and then be re-introduced to it again."

Integrating learning sciences principles into the classroom has not been without its challenges. Several d.tech faculty commented that it was at times harder to motivate students to engage in some of the practices (such as interleaving and practice tests) because they require more effort than

traditional, less effective practices such as rereading and highlighting. This is what Uncapher refers to as "productive struggle."

However, following Uncapher's advice, Pierce says he "deliberately explains brain rules to the kids, so they are more willing to accept it" and become interested in trying new approaches to learning. Lonnemann added that sharing learning sciences principles directly with students helped "take away some of the power dynamics that exist between teachers and students" because it was more compelling than simply a directive from the teacher. Ultimately both administrators and faculty believe the learning sciences principles will give students more ownership over their learning, and improved confidence in their ability to meet challenges — which aligns perfectly with the school's mission.

An added benefit of the science of learning for d.tech faculty has been a deeper understanding of how their students learn and think. This knowledge has been an asset in developing more supportive relationships with students, and to differentiate the curriculum according to each student's needs. Henry Lonnemann said, "I think this can help just add another perspective on what someone needs... if we have information on how the brain works, and what that person might be going through, or how they can actually process information."

Faculty at d.tech also seem to appreciate the administration's support as they freely design and experiment with new teaching approaches as "learning engineers." Pierce commented, "One thing that I'm learning at this school is that you have to expect a certain amount of failure from the very beginning, but we'll just reiterate....until we get it right." Through these iterations and collecting and analyzing data on their progress, teachers say they gain confidence in their own effectiveness. Lonnemann said, "For me, the [learning sciences] is objective science that says *this is how people learn*. That can help, kind of, check people when they have certain ways of teaching for so long, or it can validate what someone's been doing."

Both administrators and teachers agree that the benefits of implementing new practices using the learning sciences outweighs the challenges. Montgomery believes his staff's new "learning engineering" mindset will help them be effective in meeting challenges over the long term. Pierce agrees: "We know the educational system is broken, and the model that they're using is broken... but we're not exactly sure how to fix it. And so if we think of ourselves as not just educators, but engineers of the education process, that I think, was probably the biggest takeaway I got from the training."

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Follow the Lead of d.tech: Recommendations for Other Schools

1. **Integrate the learning sciences into existing culture/practices:** d.tech folded learning sciences principles, like retrieval practice and interleaving, into existing design thinking processes that faculty and administrators use for making decisions, designing ongoing professional development, and crafting new programs/curricula; this allowed the school to maintain it as an ongoing practice. Analyze your institution's mission and structures to determine the easiest ways to integrate the science of learning.

2. **Provide training/support:** One of the greatest challenges many d.tech teachers shared was identifying which research principles were backed by sufficient evidence. For this reason, it can be helpful to partner with a researcher to identify a set of vetted learning sciences principles that are likely to be most compelling to members of your school community, and to provide a focused professional development session — or a full series of sessions — based on implementing these principles.

3. **Give educators freedom to experiment:** d.tech administration encouraged faculty to become "learning engineers" and experiment with implementing the learning sciences in ways that would best support their "end users" (students). They also actively support failure and iteration as part of the process, and build in time for educators to prototype solutions and experiment in the classroom.

   Further, they offer different options for engagement. Cerra suggested school leaders "emphasize that the adjustments and the changes that teachers are making to their curriculum and instruction can be small and easy to implement, all the way up to more radical and more difficult to implement... You can start with easier, quicker things to implement and then see if you get results, and continue to reiterate." A smaller change could involve incorporating short quizzes into lessons for retrieval practice. A variety of options allows more educators to participate, and for evidence-based practices to spread quickly.

4. **Emphasize the long-term value:** d.tech administrators and teachers recommend school leaders emphasize the long-term value of implementing learning sciences-based practices for both educators and students. This enhances buy-in from both groups. Montgomery said, "When our staff learns about the science behind what's happening in the brain, it gives them a lot of options for how they can engineer the most productive learning environment for the kids." And, for students, self-knowledge about how they learn best can help them to excel in school and beyond.

Learn More

This case is part of our series on implementing research in practice: a collection of stories and videos that highlight examples of learning sciences research use in districts, schools, and classrooms, as well as meaningful collaborations between researchers and education practitioners.

Check out the **video** to learn more about learning engineering at d.tech.

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Special Thanks

Thank you to Design Tech High School, the Institute for Applied Neuroscience, Nicole Cerra, Henry Lonnemann, Ken Montgomery, Nathan Pierce, and Melina Uncapher.