

November 2013



Special points of interest:

- Novel approaches for Education and Training
- Game-Based Education and Training
- Privacy and Security are of Paramount Concern
- Web-Based Apps
- Mobile apps
- IRBs—Institutional Review Boards
- Virtual Robots

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ENGAGE: New methods of Large Population Analytics for Education and Training

ENGAGE Program Introduction

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Training, which is conducted in classroom, field, and virtual settings, is a critical element of military readiness. Large-scale social networks, interactive content, and ubiquitous mobile access are emerging as driving technologies in education and training. At



the same time, education analytics presents new opportunities for assessing the effectiveness of training strategies, understanding trends and effects in large volumes of education data, and relating these back to alternative modes of instruction.

DARPA created the ENGAGE program to enable the development of education and training systems

that are better, faster, continuously optimized, and massively scalable. ENGAGE is exploring software- and data-intensive education and training methods that harness the power of large user populations to optimize instruction. Where traditional educational assessments tested effectiveness on small samples (<100), the ENGAGE approach to assessment involves 1000's or 10,000's of students. To facilitate this approach, ENGAGE has focused initially on interactive technologies for K-12 students, including those served by the U.S. Department of Defense Education Activity (DoDEA), a government-sponsored organization responsible for educating the children of military personnel around the world. It is anticipated that the same techniques used in the ENGAGE program to

optimize educational content and instruction in math and science can be applied to a wide variety of military and civilian training contexts.

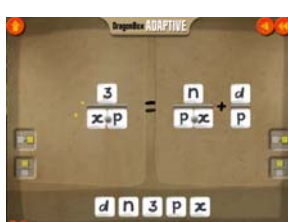
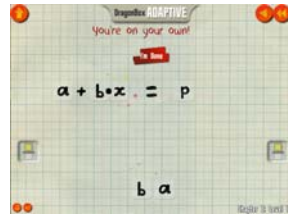


To date, ENGAGE has created several interactive learning sites, with new programs debuting every few months for both desktop and mobile devices.

ENGAGE highlights include::

- Refraction
- Treefrog Treasure
- Computer Science Student Network
- CS2N Virtual Robot Worlds
- Neurostorm
- OurSpace
- CMU's ETC Helios
- Washington State Algebra Challenge

DragonBox



ENGAGE: Games for Education and Training

Center for Game Science, University of Washington <http://algebrachallenge.org/>

What are the general methods for discovering optimal learning pathways to bring novices to experts in a given knowledge domain? Our goal is to design a novel way of learning and real-world problem solving by determining the optimal human-computer symbiotic learning and problem solving framework. Computer games allow us to dynamically alter content and challenge level in response to the user's play. By doing this, we can remove misconceptions and develop both conceptual and procedural understanding in a given domain.

We are currently developing and testing five different games about math. We are working with learning scientists to study the transfer of math understanding from our game-based learning framework into traditional tests. We are also studying players' affective and behavioral states during play. We expect to learn classifiers which can tell if students are confused, frustrated, bored, happy, concentrating, etc. while playing, based solely on this data. Additionally, these metrics

may give us some information about what players will do in the future, how well they understand the content, or what emotions they are currently experiencing. That, in turn, will feed back into our automated assessment and game adaptivity.

Smoothly integrating the games into real-world classroom settings is the next challenge, for which we are developing specific curriculum modules that can be easily implemented by any teacher.



We recently ran an event called the Washington State Algebra Challenge. The goal of the Algebra Challenge event was to improve specialization methods that can achieve mastery for every student in the classroom. In the end we far exceeded our goal of 250,000 equations over a one-week period, reaching almost 400,000 equations solved inside of a specially modi-

fied, adaptive version of DragonBox, with participation from a total of 4,192 students from public and private schools, home school programs, and after school groups.

The early results of the Algebra Challenge showed that mastery of linear equation solving can be reached in just 1.5 hours of play. More importantly, that mastery is not reached by a select few, but by the nearly the whole classroom. The average mastery rate for all grades was 92.9% after 1.5 hours. This is especially surprising since many of the participants were in elementary school, where algebra is usually not considered (it is commonly a milestone for 7th and 8th graders). We believe the adaptive nature of the game was instrumental in achieving these results. Only a tiny percentage of students finished the game without requiring at least some remediation. Some grades required significantly more effort and review than others. The game was able to adapt in real-time to each student in order to maximize the likelihood of mastery. As a result, some

ENGAGE: Games for Education and Training (Continued)

Center for Game Science, University of Washington <http://algebrachallenge.org/>

students played almost 10 times more levels than others. The engagement structures of the game ensured that they persisted through this challenge.

Some of the significant results and findings to come out since the inception of the ENGAGE program University of Washington research have been the following:

An infinitely adaptable interactive curriculum can be automatically optimized through use of student and teacher data, to achieve staggering feats of mastery by 93% of all students even 5 to 6 years earlier than such material is introduced in standard schools. Likewise, the same structures were able to lead complete scientific novices towards publishing 4 scientific discoveries in biochemistry in less than a year. These discoveries were world-class and they were published in the most eminent scientific journals. While we demonstrated these outcomes on a few isolated instances, our goal is to transform educational process by covering more learning and scientific do-

main and show that these learning structures work for every learner.

There are four interconnected novel aspects of our approach that make this possible:

1. develop highly-malleable curriculum capable of maximally adapting to each learner. We've developed new techniques that can turn a standard curriculum into an infinitely variable one.

2. Use machine learning to explore the space of curriculum variations to adjust to each learner and each tutor. Our methods adapt best practices on the fly with every new data point.

3. Optimize for both engagement and mastery at the same time. This requires new learner models that incorporate more complete psychological description of a learner, rather than standard models that primarily consider mastery on a learning domain.

4. Optimize the entire learning ecosystem that includes teacher, classroom, parent. Rather than deliver just the learner in-

tervention, our framework aims to optimize for the skills of the tutors, as well as the classroom environment towards best outcomes. Our learning delivery structures aim at development of not just learners, but also tutors, teachers and parents. These structures also maximize the usefulness of the support system without presupposing exiting skills. This allows for strong results even in environments where tutors and parents do not have any knowledge of the learning content.

DragonBox



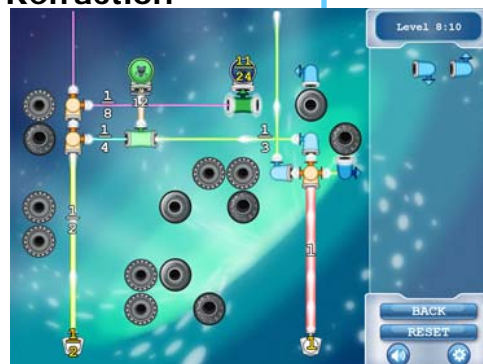
Creature Capture



Treefrog Adventures



Refraction



RoboBall; Game based introduction to physics concepts for K-3.
Intific, Inc.



Figure 1 – Intific’s OurSpace Game Portal; RoboBall’s Main Webpage.



RoboBall is a deterministic physics game for students K–3, focusing on mass, motion and force. The game concepts are paired with validated force and motion physics concepts developed by CRESST at UCLA and Dr. Paul Horwitz, a well-known physicist. The physics learning progressions are measured throughout gameplay and correspond to a student’s understanding of those concepts. The goal is gameplay that results in measurable metrics that demonstrate that the game provides an innovative approach to physics learning and student emotional resilience.

Intific’s RoboBall game was created for DARPA’s EN-GAGE program, and has been developed, assessed

and refined over the past 2 years. During this time the team has generated an HTML5 editor, 100+ physics puzzle levels, 6 social emotional learning scenarios, and data structures that aid in educational efficacy assessments. The Open Beta release includes an adaptive learning feature that tailors the game to each user based on his or her performance. The Intific team collaborated with educators, researchers and students to develop scaffolding for physics pedagogies that are intuitive for the target age range. Feedback gathered from DARPA, CRESST at UCLA, Sesame Street Workshop, and The Electric Company was used to refine the final game concept.

Intific has built a Test-Ready physics puzzle and emotional resilience game that can be used to evaluate the effectiveness of gameplay and learning progressions in a digital format. This is done by leveraging the in-game assessment data output by RoboBall. The game captures every data point from gameplay and makes it accessible from the OurSpace website where RoboBall is hosted. Researchers can view up to 100 data logs on a single webpage or download a .csv file for further examination.

Intific is exploring transition opportunities to bring the game to a wider audience. Look for those announcements in early 2014.



ENGAGE CRESST Program Overview

UCLA/CRESST <http://engage.cse.ucla.edu>

The goal of the ENGAGE CRESST project is to conduct high-quality research, development, assessment, and evaluation of video games to help young children learn advanced physics and promote scientific reasoning and socio-emotional skills. As the educational experts within an interdisciplinary team of designers, developers, and artists, the National Center for Research on Evaluation, Standards, and

Student Testing (CRESST) is generating knowledge, models, and tools that contribute to the research and development (R&D) field on how to effectively create, evaluate, design, and test games.

TESTBED DESIGN MODEL

Building on prior CRESST work, the ENGAGE CRESST project follows a model of game development that supports rapid changes to games

and allows researchers to be agile in their testing.

ENGAGE CRESST developed two games as testbed environments to address the complexities of game development (game design, graphics, learning, assessment), the uncertainties of the research outcomes, the fast iteration required to support data collection, and uncertain school schedules.



CRESST TESTBED GAMES:

In *Go Vector Go*, children learn by:



<http://engage.cse.ucla.edu/GVG.html>

Solving force and motion problems involving interactions between force magnitude and direction, friction, slope, mass, and gravity.

Engaging in game mechanics that use accurate physics representations.

Programming Vector the train by manipulating parameters of physics factors.

Adaptive gameplay that provides a personalized game experience.

Playing mini-games that promote pattern recognition and data analysis.

Using the video replay function to review their gameplay.

Go Vector Go has been tested with **277 students** (K-5). They showed significant improvement after **45 minutes** of gameplay. The **.6 effect size** indicates that *Go Vector Go* is an effective game for learning.

In *Team Vector to the Rescue*, kids learn key SEL and physics skills by:



<http://engage.cse.ucla.edu/TV.html>

Resolving and de-escalating observed bullying conflicts.

Responding appropriately to scenarios depicting children in problematic situations.

Manipulating physics components (i.e., force, friction, motion, mass, and slope) to ride Vector the train to reach the children needing their help.

Problem solving what physics parameters will get them to the children the fastest.

Team Vector to the Rescue has been tested with **117 students** (K-5). They showed significant improvement after **30 minutes** of gameplay.



Helios

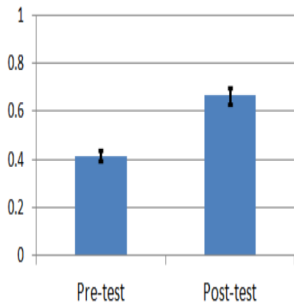
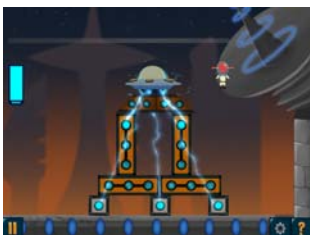


Table 1. Results from educational assessment of Rumble Blocks, showing 95% confidence bars and accuracy scores on contrasting cases pre- and post-tests.



RumbleBlocks

ENGAGE Games Developed by the Entertainment Technology Center Carnegie Mellon University/ETC
http://www.etc.cmu.edu/projects/impact/?page_id=18

The communications theorist Marshall McLuhan once stated: "Anyone who thinks education and entertainment are different doesn't know much about either." People of all ages and especially today's "born digital" youth find games fun. If learning complex concepts can be viewed as play rather than work, i.e., can be packaged in a game rich with intrinsic motivational fantasy, then students may learn more and develop positive attitudes toward the topics of study as a result of the game interactions.

As part of the ENGAGE program, teams at Carnegie Mellon University's Entertainment Technology Center have developed four dynamic games, demonstrating their efficacy for early learning. These Unity games were designed with feedback from early childhood educators and learning researchers. The ETC is known for an iterative, organic approach to the development of games designed to teach. Our creative methodology is rooted in the belief that unless the game is fun when compared to all games (not just

"educational games"), the odds of the student being engaged by the game itself greatly diminishes and, along with the associated lack of engagement, so too will diminish the opportunities for deeper learning.

The educational games under development are being evaluated based on: effectiveness for learning, creativity and entertainment afforded to players, impact on the attitudes of students toward the concepts being taught, as well as objective evaluation metrics of knowledge gained. The first two and most mature games, RumbleBlocks and Beanstalk, have been tested with over six hundred children in schools. Both have shown to foster learning and engagement. Outcomes of these evaluations are being used to continually improve the games.

Our newest ENGAGE game, called Helios had design decisions that were particularly influenced through collaboration with Sesame Workshop, who provides professional and experienced insight into development of educational materials for children.

Although the creation of several effective games for learning is useful, we strive for much broader impact. Under MacArthur Foundation funding, the ETC is creating the Working Examples web site (<http://workingexamples.org>). The goal of the site is to collect lessons learned in the creation of new media for learning. It is leveraging the power of "markets" and "crowds" and collaborations to make new discoveries and break out of traditional molds for creating serious games that teach. We are codifying our design decisions and development processes which are showing that tight coupling between the educational and play/story aspects of the game is essential. This ensures the learning in our games happens as part of the fundamental game play (rather than being an interruption to the game elements). Our model will be made available through the Working Examples website as an exemplar for individuals, organizations, and agencies for their use in an effort to spread best practices developed under the sponsorship of the ENGAGE program.

DARPA is Developing Games that Teach Kids how to Program Robots! By Carnegie Mellon's Robotics Academy (CMU/RA) <http://www.cs2n.org>

Robotics Competition Simulated Games

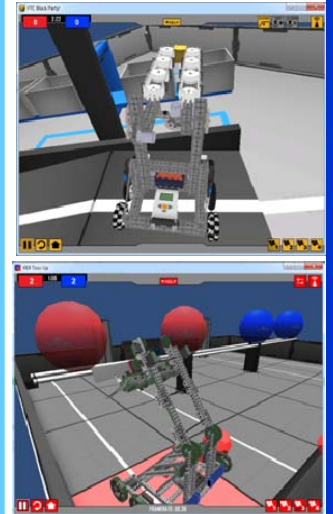
DARPA and Carnegie Mellon's Robotics Academy (CMU) have teamed with the two largest Robotics Competition sponsors in the United States, FIRST Robotics and the REC Foundation, and are developing games that are scalable and reconfigurable that teach students how to program robots. The robotics competition sponsors target middle and high school age students from both formal and informal learning environments and use robotics competitions to motivate more students to pursue Computer Science and Engineering careers. Each year competition sponsors develop a new robotics game and over 10,000 US teams participate in the robotics competitions that this project supports. CMU has developed technology using virtual robots that includes the same sensor types that are found on the physical competition robots (infrared, accelerometer, encoder, gyro, light, and touch sensors), a realistic physics engine, a real-time debug-

ger, virtual robots that are programmed using the same programming languages used to control the physical robots, and a simulated representation of the robotic challenge. This project solves a major obstacle that teams face when trying to teach a large number of students to program their team's robot, the cost of providing individual robots for each student, and provides students the opportunity to continue learning programming at home.

CMU provides the robotics competition community with several versions of each game. First, one that is designed to simulate the actual competition which involves a combination of remote control and autonomous programming, and second, a game that is slightly modified and can be challenged using all autonomous programming. The modifications include: "safe zones" where students can upload additional autonomous code on their robots without penalties, "auto-load zones" where students can go to get game scoring pieces, and in some case a slightly

modified playing surface. And lastly, a Learning Management System that includes other simulated worlds designed to scaffold instruction for new programmers.

The games integrate automated assessment tools (badges) designed to track student progress using DARPA/CMU's Computer Science Student Network (CS2N) website and share the student's progress with the student's teachers as well as researchers on the project. Badges are awarded as students demonstrate programming competencies as they play the games. During the summer of 2013 CMU's Robotic Academy hosted a virtual Robotics Summer of Learning (RSOL) where students participated in online classes, played simulated games, and competed in a virtual competition. Over 2,500 students participated the virtual class and competition and thousands of other students programmed virtual robots; students earned over 50,000 programming badges! There is significant evidence that the robotics simulation environments



DARPA is Developing Games that Teach Kids how to Program Robots! By Carnegie Mellon's Robotics Academy (CMU/RA) (CONTINUED)



are moving into classrooms across the US; from August through September 2013 over 175 teachers have setup virtual classrooms via the Computer Science Student Network that enable them to track their student's progress; many of those teachers setup multiple classroom sections. Select the Robotics Academy Summer of Learning picture to learn more about our virtual robotics competitions.

Initial Research on Motivation and Persistence

One part of our research involves investigating whether the Badges that we've integrated into our games can motivate longer and deeper learning. During the RSOL project students were randomly sorted into groups which received Badges throughout their course of study, and groups which interacted with the exact same curriculum and activities, but without Badges displayed. With the Summer of Learning events now concluded, analysis of the data is in progress. Through this and future studies, CS2N will



directly support the collection of meaningful experimental data to answer key empirical questions about the effectiveness of Badges in both motivation and credentialing, and the eventual establishment of best practices surrounding Badges.

The first paper on the motivational effects of Badges in CS2N was published in March of 2013, documenting large, subtle trends in student response to Badges, which warrant careful consideration in the design of Badge systems!

The picture at the left shows a badge earned in the Operation Reset programming environment. In order to earn this badge, students are required to write a program to navigate to the communications tower. Once they reset the communication tower they open up additional levels and new programming challenges.

Multi-Robot, Cloud-based Game Development

Many robotics competitions have teams competing against each other with robots that are controlled using a combination of autonomous and remote control code. CMU recently completed another milestone when it demonstrated that it could have multiple robots compete in a cloud-based simulation of those competitions. Game players played a game on four different computers in four different locations on a cloud-based environment. This innovative technology provides the following educational opportunities:

Students can program their virtual robots to compete or collaborate with other robot teams without having to travel, saving thousands of dollars.

Current educational technologies offer students the opportunity to program single robots to solve single robot problems. This technology will enable students to program multiple robots to communicate autonomously to complete tasks collaboratively. This is a game-changer; all robotics know that all future

DARPA is Developing Games that Teach Kids how to Program Robots! By Carnegie Mellon's Robotics Academy (CMU/RA) (CONTINUED)

robot systems will be part of much larger communication networks. It is imperative that we begin developing future innovators today that able to design and program these systems tomorrow.

Over the next two months, the focus of this project will be to improve the game in four main areas: Game Synchronization, Player Communication, Performance, and UI.

Game Synchronization: It's crucial that the game clock and location of all of the game objects is the same for all players. If one player moves a ball, that same movement must appear in all instances of the game. The system must be intelligent enough to synchronize 4 robots and over 30 game objects, with every player constantly making changes to the environment!

Player Communication: In the real-world version of these competitions, you can easily talk with members of the other team to convey your robots ability, desired starting point, and gameplay tactics. This is a challenge in a virtual, cloud

-based setting; we've implemented Chat functionality, with the ability to talk with just your partner or all players. Making it intuitive to use and including an adequate set of messages for clear communication is key.

Performance: Rendering a single robot on a game field is similar to asking your computer to render a character and environment in a video game. Rendering four robots is even more resource intensive, so part of our research will be spent optimizing the performance requirements. To add to this, we'll also be optimizing the amount of data traffic needed to keep all instances of a match synchronized, without using excessive bandwidth.

User Interface: if we want this technology to go to scale, then the UI has to be intuitive.

In January this game will be tested by multiple robot teams from different regions of the country. The project development team is currently modeling games around the robotics competition community,

but in the future envisions developing games that use Real Time Data Sites that stream data into the game different variable in the game so that the game is different and interesting every time it is played. The long-term focus of the project is to develop a multi-player online game that teaches multi-robot communications, programming, data logging and analysis, and is fun.

Expedition Atlantis, a Calculated Deep Sea Underwater Adventure - Developing a Game that Teaches Algorithmic Thinking and Mathematics

Expedition Atlantis takes the lessons learned during CMU/University of Pittsburgh Learning Research and Development Center's (LRDC) NSF funded Robot Algebra Project and integrates them into a game designed to teach kids the math behind robot movement. The game successfully integrates the motivational effects of the Legend of Atlantis, robots, and a graphically stimulating underwater environment to teach proportional reason-



The project team modeled above is the 2013-14 REC Foundation VEX Toss-Up game.



**DARPA is Developing Games that Teach Kids how to Program Robots!
By Carnegie Mellon's Robotics Academy (CMU/RA) (CONTINUED)**

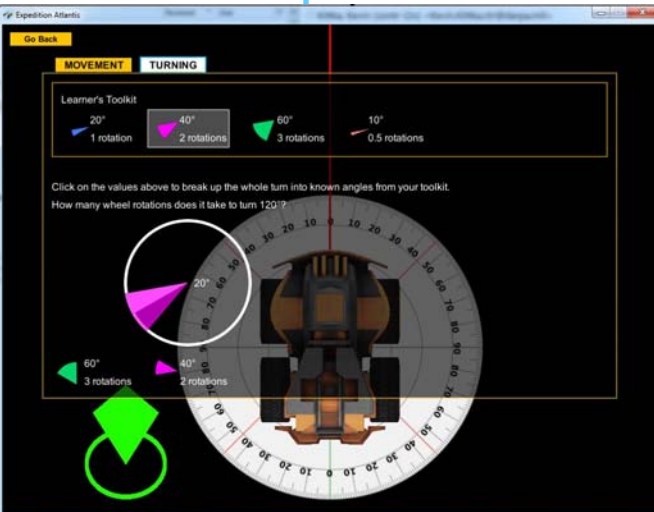
ing. Students are placed in the role of underwater explorer as they attempt to solve the riddle of Atlantis. Explorers learn how to play the game "in the game"

puzzle.

The Robot Algebra Project was a four year collaborative study by CMU and LRDC where we studied how informal and formal education settings taught robot math. We observed that many educators propose to use robotics as an organizer to teach mathematics, but we found that few actually foregrounded the robot math in ways that were effective. We learned that in order to be effective we needed to separate the mathematics from the programming and that in order to generalize a student's understanding of the mathematics that we needed to create tools for teachers enabling them to make connections between robot math and real world math. This game targets proportional reasoning which is taught in 4th and 5th grade level mathematics classes, but has shown to be engaging to older students also. The game includes math problems at multiple math levels: all problems in whole numbers, simple rational numbers (i.e. 1.5, 2.5), and any

rational number, enabling differentiated instruction so that all students can be successful. We've written numerous papers on "Teaching Robot Math" and they can be reviewed at: <http://www.cs2n.org/teachers/research>

In order to make the game more mathematically rich we developed a Robot Transformer which enables students to outfit their robots with different diameter wheels and different robot chassis. The wheel diameters and chassis sizes we specifically designed by the game designers to enhance the mathematical challenges integrated into the game. In order to ensure that students actually use all robot types different parts of the game require students to change robots. Expedition Atlantis is being tested in four middle schools this fall. It is also Badge enabled and connected through CS2N and will be tested by our online community. Testing includes pre and posttests analysis, classroom observations, and exit interviews with all stakeholders. Select



and their intuitive understanding of proportional reasoning is challenged and strengthened as they mathematically move their robot through the underwater

**DARPA is Developing Games that Teach Kids how to Program Robots!
By Carnegie Mellon’s Robotics Academy (CMU/RA) (CONTINUED)**

the picture for a quick look at screenshots as well as a detailed explanation of Expedition Atlantis.

Badges Earned in Games Lead to Certifications

Modern digital Badges are descendants of both the merit badge systems from the Scouting tradition (e.g. Boy Scouts, Girl Scouts), and the Achievement systems of online video gaming. Badges connect accomplishments using a compact, portable form of recognition designed to motivate earners to pursue further achievement. CMU is focused on designing Badges that are awarded when students demonstrate programming proficiency. The Badges are accompanied by direct evidence student work – a copy of source code, a sample of exam questions, or another type of computational artifact. Our project aligns with CS Principle’s Computational Thinking Practices identified as important for all students to understand by NSF Special Projects O938336 (Astrachan, et al., 2009-

2013) and is currently being used to assess both students and teachers as they work toward college and industry recognized certifications.

CMU uses Badges to motivate students, help them to define pathways and set goals, and indicate that they have mastered concepts.

The Badge Pathway illustrated to the right provides a Badge-based map showing a learner potential next steps as well as the types of computational artifacts that they can link to the badge. The badge then serves as a digital portfolio that enables badge earners to show off their accomplishments.

The evidence page enables badge reviewers to see: the level of proficiency, When the badge was earned, a sample of the test questions, who awarded the badge, links to computational artifacts, and how it the badge aligns with academic or industry standards.

Using Games as part of Teacher Certifications

The screenshot displays a digital badge interface for 'Exploring Computer Science With Robotics' by Carnegie Mellon Robotics Academy. It features a 'Badge Pathway' diagram showing 'Robot Programming Foundations' (Basic Programming Concepts) leading to 'CS 2N' (Data and Algorithms), which then leads to 'Computer Science Principles'. Below this is a section for 'Artifacts and Evidence' with icons for Creativity, Abstraction, Data, Algorithms, Programming, Internet, and Impact. The main part of the screenshot shows the details for the 'ROBOTC Programming Foundations (RVW)' badge, including its description, requirements (100% complete), gold requirements (endorsed by Tim Friez), standards (College Board AP Computer Science Principles), and pathways.

CMU had developed badge pathways that include badges earned in games that lead to certifications. Parts of the authentic assessment, where students demonstrate proficiency, can be earned by earning badges in the games. Certified teachers have the ability to CS2N class groups and use curriculum with students. Teachers can

**DARPA is Developing Games that Teach Kids how to Program Robots!
By Carnegie Mellon’s Robotics Academy (CMU/RA) (CONTINUED)**

then view the Badge trail left by students in their classes as they progress, giving them a data-driven assessment tool for both progress and mastery (based on the content of the student badges).

Our project develops resources for and trains FIRST and REC Competition teachers. Certified teachers earn a pedagogy badge when they participate in CMU training. Train-

ing covers:

- How to create a teacher/student learning community in their school that promotes active learning, teamwork, and problem solving that is jointly led by students and teachers.
- What appropriate questioning techniques look like, and how to ask students leading questions.
- How to scaffolding CS Instruction—teachers wear a “student hat” when they are learning, and then switch to a “teacher hat” during the end of session discussion when they discuss pedagogy.
- Common student programming misconceptions and how to debug code.

Robotics Academy Certified Robotics Instructors



<p>Work Experience List your work experiences below, starting with your most recent one.</p> <p>Work Experience 1</p> <p>Employer: _____ Start Date: Month [] Year [] <input type="checkbox"/> Current Job</p> <p>Job Title: _____ End Date: Month [] Year []</p> <p>Job Responsibilities: _____</p>	<p>Resume-Based Credentials Indirect Claims of expertise</p>
<p>Hover over any Badge to view evidence of applicant’s qualifications or experience:</p> <ol style="list-style-type: none"> Understand the design principles of integrated electromechanical and software systems <div style="display: flex; justify-content: space-between;"> <div data-bbox="186 1743 292 1848"> <p>Robotics Technician Certification Demonstrate technical proficiency in areas identified by key robotics industry stakeholders, including the design and prototype testing of electromechanical systems, maintenance of... <i>Mouse over badge for additional information</i></p> </div> <div data-bbox="186 1858 292 1938"> <p>FIRST Robotics Competition Team: Participant Member of a 2013 FIRST Robotics Competition team, participating in at least one regional competition. Participated in the design, construction, testing, and marketing of a robot...</p> </div> </div>	

- That robotics is an eclectic mix of technology and academic concepts and that it is necessary to foreground and measure a topic if they want students to learn it.
- How to use specific CMRA/LRDC pedagogy and curricular support tools.

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Related Websites:

To date, ENGAGE has created a number of interactive learning applications, with new programs debuting every few months for both desktop and mobile devices. Current sites include:

- 1) Refraction: <http://www.centerforgamescience.org/ite/games/refraction>
- 2) Treefrog Treasure: <http://www.centerforgamescience.org/portfolio/treefrog-treasure/>
- 3) Washington State Algebra Challenge: <http://algebrachallenge.org/>
- 4) Computer Science Student Network: <http://www.cs2n.org>
- 5) CS2N Virtual Robot Worlds:
<http://cs2n.org/activities/robot-virtual-worlds/expedition-atlantis>
- 6) Neurostorm: <http://www.intific.com/index.php/products/neuroscience/neurostorm>
- 7) OurSpace: <http://www.intific.com/index.php/products/education/our-space>
- 8) CMU's ETC Helios: http://www.etc.cmu.edu/projects/impact/?page_id=18
- 9) UCLA CRESST ENGAGE: <http://engage.cse.ucla.edu>

Additional Information:

DARPA-BAA-11-36: ENGAGE:

<https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-11-36/listing.html>

DARPA I2O ENGAGE Program:

http://www.darpa.mil/Our_Work/I2O/Programs/ENGAGE.aspx