

TEACHING WITH VIDEO GAMES: ENGAGING ALL STUDENTS IN STEM EDUCATION



Presenters

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With Partners



Funding for the project is provided by...

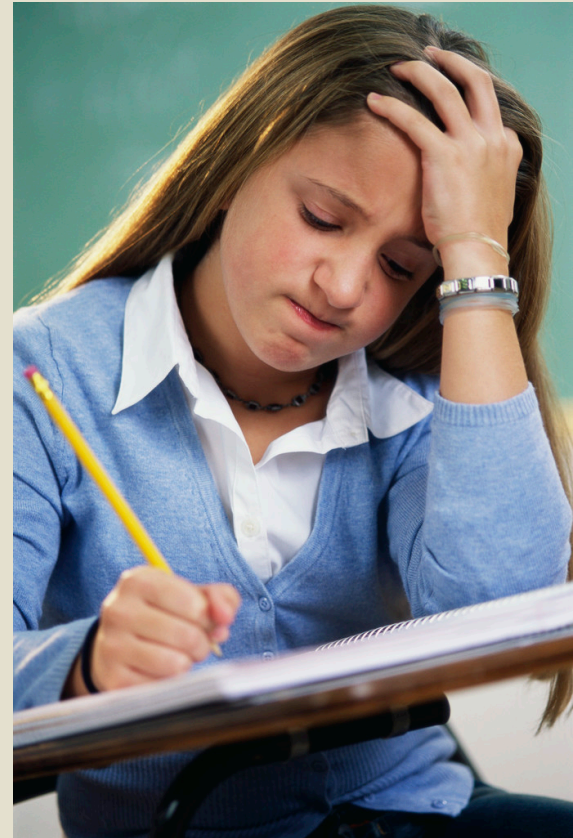


Game-enhanced STEM ~ Project Goals

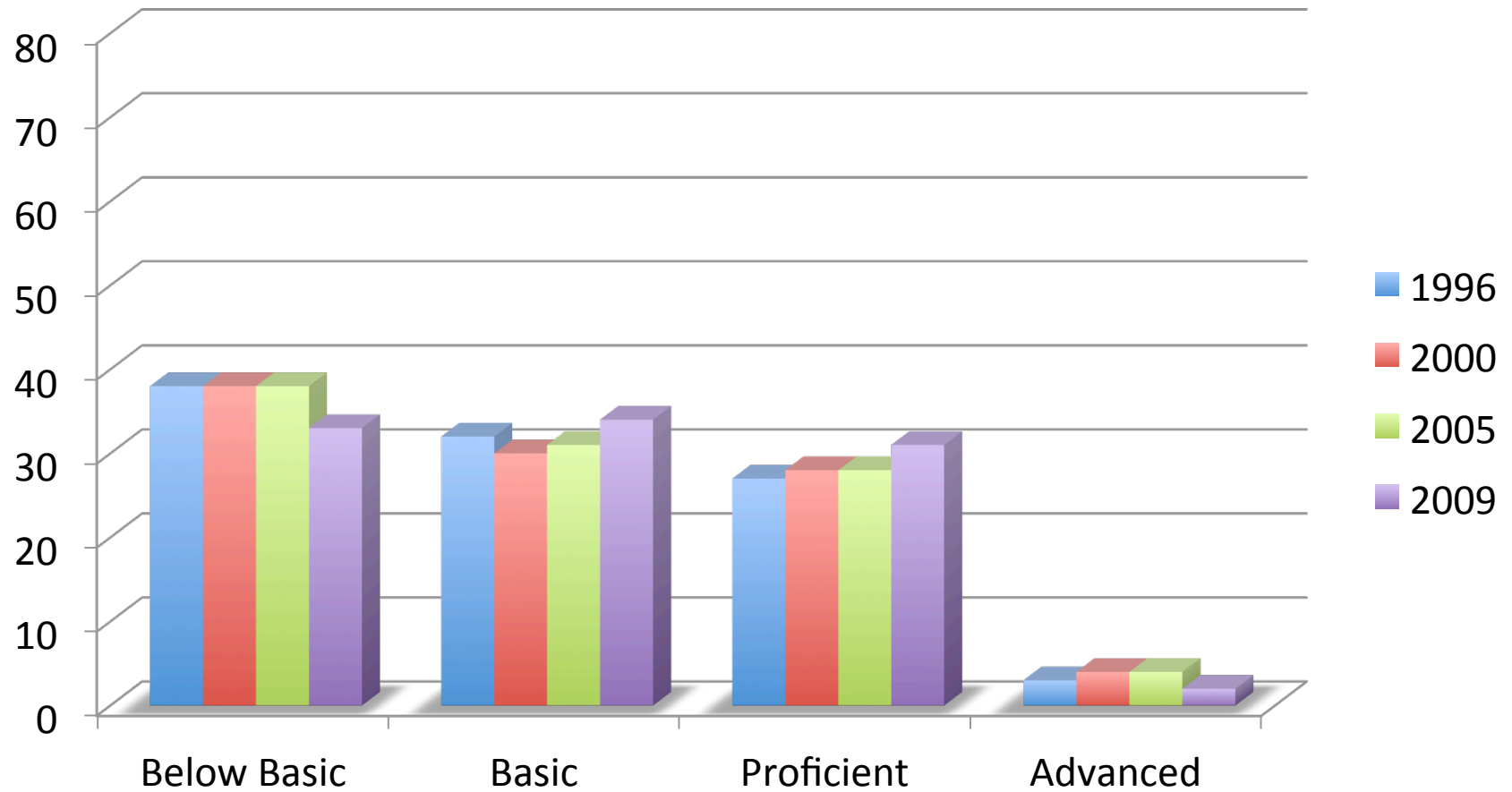
- Create and assess the efficacy of video games that integrate STEM content
- Apply innovative evidence-based instruction and assessment principles to video games
- Increase accessibility of middle school STEM curricular materials for ALL students
- Reduce the STEM achievement gap by improving learning outcomes for students with disabilities and those who are at-risk of learning failure
- Incorporate Universal Design for Learning and progress monitoring tools in the games
- Strategically target traditionally marginalized students during middle school, before they become disenfranchised with STEM

What's So Difficult About STEM?

- More new vocabulary than in the first year of a high school foreign language course
- Complex expository texts that limit of poor readers' comprehension (Lee & Erdogan, 2007)
- New information is *covered* at a rapid pace
- Increased emphasis on using the scientific method to solve complex multi-step problems

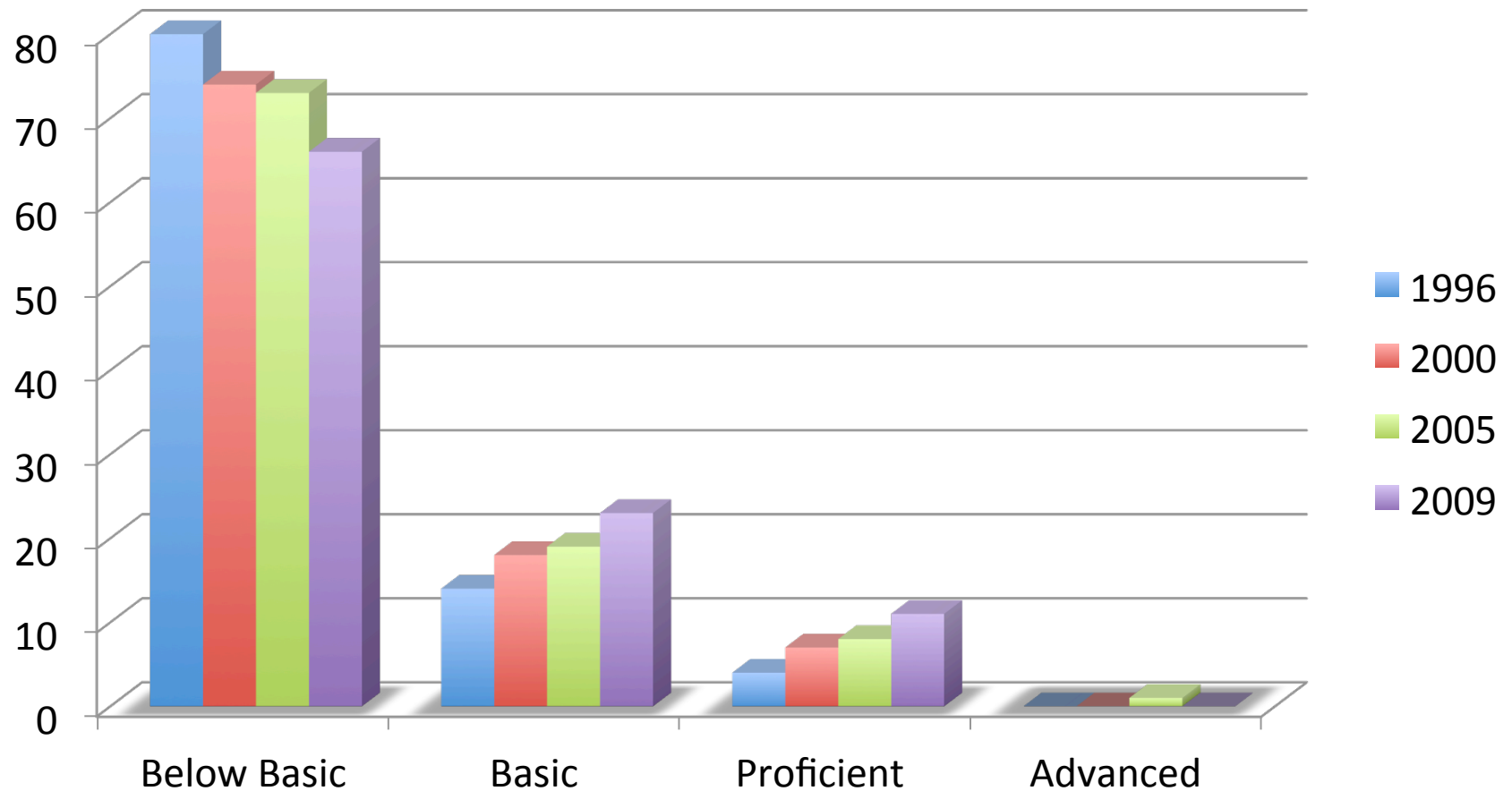


8th Grade Science Performance of Students Without Disabilities



U.S. Department of Education, National Center for Education Statistics (2010)

8th Grade Science Performance of Students With Disabilities



Outcome - Only 5% of SWD enter the STEM workforce (Leddy, 2010)

Students with Learning Disabilities

- Have difficulty activating prior knowledge
- Are reluctant to pose questions or hypotheses
- Are less likely to have a systematic plan to approach problems
- Struggle to implement instructor feedback
- Have difficulty making inferences during inductive and deductive reasoning processes
- Seldom transfer knowledge across contexts
- Are less likely to be aware of their metacognitive processes



[Technology](#) » [Gaming](#) ■ [Game Hunters](#) ■ [Jinny Gudmundsen](#) ■ [Marc Saltzman](#) ■ [Shop for Games](#)

Survey: Nearly every American kid plays video games

Posted 9/16/2008 12:12 PM | [Comments](#) [61](#) | [Recommend](#) [12](#)[E-mail](#) | [Save](#) | [Print](#) | [RSS](#)[Enlarge](#)By Sue Beyer, The Express-Times
via AP

Billy Nolte, foreground, plays "Guitar Hero III" during at Cyberdome in Easton, Pa. Cyberdome is a gaming center with 25 Xbox 360 consoles and two Nintendo Wiis connected to high-definition TVs that lets teens play video games in a social atmosphere.

By Martha Irvine, AP National Writer

CHICAGO — Katherine Graden doesn't really like shoot-'em-up video games. She prefers games on her Wii system that test her fitness and agility — the ones her guy friends tease are her "sissy games."

"I'm like, 'Fine! Go play your violent games. I'll stick with mine,'" the high school freshman from Chicago says, chuckling.

It's a common scenario, according to a new national survey from the Pew Internet & American Life Project that illustrates just how ingrained games have become in youth culture.

PEW REPORT: 'Teens, Video Games and Civics: Teens' gaming experiences are diverse and include significant social interaction and civic engagement'

The survey found that while young Americans don't necessarily play the same thing, nearly all of them — girls included — play video games of one kind or another.

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Who Plays Video Games?

- 99% of boys & 94% of girls play video games
- 54% play daily (500k middle school students with LD)
- 34% of boys & 18% of girls play for >2 hours daily

Where do they play?

- 86% on consoles
- 73% on computers
- 60% on portable devices
- 48% on cell phones



Lenhart, A. (2008) Teens, video games and civics. Pew Internet and American Life Project
<http://www.pewinternet.org/Reports/2008/Teens-Video-Games-and-Civics.aspx>

Note: error +/- 3 points

“Serious” Video Games

Educational video games represent the next generation of technology-enhanced instructional materials



Students can become immersed in fun and engaging standards-based environments (e.g., inside the human body) that are unobtainable in traditional classrooms (U.S. Department of Education, 2010)

Play some serious games at <http://www.filamentgames.com/projects>

GILS Trailers



Preliminary Research on Gaming and SWD

- Can be more effective than traditional instruction (Twyman & Tindal, 2006)
- Increases motivation (Charlton, Williams, & McLaughlin, 2005)
- Promotes self-esteem (Harris & Rea, 2009)
- Improves skills for extended periods after the game ends (Beaumont & Sofronoff, 2008)
- Accelerates learning (Charlton et al., 2005)

Universal Design for Learning (UDL):

A framework for accessible videogame design

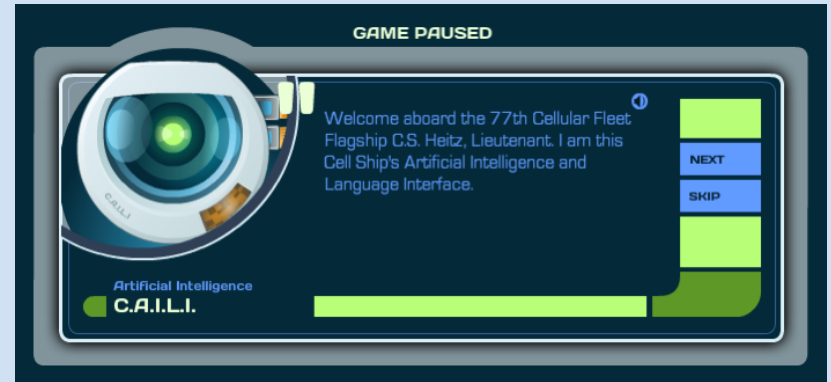
- Provide scientific data using multiple means of representation (e.g., pictorial representations, tables, simulations, etc.)
- Provide options for students to demonstrate their comprehension of concepts and phenomena (i.e., multiple forms of assessments)
- Allow students to engage with the materials in a diverse manner that fosters their motivation and unique learning needs

Center for Applied Special Technology (2009)

<http://www.cast.org/>

Instructional Supports in the Games

- Clear goals and objectives
- Text-to speech
- Virtual dictionary
- Expert modeling via a virtual mentor
- Extended learning and practice opportunities
- Immediate corrective feedback
- Advanced organizers to assist with planning and problem solving
- Collaborative grouping & peer tutoring options
- Iterative learning cycles ~ each level builds on and reiterates previously learned knowledge and skills



29 FPS

Platform: Windows 7
Release Player: WIN 10.1.02.14

THE HOST

pathogen design studio

What kind of virulent disease will you create? Be sure you choose attributes capable of withstanding your human host's defenses!

TYPE

Bacterium

TRANSMISSION

Airborne

PERK

Lighter

SHAPE

Rod

PERK

Flagellum

pathogen name

PROPAGATE!

50 FPS

Platform: Windows 7
Release Player: WIN 10.1.02.14

DURABILITY

Click and hold to INJECT!

Click and hold to INJECT!

SPACEBAR

29 FPS

Platform: Windows 7
Debug Player: WIN 10.1.02.14

62

Click and hold to INJECT!

Pathogen replicating! ^_^

SPACEBAR

26 FPS

Platform: Windows 7
Debug Player: WIN 10.1.02.14

94

INVASION PROGRESS

Click and hold your mouse now to begin injecting RNA!

GENETIC TRANSFER

SPACEBAR

UDL in a Game Environment

Complex multi-step directions are presented using a series of easy to follow tasks that aid students with processing difficulties. Tasks are presented using text with a read aloud option.

Rich graphics provide students with multiple ways to view the same data. Teachers and IEP teams receive reports on player choice and performance. These reports can be easily exported.

“Sandbox” gameplay allows players to experiment with variables without high-stakes repercussions.

Players have access to narration for any and all text in the game.

In-game experts provide modeling, tutorials and corrective feedback when students are unable to complete tasks independently.

Difficulty level adjusts dynamically based on player performance or teacher-specified proficiency levels. Students can track their progress toward benchmark objectives at any time.



The player has a choice of analytical tools that they can use to meet their individual learning needs.

Interactive learning environment motivates students by allowing them to customize the game based on their own preferences.

Another UDL Game Example

Complex multi-step directions are presented using a series of easy to follow tasks that aid students with processing difficulties. Tasks are presented using text with a read aloud option.

Monitoring tools document students' progress toward educational objectives. Teachers and IEP teams can use the data to enhance planning and instruction. The data is easily exported to programs like Excel.

Avatar of expert scientist provides modeling, tutorials and corrective feedback when students are unable to complete tasks independently.

Speech-to-text allows students to record observations and hypotheses in an electronic journal. The text can be exported to word processing programs.

Other tools provide essential information about concepts and vocabulary that students should have obtained during prior learning experiences.

Database tools provide additional information about the game environment and content using graphic illustrations, tables, charts, and video clips.

Orientation tools remind students of their location in the game.

Interactive learning environment motivates students and presents information from multiple perspectives.

Camera allows students to take screen shots as evidence that supports or refutes their hypotheses.



Game-enhanced STEM Project Timeline

Sept 2010 –
June 2011

- Proof of concept



**2011 ~ Grand Prize Developer Award Winner
U.S. Department of Education**

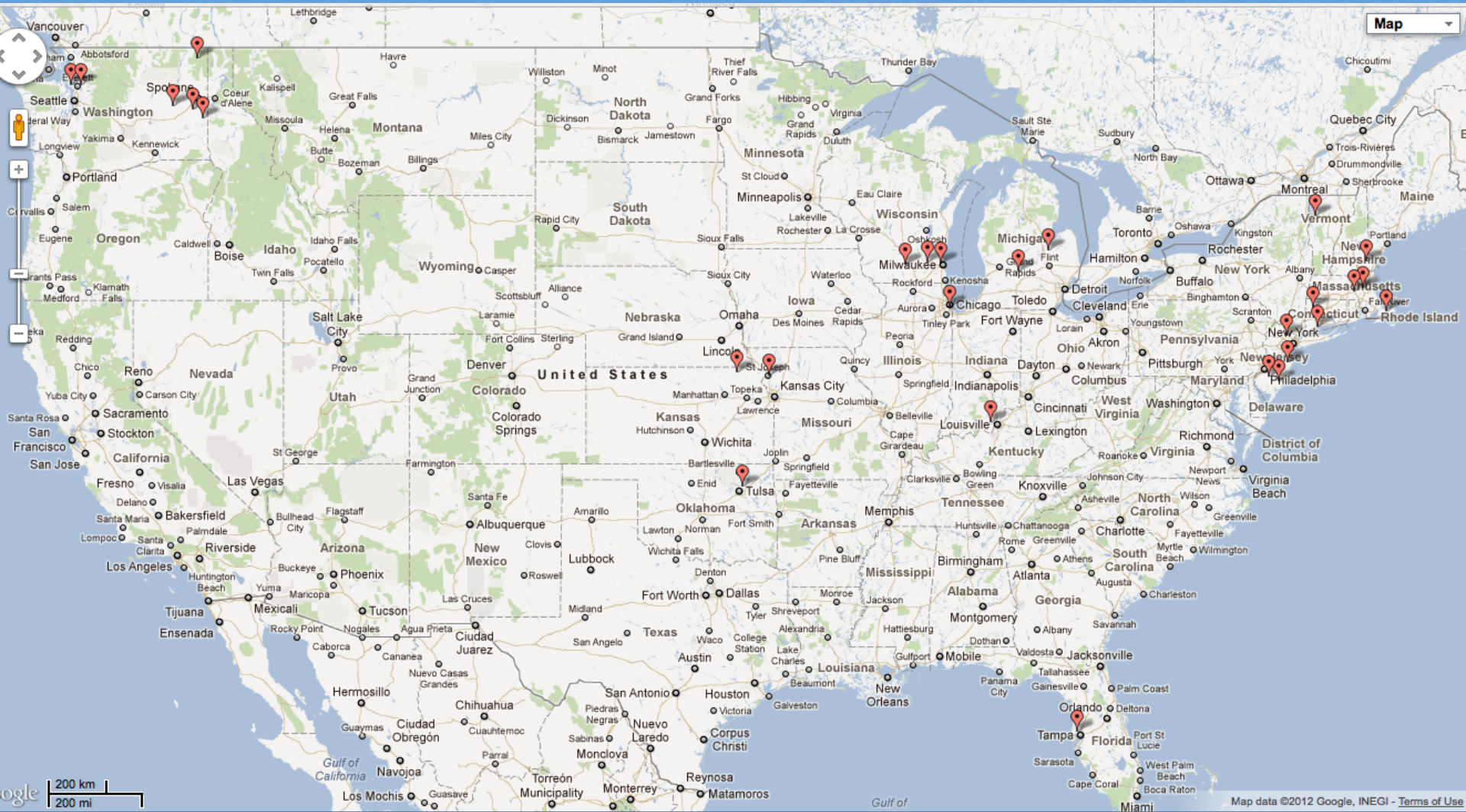
July 2011 –
March 2013

- Development & Innovation (10 games, PD, assessment measures, data collection system)

Sept 2013 –
August 2015

- Systematic implementation, Efficacy Study

Research Overview



2010 – 2013 Research Goals

- Gather playability, usability, and feasibility data on beta builds of all the games
- Develop and pilot test evaluation instruments (e.g., demographic, attitude and motivation surveys, paper and pencil assessments of students' knowledge and learning)
- Pilot test data collection mechanisms (e.g., timing and means of deploying surveys and assessments; training and support of teachers; the design, implementation, and reporting of game play data)
- Test methods of integrating and analyzing traditional survey and assessment data with game play data

What Teachers Told Us

- All teachers reported that their students were **excited and motivated to play the game** and participate in the research process.
- Teachers **appreciated learning scaffolds in the game** (i.e., highlighting vocabulary words, links to the pages in the textbook, and the visual dictionary).
- The games spurred **unanticipated discussions** about the content and scientific method, which **led to increased learning** by the entire class.

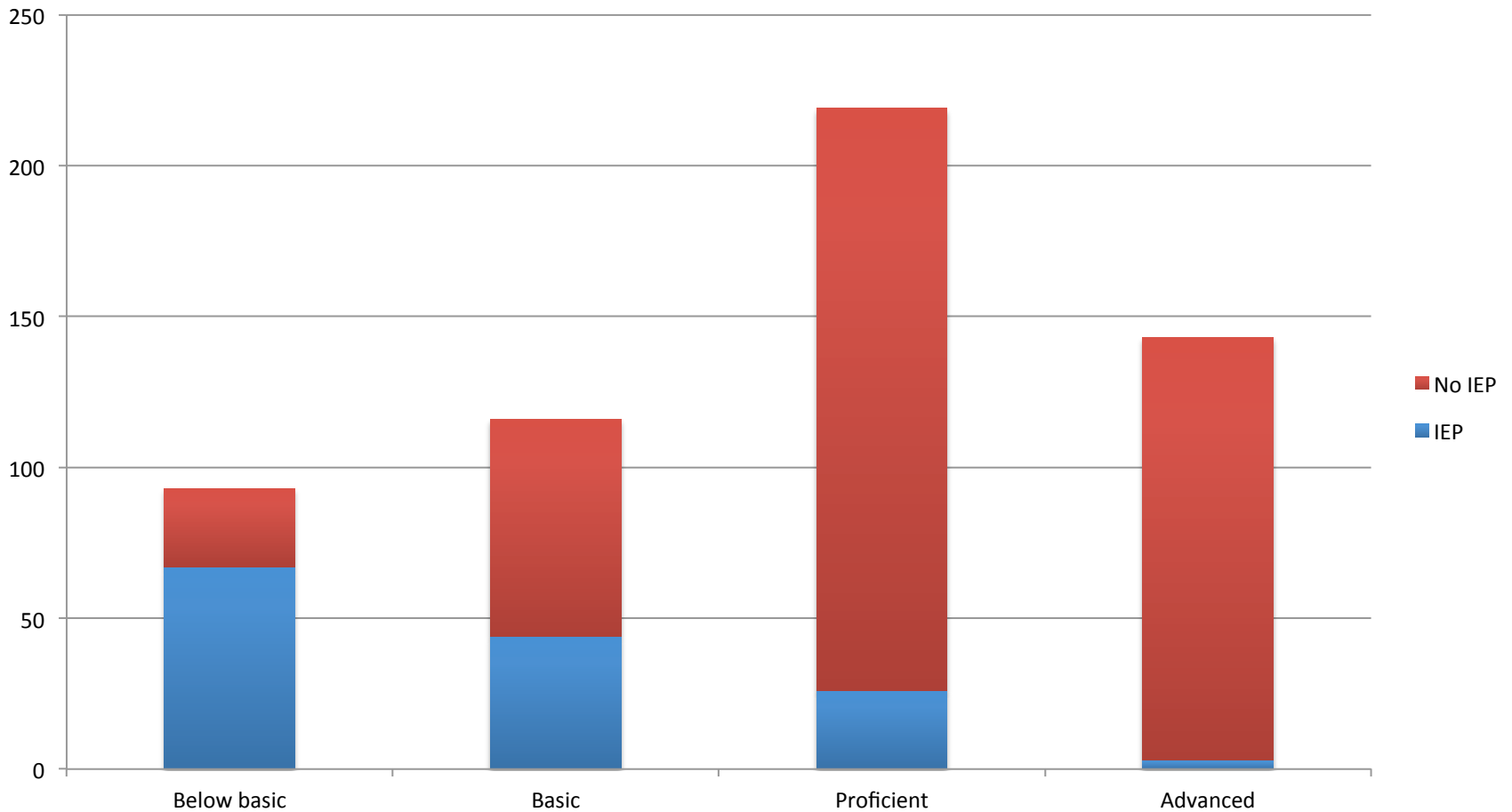


What Students Told Us

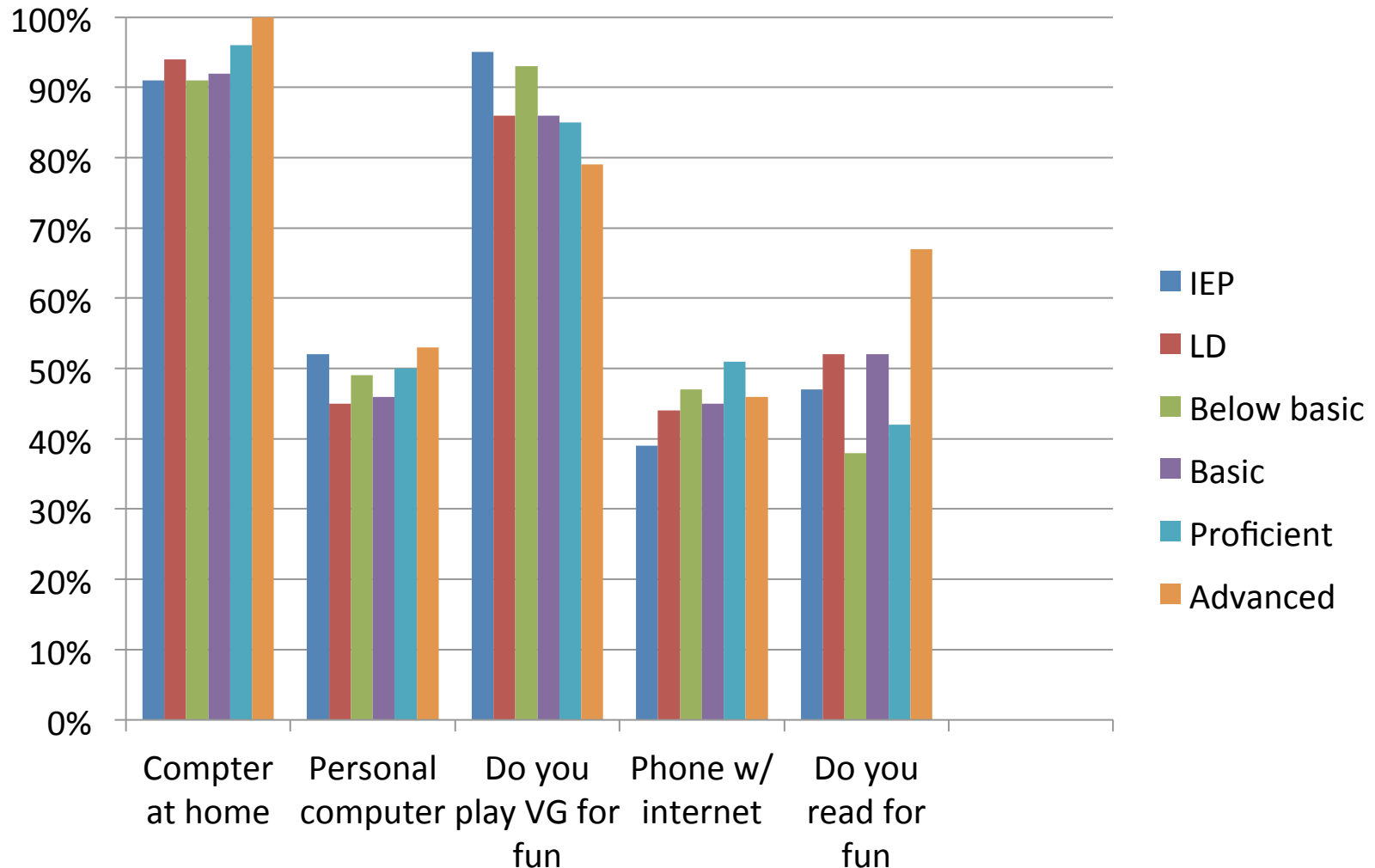
- The vast majority of students reported that **the game enhanced the science curriculum** and **made learning about science more fun**.
- A majority of students praised the ability to collaborate during the game and **asked for more opportunities to collaborate** physically and in online in teams of 2 – 4 students.
- With few exceptions, all **students said they would rather play videogames than take a traditional paper and pencil test**.



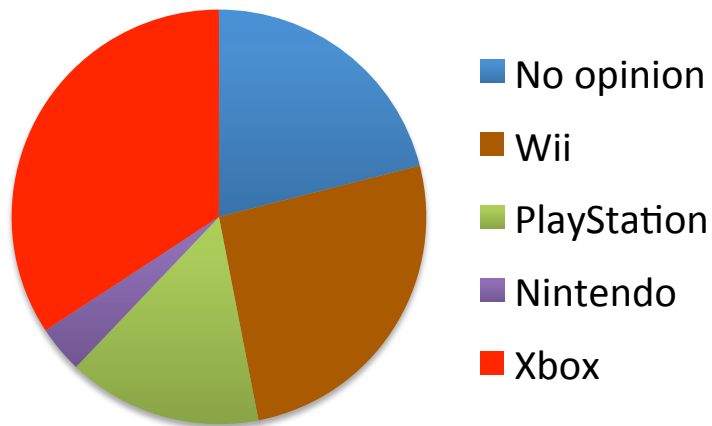
Distribution of Students on an IEP by Reading Ability Level



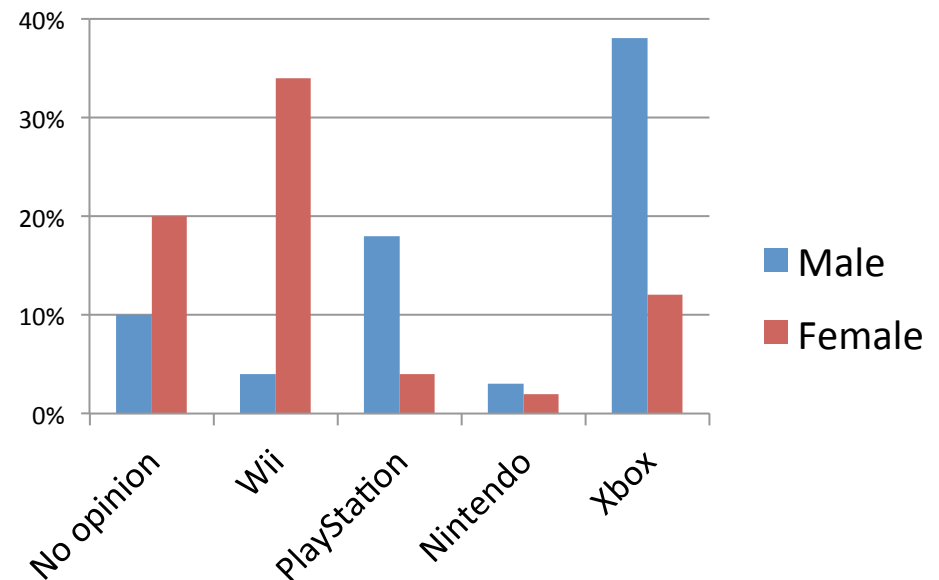
Percentages of students responding “yes” by reading ability group and disability status



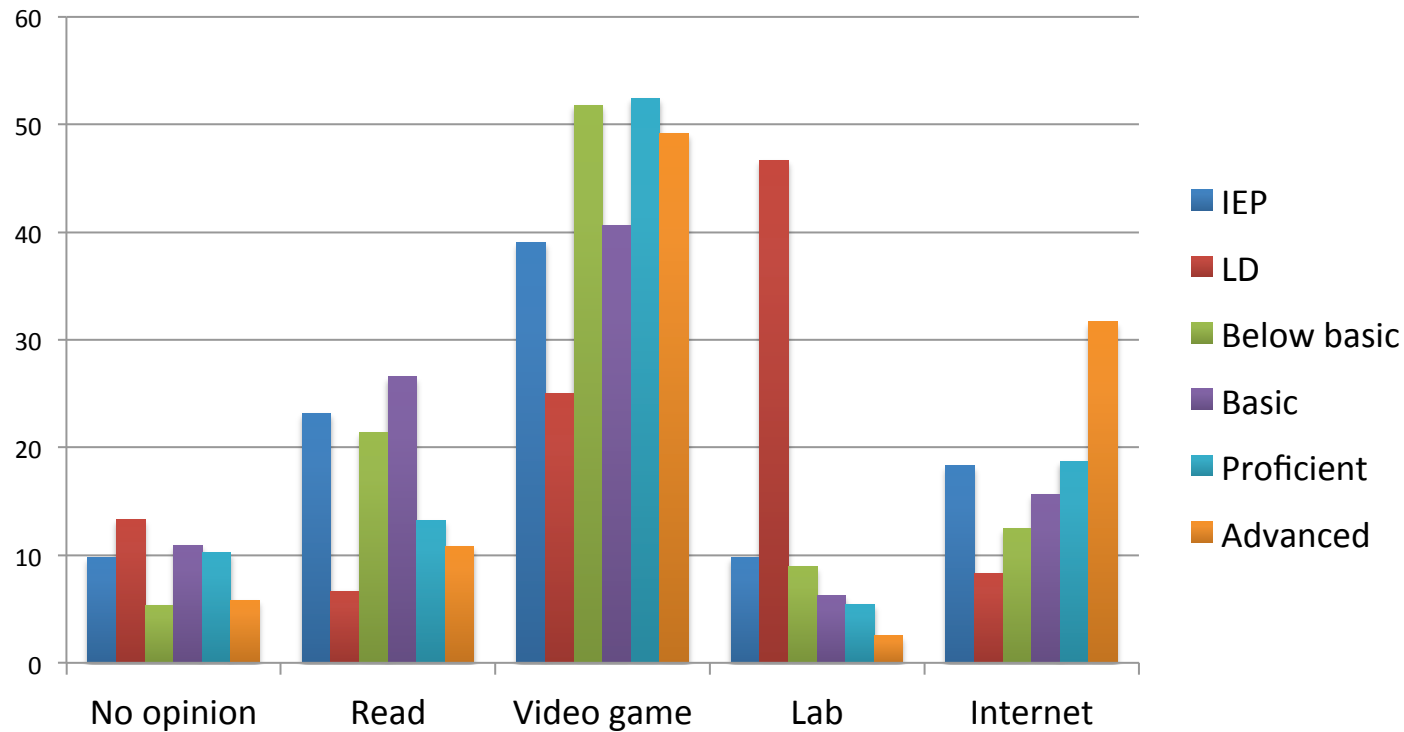
Preferred Game Platform (overall)



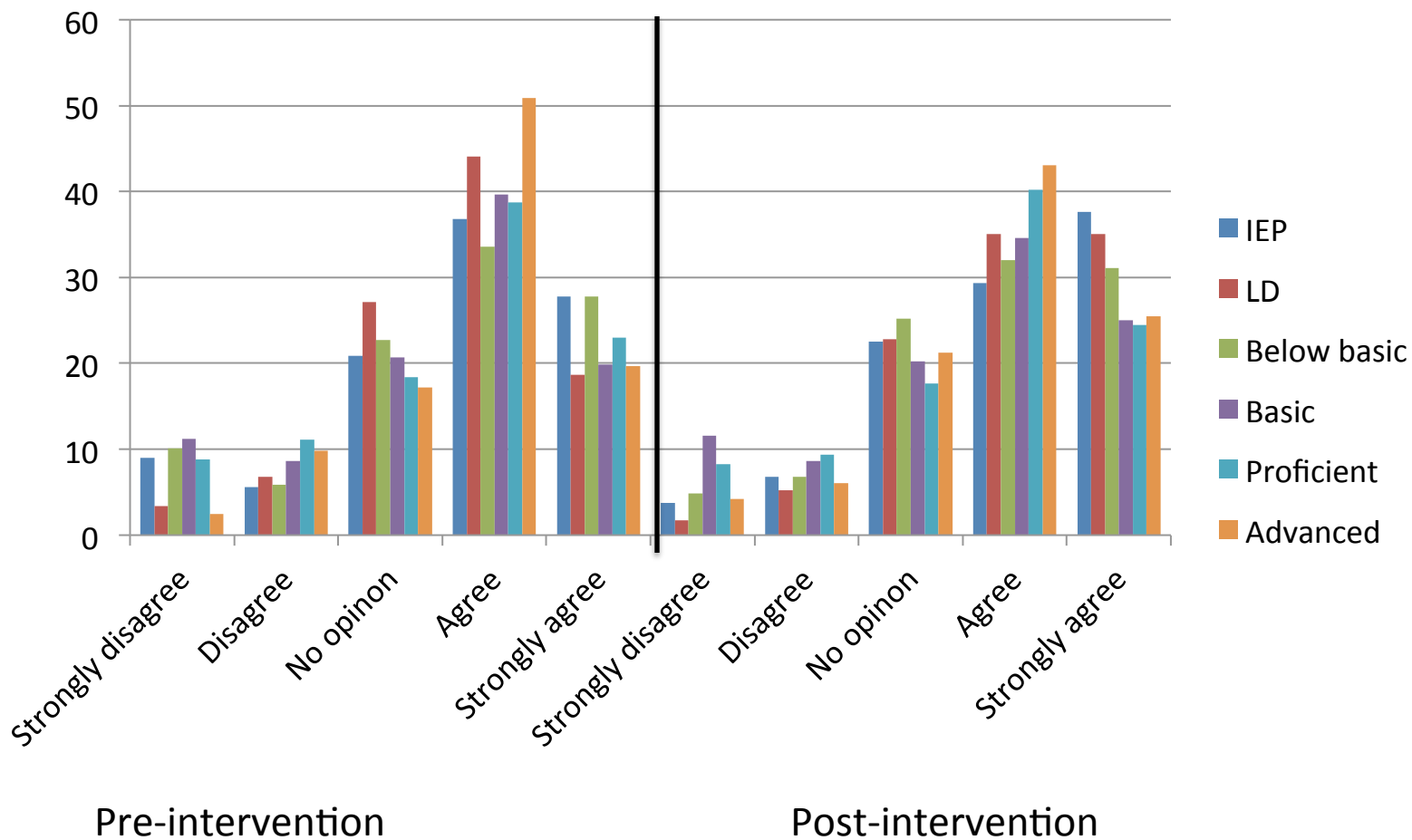
Preferred Game Platform by Gender



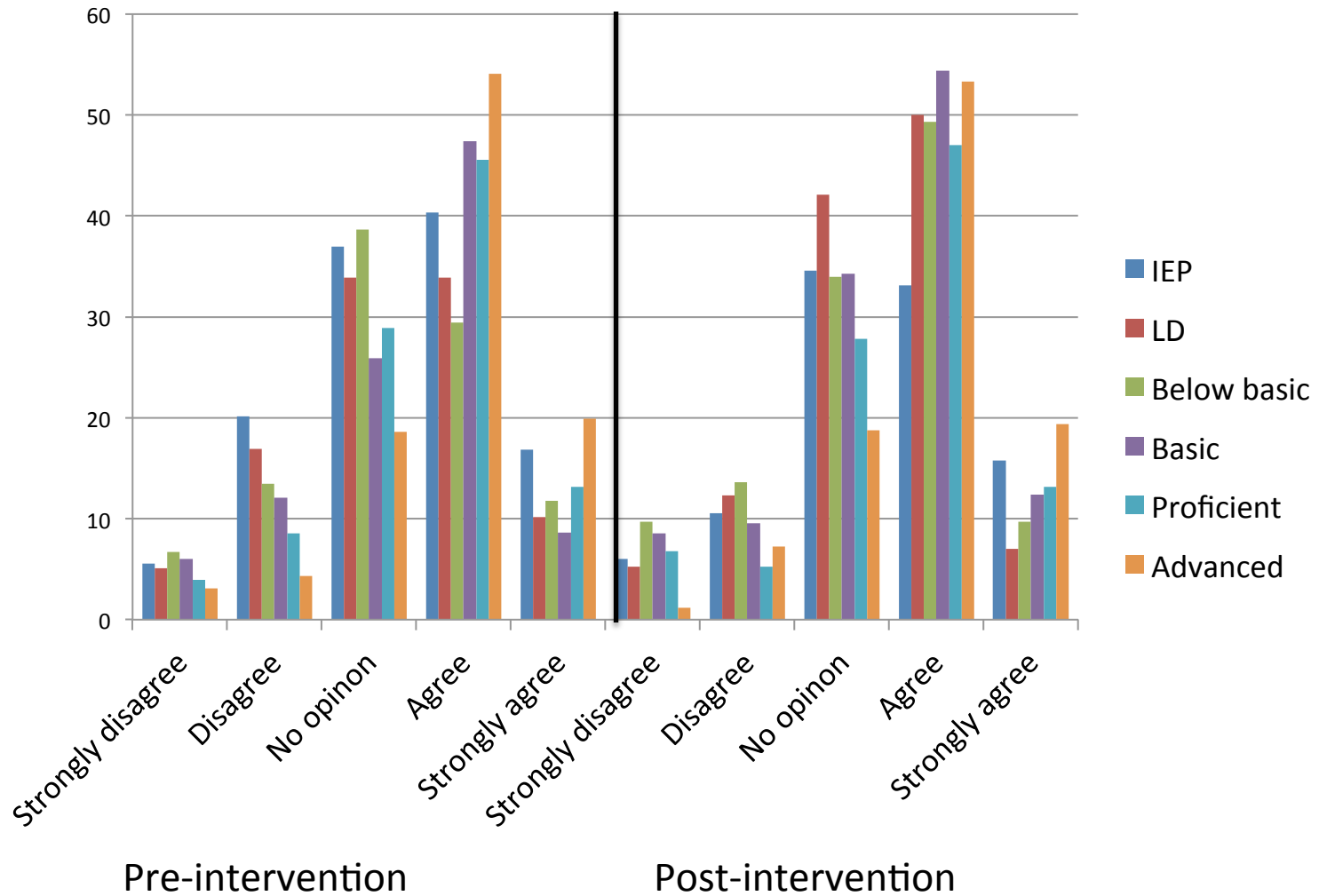
Preferred Way to Learn Science



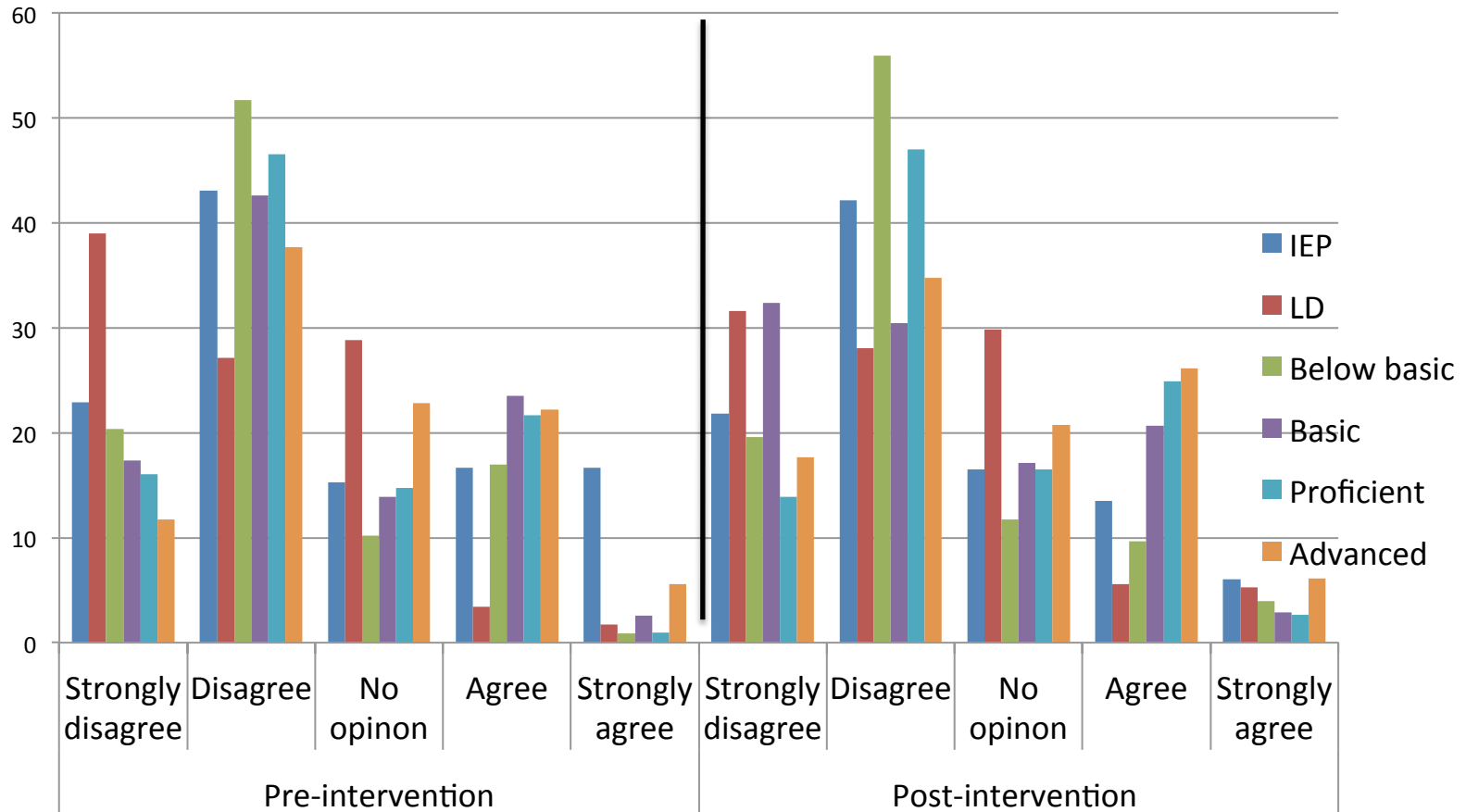
I like Science



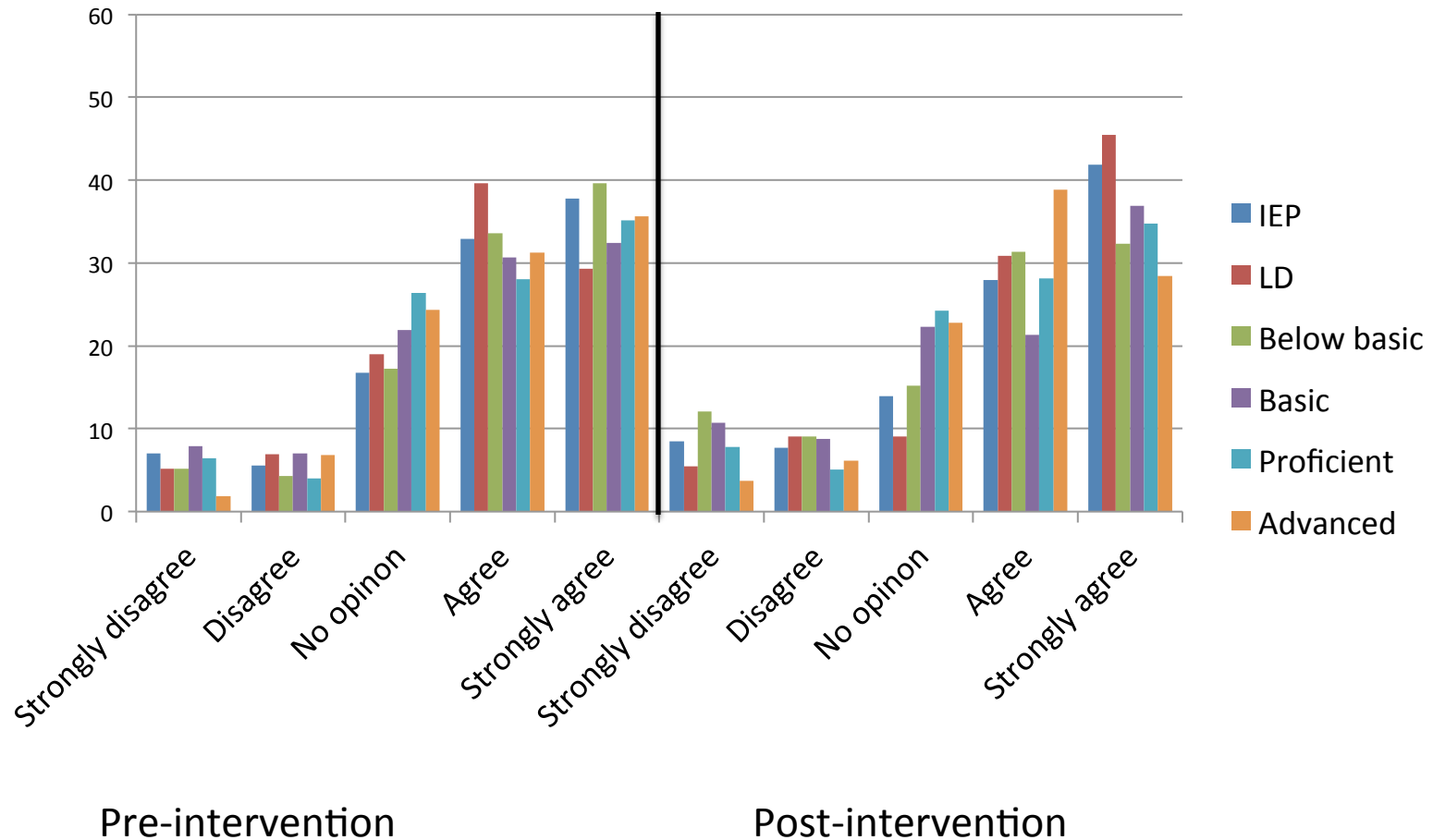
Good at Science



Want Job as a Scientist



Video Games Make Learning about Science Fun



UDL-based Games Address Problems with Traditional Assessments

- Print-based assessments measure decoding ability, writing ability, reading fluency, and reading comprehension before they measure subject-specific content knowledge
- Students' performance on print-based assessments can cause teachers to purport inaccurate inferences regarding students' learning (Russell & Haney, 2000)
- Traditional assessments often focus on outcomes (e.g., # of terms recalled) without considering process

What Teachers Told us About Games & Assessment

- Based on discussions with students, teachers reported the games **helped a majority of students**, especially students at the margins, **learn complex concepts and vocabulary**.
- The **paper and pencil test** was difficult for struggling readers and **was not an accurate indication of what students actually knew** about the content.
- **Gameplay statistics (user analytics)** might be a better indicator of students' actual knowledge and skills.



Using Games as an Assessment

- Develop a portfolio of assessment options or choices for students
- Map gameplay to specific learning objectives
- Record students' game progress (e.g., screen captures or digital photo's)
- Be sure to engage students in a dialogue about their gameplay
- Develop transfer tasks that challenge students to connect learning objectives, gameplay, and real problems they experience in their community



certificate of VIRULENCE



Pudge



28%

infection
success



Gretchen

0%

infection
success



Lewis

0%

infection
success



Cass

0%

infection
success



Bernard

0%

infection
success



Margaret

0%

infection
success



Meningitis

BASE
BACTERIUM

Influenza A

BASE
VIRUS

overall virulence rating

64%

MINIGAME SCORE

area invasion

0%

MINIGAME SCORE

physical invasion

50%

MINIGAME SCORE

airborne invasion

0%

MINIGAME SCORE

lungs invasion

0%

MINIGAME SCORE

stomach invasion

20%

MINIGAME SCORE

cell invasion

0%



successful host /
pathogen matches

100%



bonus questions
performance

66%

Completed on Monday, February 6, 2012 at 6:50pm - Time Spent: 29 Minutes

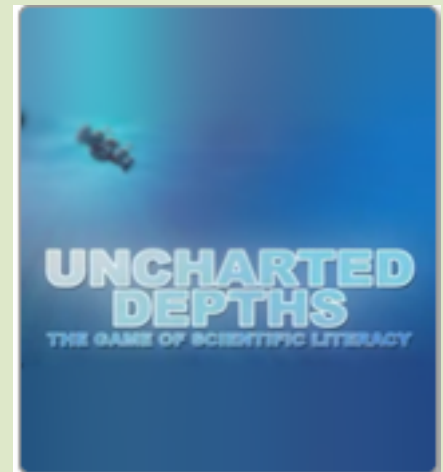
TITLE SCREEN

PRINT

REPORT

Teaching with games

- Games should not and cannot replace the role of an effective teacher!
- Start class with a discussion about students' goals and learning objectives while playing the game
- Games provide opportunities for teachers to conduct tiered interventions while some students play the games
- Highlight “teachable moments” in the game
- Conclude each class with a discussion about what happened, what students' learned, and what the plan is for next time



Questions / Discussion

- What teachers say about using video games in the classroom
- University research partnerships with private industry
- Scalable implementation with fidelity
- Measures, construct validity, reliability
- Data collection and analysis
- Project management
- Budgets and timelines

On the Web

Games

- [FILAMENT GAMES](#)
- [Wolfquest](#)
- [Selene: A lunar construction games](#)
- [Gamestar Mechanic](#)
- [Surge](#)
- [BrainPOP Game up](#)
- [Whyville](#)
- [ImmuneAttack](#)
- [Urban Science](#)
- [Learning Games Network](#)

Other Resources & Simulations

- [NBC Learn](#)
- [Real Time Physics](#)
- [Animal Diversity Web](#)
- [BIOkids](#)
- [PhET Simulations](#)
- [Physlets](#)
- [Interactive Physics](#)
- [STELLA](#)
- [SimScientists](#)
- [StarLogo](#)
- [Froguts](#)



Other Resources on the Web

The Super Book of Web Tools for Educators

A comprehensive introduction to using technology in all K-12 classrooms.

There are teachers around the world who want to use technology in their classrooms, but they're just not sure where to start. That's why eleven prominent bloggers, teachers, and school administrators got together to create this free ebook.

Introduction: pages 2-3

An Administrator's View: pages 4-7

Elementary School: pages 8-25

Middle School: pages 26-35

High School: pages 36-42

ESL/ELL: pages 43-46

Teaching Online: pages 47-50

Connect Via Skype: pages 51-61

Elementary School Blogging: pages 62-65

Alternative Ed Tech: pages 66-68

Social Media for Educators: pages 69-71

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Transforming American Education

Learning Powered by Technology

National Education Technology Plan 2010

U.S. Department of Education
Office of Educational Technology

Learning Science Through Computer Games and Simulations

Committee on Science Learning:
Computer Games, Simulations, and Education

Margaret A. Honey and Margaret L. Hilton, Editors

Board on Science Education

Division of Behavioral and Social Sciences and Education

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