Finding the connection between Game-Design and Problem-Solving: Game-Design and Learning Programs

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Connecting Game-Design and Problem-Solving: Game-Design and Learning Programs

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…Life can be much broader once you discover one simple fact: Everything around you that you call life was made up by people that were no smarter than you and you can change it, you can influence it, you can build your own things that other people can use.

Once you learn that, you’ll never be the same again.”

*Steve Jobs, 1995*
Design is...
- Synthesis of variables in multiple unique ways
- A quintessential ill-structured problem
- Problem-solving, problem-finding, inquiry
- Involves creating new objects, processes, or ideas
- Personally meaningful
- Engaging
- Important for STEM careers
Hard to teach in formal schooling contexts

Design and problem solving skills

syste
design
(digital) Game-Design

engaging visual representations for complex systems requires computer programming and problem solving

Image credit to Empire Building Network
Game Design

Coding

Problem solving
Game-Design and Learning (GDL) courses after or summer school
GDL goals

SYS = system analysis and design, DM = decision-making, TS = Troubleshooting
Design of GDL Curriculum

Curriculum Design Process

Pedagogies
- learners as designers
- constructionism
- guided discovery

Theories
- problem-solving
- methods of teaching of problem-solving

Game-design software

Instructional activities

Students

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
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<tbody>
<tr>
<td>Summer 2011</td>
<td>Istanbul, Turkey</td>
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<td>Summer 2012</td>
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<td>Fall 2012</td>
<td>Lansing, MI</td>
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<td>Statesboro, GA</td>
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<td>Spring 2015</td>
<td>Savannah, GA</td>
</tr>
</tbody>
</table>

over 200 students, and growing
Research

GDL

Problem solving

SYS
DM
TS

Cognitive Outcomes

SYS = system analysis and design, DM = decision-making, TS = Troubleshooting
Instruments

System analysis and Design

Trouble shooting

Decision making
Study design

GDL

Female = 4  
Male = 16

Control

Female = 12  
Male = 12

n = 20 ---->  n = 44  <--n = 24
Procedures

PRE
Problem solving (PISA)

control

POST
Problem solving (PISA)

GDL Program (~20 hrs)

experimental
RQ
Are there differences between control and GDL students in terms of their gains in problem solving skills?
Pre Post

Control group

Experimental group

(Wilks’s $\Lambda = 0.733), F(3, 40) = 3.0, p = 0.006, \eta = 0.267
Problem-solving skill change for GDL vs Control

System analysis and design, $t(19) = 4.7, p < .001, d = 1.062$
Decision-making, $t(19) = 4.7, p < .001, d = 1.05$
Troubleshooting, $t(19) = 3.9, p < .001, d = 0.87$
GDL

Cognitive Outcomes

Problem solving

SYS = system analysis and design, DM = decision-making, TS = Troubleshooting
Discussion

Intervention worked

Curriculum
Theories
Software
Activities

Students
Limitations

Quasi-experimental research

- Self-selected sample
- Multi-faceted intervention
Other outcomes?

Game Design
- System analysis and design
- Decision making
- Trouble shooting

Content (e.g., environmental literacy, ecology, biology, etc.)

STEM

Programming (advanced programming, advanced game-design)

Value

Interest

Complex Problem Solving

Implications

Future
CONSUMERS -> PRODUCERS
Connecting Game-Design and Problem-Solving: Game-Design and Learning Programs

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Research


The U.S. Department of Labor has projected that by 2018, the U.S. will have more than 1.2 million job openings in STEM fields.¹

4 in 5 STEM college students made the decision to study STEM in high school or earlier.

61% of male STEM college students say that games or toys sparked their interest in STEM; the top factor for men.

68% of female STEM college students say a teacher or class sparked their interest in STEM; the top factor for women.

ONLY 16% OF BACHELOR’S DEGREES IN 2020 WILL SPECIALIZE IN STEM.⁵

Source: Our Future Demands – Microsoft
Collapsing two groups into one

• Our analysis indicated that there were not any significant differences between the experimental groups in terms of their initial levels of problem solving, (Wilks‘s $\Lambda = .866$), $F (3, 16) = 0.827$, $p = .498$, $\eta^2 = .13$;

• as well as the gains they showed after attending the GDL program, (Wilks‘s $\Lambda = .903$), $F (3, 16) = 0.571$, $p = .642$, $\eta^2 = .097$.

• The two GDL groups, therefore, were combined and treated as one group for the further analyses.
To answer the research question, the gain difference between control and the GDL group students in three problem-solving skills, a repeated-measures multivariate analysis of variance (RM-MANOVA), having two levels of time (pre vs. post) as within subjects factors, and two levels of group (control vs. experimental) as between subjects factor (i.e., mixed-factorial design) was conducted on the dependent variables.

The multivariate omnibus for time was significant (Wilks's $\Lambda = .616$), $F (3, 40) = 8.328$, $p < .001$, $\eta^2 = .384$; as well as the omnibus for group, (Wilks's $\Lambda = .733$), $F (3, 40) = 3.0$, $p = .006$, $\eta^2 = .267$; and the interaction between time and group, (Wilks's $\Lambda = .505$), $F (3, 40) = 13.063$, $p < .001$, $\eta^2 = .495$.

The results indicate that compared to the control group, the students in the GDL group showed significantly larger gains in the three problem-solving skills. In fact, the control group did not improve in any of the problem-solving skills.
Follow up T-tests

• The results of the $t$-tests indicated that the GDL group demonstrated significant improvements in all three problem-solving skills
  – (system analysis and design, $t(19)= 4.700$, $p < .001$;
  – decision-making, $t(19) = 4.694$, $p < .001$;
  – troubleshooting, $t(19) = 3.853$, $p = .001$).

• All the effect sizes were large according to Cohen’s criteria for effect size interpretation (1988):
  – system analysis and design, $d = 1.062$;
  – decision-making, $d = 1.05$;
  – troubleshooting $d = 0.87$. 