Utilization of a Game-Based Homework Platform to Personalize Learning within a Large Chemical Product Design Class

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Motivation for Study

* Increased enrollment has led to larger class sizes
* This leads to difficulties with:
  * Building student-teacher relationships
  * Customizing course materials for students
  * Student engagement in the classroom
  * Detailed feedback for student development

Image obtained from: http://acreelman.blogspot.com/2013/03/challenges-of-online-classroom.html

Personalized Learning

* Provides instructions that meets the needs of each student through a variety of[1]:
  * Educational experiences
  * Instructional approaches
  * Academic support strategies
* Could serve as a solution to issues associated with large class sizes

Image obtained from: http://ade-ple.wikispaces.com/

1. Personalized Learning. [Web long post]. Retrieved from http://edglossary.org/personalized-learning/ on August 25th, 2015.

Approach: Game-Based Homework Portal

* Provides students with the option to personalize their learning experience
* Students select which quests (activities) to complete while meeting a minimum set of learning objectives
* Students are informed about quests through:
  * Quest descriptions
  * Time ratings
  * Student rankings

Image obtained from: go.nmc.org

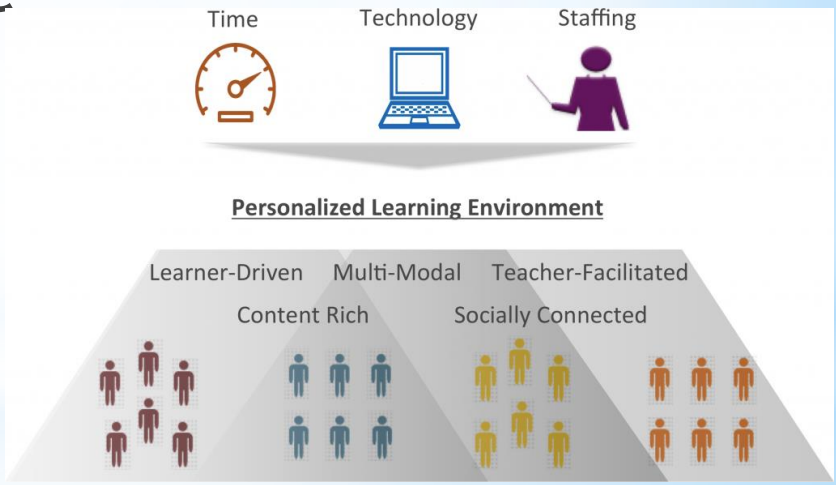
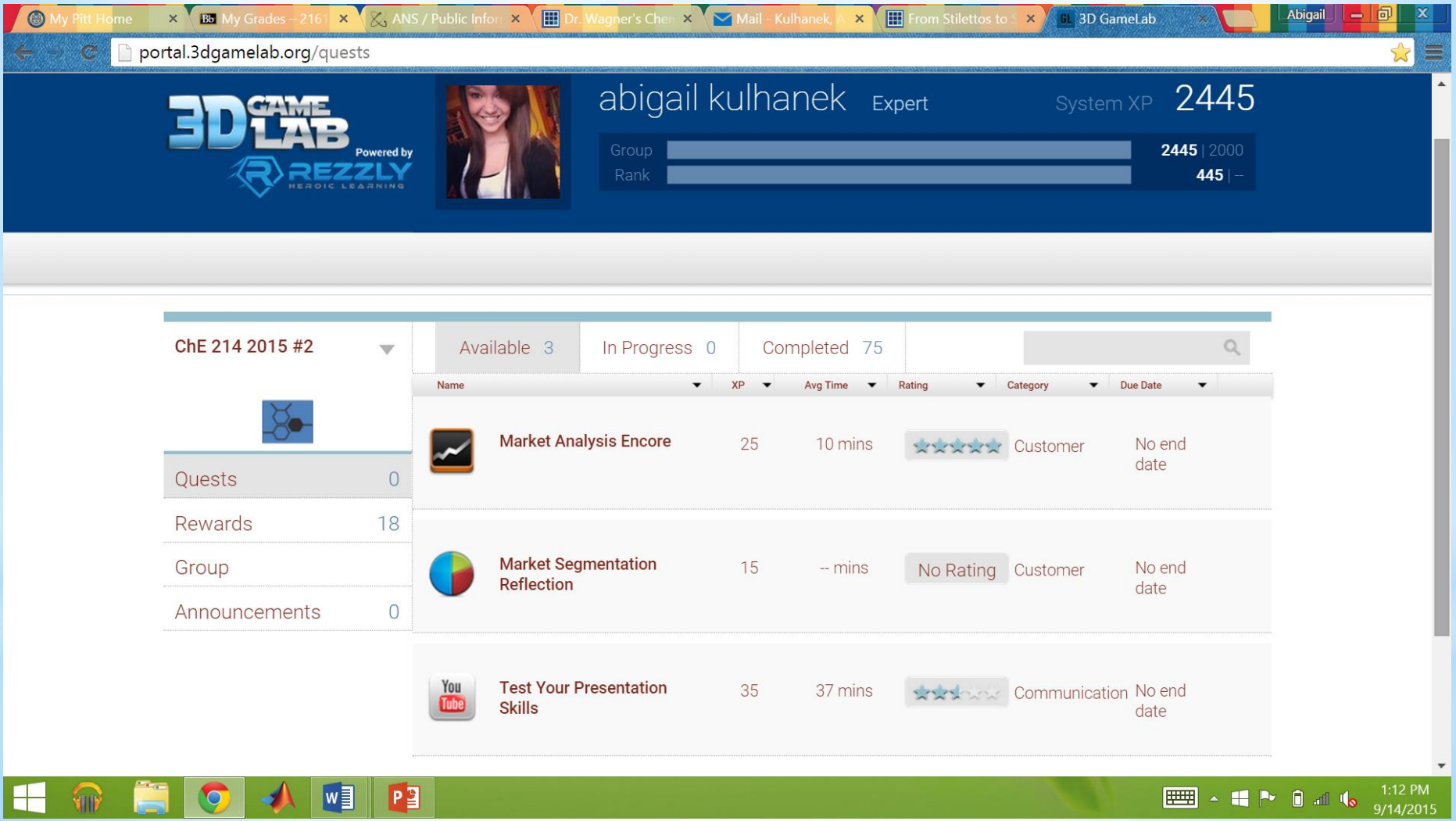


Image obtained from: http://masterydesign.org/about-us/mission/

Approach: Game-Based Homework Portal



Research Questions:

* What motivates students to pick the assignments that they complete and the order in which they complete them?

* Can student performance within the game-based portal be related back to profiles of types of students in gamification environments?

Study Design

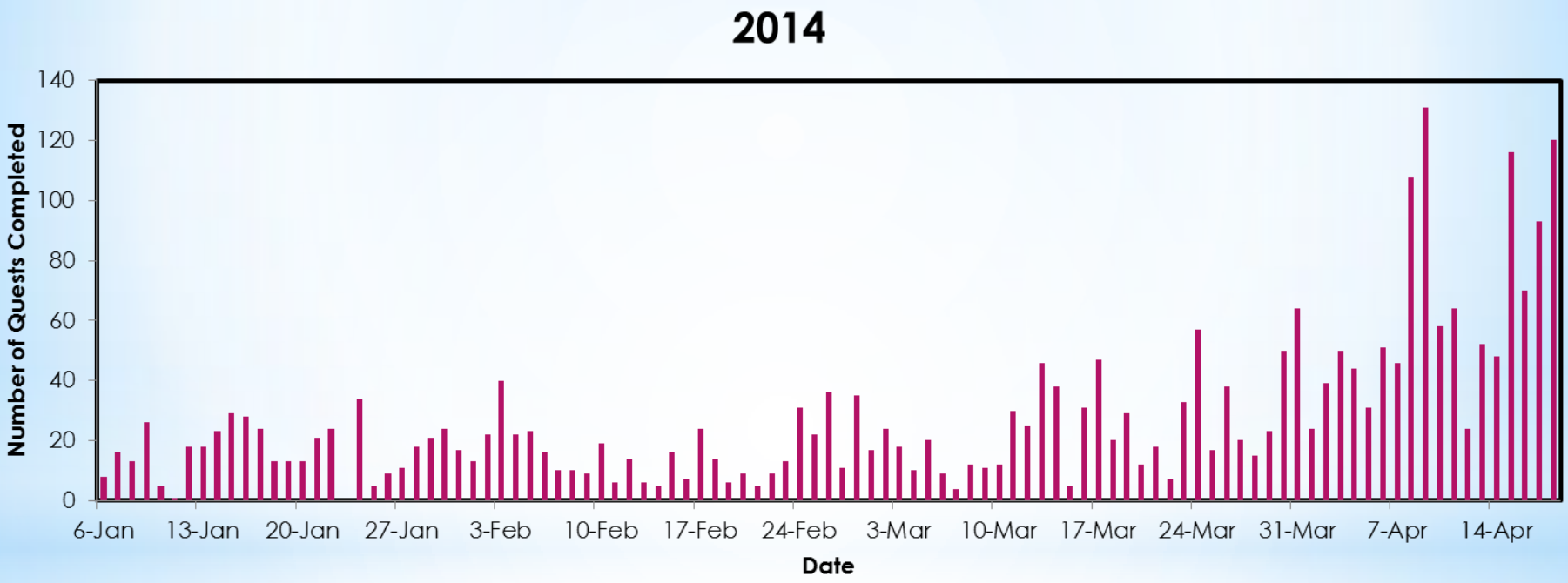
* 3D Game Lab was implemented as a homework portal for a sophomore level Introduction to Chemical Product Design class in Spring 2015
* Two sections used the homework portal:
  * 1 pm section – 80 students
  * 2 pm section – 86 students
  * Total – 107 male and 59 female students
* As students completed quests, their progression through the system was tracked weekly by:

- Total Experience Points (XP)
- Quest XP
- Reward XP
- The number of badges, awards, and achievements the student received
- XP in each of the quest categories
- The student's rank
- The number of quests the student completed
- The average time it took the student to complete each quest
- The average rating the student gave each quest

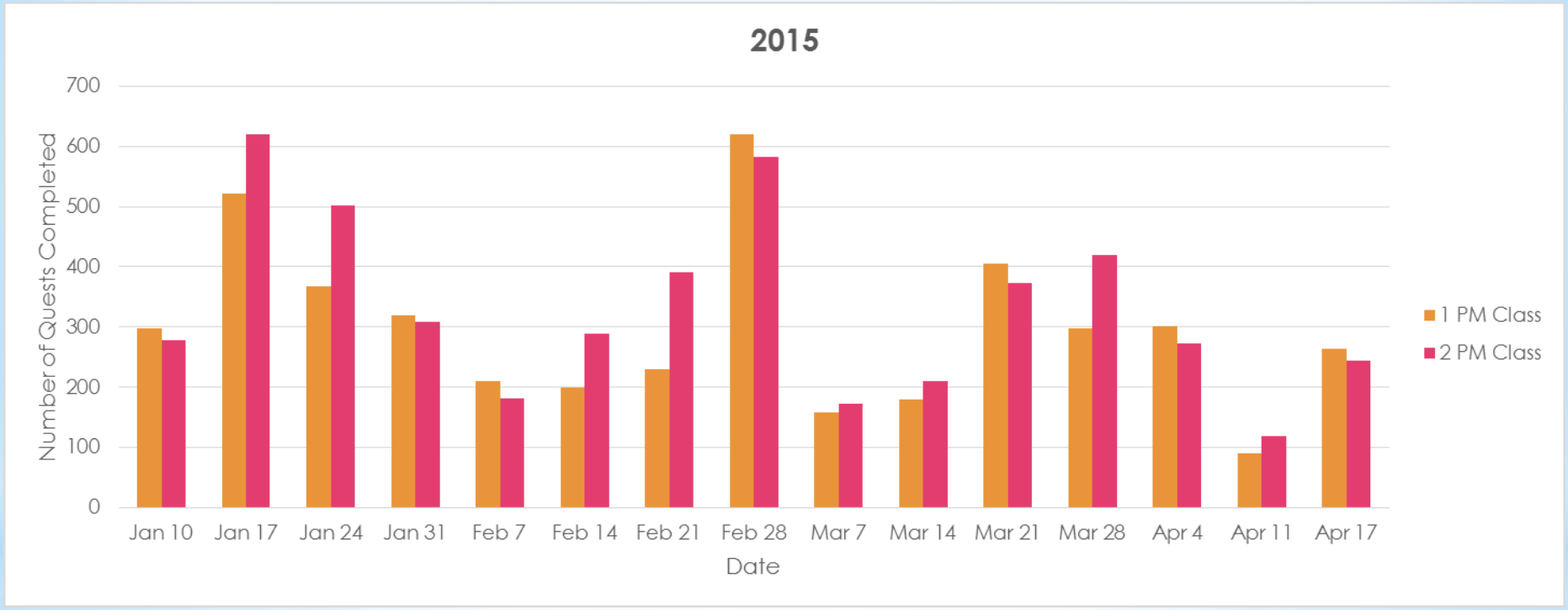
Study Design Cont.

- Monthly deadlines were imposed to help students stay on track
  - January 31st – 500XP
  - February 28th – 1,000 XP
  - March 31st – 1,500 XP
- Target goal for 100% homework grade was 1,750 XP by end of course
- Deadlines were imposed due to previous experiences with the platform and student difficulty at managing meeting the end course goal without a scaffolded structure

2014 Quest Completions



2015 Quest Completions



Research Question #1:

What motivates students to pick the assignments that they complete and the order in which they complete them?

Motivation and Gamification

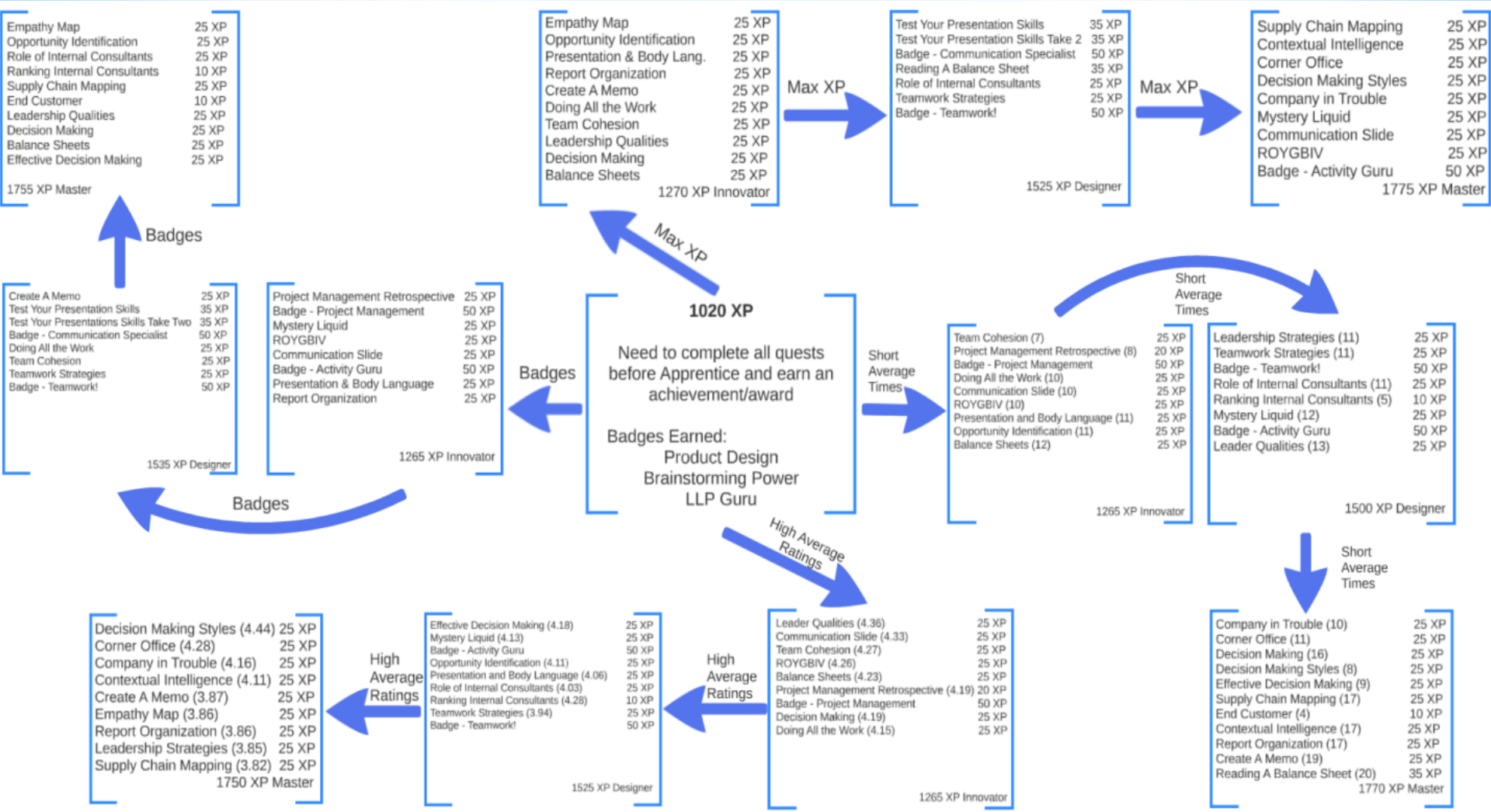
* Two types of motivation[1]:
  * Intrinsic – engage in activities due to interest
  * Extrinsic – engage in activities for outcomes such as rewards

Game Element	Why it Motivates
Experience Points	Positive reinforcement
Badges	Fulfill players need for success, works as status symbol, functions as goal setting
Leaderboards	Provides information about the player, fosters feelings of competence for players at the top
Progress Bars	Symbolizes progression towards goal, provides direct feedback
Quests	Directly linked to rewards and provides clear goals
Meaningful Story Elements	Meets players interests, fosters feelings of autonomy
Avatars	Sparks interests, fosters feeling of autonomy, arises emotional bonds and positive feelings by taking developmental progress with avatar

Sailer, M., Hense, J., Mandl, H., Klevers, M. (2013). Psychological Perspectives on Motivation through Gamification. *Interaction Design and Architecture(s) Journal, 19,* 28 – 37.

1. Eccles, J.S., Wigfield, A. (2002). Motivational Beliefs, Values and Goals. *Annual Reviews of Psychology*, **53**, 109-132.

Pathways through 3D Game Lab Homework



Pathways through 3D Game Lab Homework – Percentages of Quests in Categories Necessary to Fulfill Pathway Requirements

Category	Badges		Max XP		High Average Ratings		Short Average Times	
	1 PM	2 PM	1 PM	2 PM	1 PM	2 PM	1 PM	2 PM
Communication	100%	100%	100%	100%	100%	82.93%	100%	82.93%
Customer	74.73%	74.73%	70.33%	70.33%	69.23%	72.53%	74.73%	69.23%
Decision Making	55.56%	37.04%	55.56%	37.04%	55.56%	55.56%	55.56%	55.56%
Leadership	62.5%	25%	62.5%	50%	62.5%	62.5%	62.5%	62.5%
Finance	43.59%	25.64%	56.41%	56.41%	56.41%	38.46%	56.41%	56.41%
Brainstorming	100%	100%	100%	100%	100%	100%	100%	100%
Teamwork	100%	100%	100%	100%	100%	100%	100%	100%
Project Management	100%	100%	100%	100%	100%	100%	100%	100%
Product Design/Student	100%	100%	100%	100%	100%	100%	100%	100%
Number of Badges Earned	6	7	6	5	6	6	6	6

How did Students Perform?

Category	1 PM Class	2 PM Class
Communication	79.1%	82.93%
Customer	72.53%, 67.03%, or 74.73%	61.54%, 69.23%, 67.03%, or 74.73%
Decision Making	55.56%	55.56%
Leadership	62.5%	62.5%
Finance	56.41%	56.41%
Brainstorming	100%	100%
Teamwork	100%	100%
Project Management	100%	100%
Product Design/Student	100%	100%

Category	Badges		Max XP		High Average Ratings		Short Average Times	
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Leadership	62.5%	25%	62.5%	50%	62.5%	62.5%	62.5%	62.5%
Finance	43.59%	25.64%	56.41%	56.41%	56.41%	38.46%	56.41%	56.41%
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Teamwork	100%	100%	100%	100%	100%	100%	100%	100%
Project Management	100%	100%	100%	100%	100%	100%	100%	100%
Product Design/Student	100%	100%	100%	100%	100%	100%	100%	100%
Number of Badges Earned	6	7	6	5	6	6	6	6

What Motivates Students?

* Achieving key goals influenced performance
  * 125 of 166 students reached 1,750 XP
  * 156 of 166 students reached 1,500 XP
* Comparing student performance to quest pathways it appears that:
  * 2 pm class was mostly motivated by short average times
  * 1 pm class didn't fit into any specific pathway
    * Potential that multiple factors motivated them

Research Question #2:

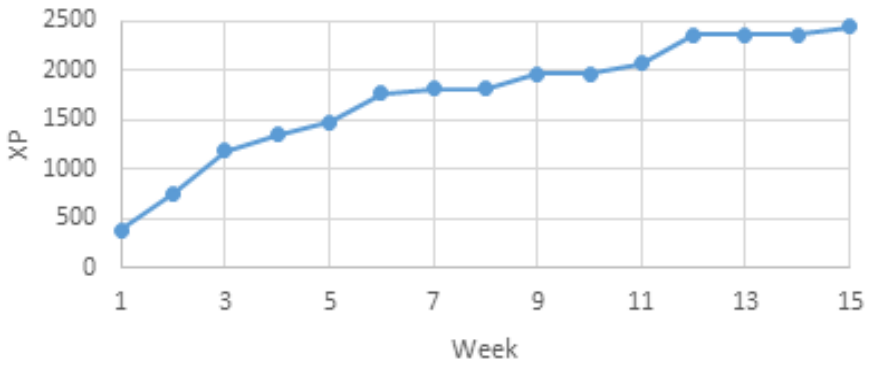
Can student performance within the game-based portal be related back to profiles of types of students in gamification environments?

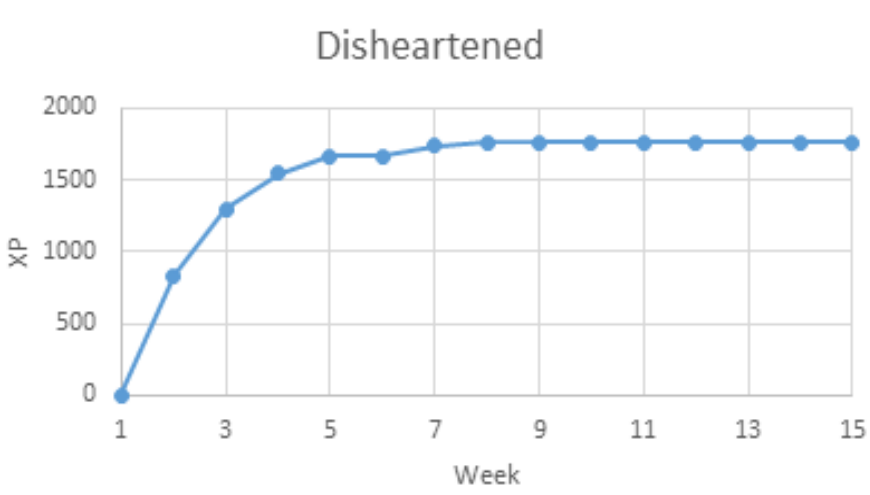
Student Types in Gamification Environments[1]

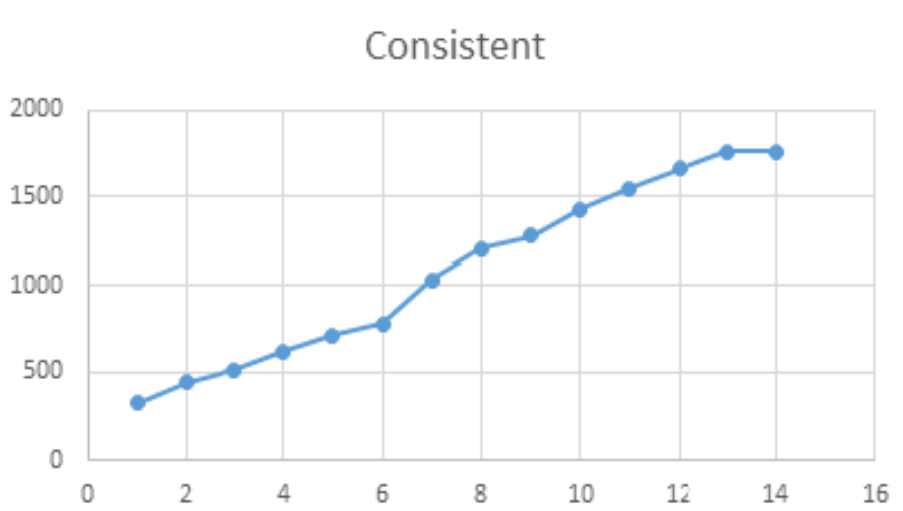
* Four types of students:
  * Achievers – tended to stay ahead of course goals and sought to be near the top of the leaderboard
  * Procrastinators / Late Awakeners – Weren't very active in participating until close to deadlines but then did well
  * Disheartened – Started very strong but then dropped down in effort over the course of the semester
  * Consistent – Always submitted work and completed quests at a steady pace throughout the semester

1. Barata, G., Gama, S., Jorge, J., Goncalves, D.(2013). So Fun it Hurts – Gamifying an Engineering Course. *Foundations of Augmented Cognition Lecture Notes in Computer Science, 8027,* 639 – 648.

Student Type Profiles in 3D Game Lab







What Student Types Were Observed?

Student Profile Type	% of Students Observed
Achiever	6.6
Procrastinator	28.9
Disheartened	16.3
Consistent	48.2

Linkage Between Student Performance and Student Types

- Similar to study by Barata *et. al.* (2013), majority of students were found to be consistent in nature
- Many students started as achievers but then dropped into the disheartened category
- This observed change in student type may be due to:
  - Increased workload from other classes
  - Decreased interest in game-based portal
  - Other factors that are not known

Conclusions

- Game-based homework portal can help motivate students by providing a personalized learning experience in a large class
- Many factors may influence students' quest selection including:
  - Badges
  - Maximum points
  - Shortest completion times
  - Highest average student ratings
- Most students tend to follow a consistent approach to completing the quests

Acknowledgements

* Chemical Product Design TAs

* Support from the University of Pittsburgh Chemical Engineering Department

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