Incorporating game mechanics into a network of online study groups

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Abstract. The recent movement towards publishing open educational resources has increased the variety and quantity of learning materials available to students outside of the traditional classroom environment. Several core characteristics of the classroom environment, however, are difficult to offer through a web-based interface, including: (1) interaction and camaraderie among a cohort of peers, (2) the ability to get "real-time" answers to pressing questions, and (3) a motivating force to keep the student engaged over time. An online learning environment can approximate the value of peer cohorts and live question-answering by supporting (and encouraging) synchronous interactions among individuals studying a common topic. A learning system can motivate participation and collaboration by incorporating elements of game mechanics in the activity. We discuss Grockit, a recently-launched website that combines a virtual study group format with multi-player game dynamics to provide an engaging live collaborative learning environment for geographically-dispersed learners.

Keywords. learning games, study groups, motivation, collaboration

Not all learning happens in classrooms. Self-motivated learners have a wealth of options, vastly enriched by widespread access to the internet. Now, in addition to local libraries, students have access to open educational resources such as MIT's OpenCourseWare initiative [5] and educational podcasts such as those found on iTunes U [1]. But several key aspects of classroom learning are still not readily available, including (1) a peer group to learn with and from, (2) the opportunity to ask someone a question and get an immediate response, and (3) the structure and motivation that helps students remain committed over time. Synchronous communication among learners on an educational site could theoretically enable a virtual community of peer learners. The approach that we have been pursuing at Grockit (grockit.com) has been to leverage various game mechanics to affect how students choose to participate and interact with each other. With respect to AIED systems, the goal of the current approach is to reduce the traditional challenge of identifying and remediating learner misunderstandings to the much simpler task of enabling and motivating peers to do this for one another.

As of June 2009, Grockit has built support for two groups of learners. The first is for students studying for the GMAT, a common business school entrance exam. The second is for students studying for the SAT, a national college entrance exam. These types of groups offer a good testbed for live online learning communities, as there are a large number of students who share the common learning goal of mastering the skills that

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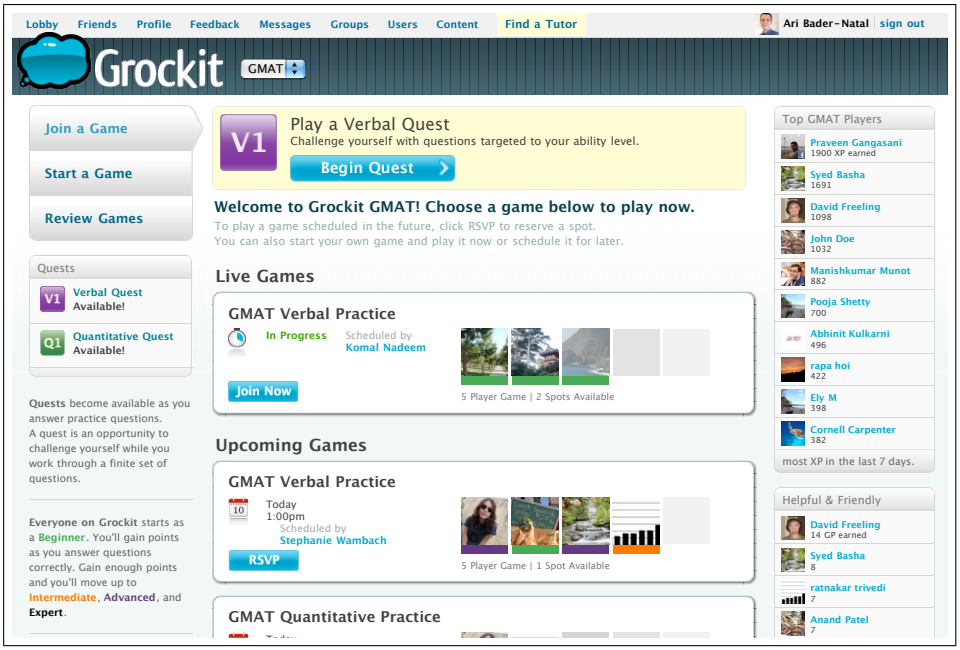

Figure 1. Each learning community has a "game lobby" which serves as an entry point, displaying in-progress and upcoming study sessions. (Note that all screenshots were captured in June, 2009). Leader-boards are displayed on the left, and available quests are displayed on the right.

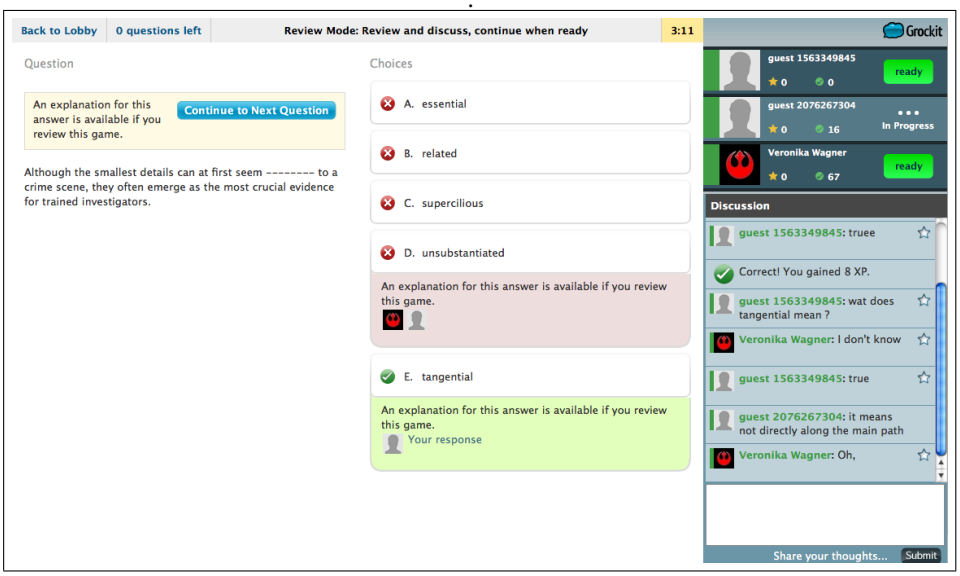

Figure 2. In each game, a series of questions are presented, such as the one above. After all players answer the question, they are provided with an opportunity to see, and discuss, the correct answer before moving on to a new question. The discussion pane includes both player discussion and system feedback (e.g. point awards). Within each study group session (referred to as a "game"), discussion among students ("players") takes place in a chat pane.

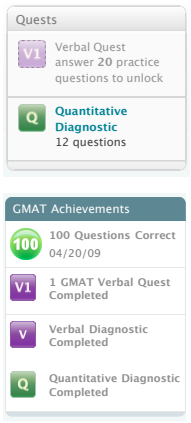

Figure 3. Diagnostics and Quests (top), and Badges (bottom).

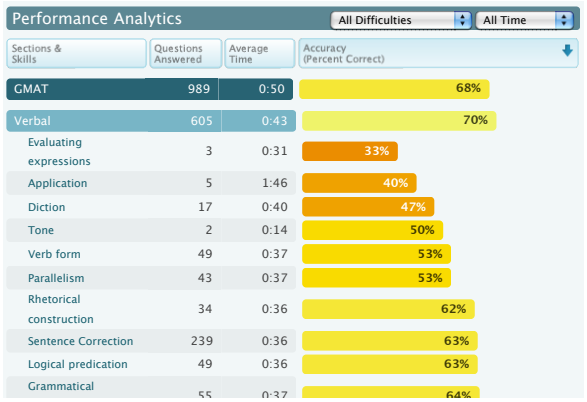

Figure 4. Player performance statistics are reported at the test, section, and skill levels. Color-coded bars help students focus their attention (for future games and reviews) on the skills for which the student had the lowest percentage accuracy.

are tested with the exam. At any time of the day, there are generally several groups of students collaborating (and site activity is quickly increasing).

For the GMAT site, students connect from around the world, generally from a home or shared computer. As aspiring business school students are often several years out of school, they are less likely to have friends or co-workers currently studying for the same exam. The characteristics of the standardized test-based groups (i.e. large numbers of students independently studying the same material) appear to be a good match for the live online study group, though future Grockit groups will not be restricted to test-oriented domains.

Over the past several months, we have incorporated into Grockit a variety of game-like mechanisms to motivate students to productively engage in the learning community:

Points and Leaderboards Grockit currently incorporates two point systems, which serve as reputation-like indicators: Experience Points (XP) and Grockit Points (GP). A player earns XP by answering questions. The point value for an answer is a function of the difficulty of the question (as estimated by a one-parameter Item Response Theory model) and the accuracy of the response. While this XP metric reflects the player's participation and performance as a *learner*, the GP scale reflects the player's activity as a *teacher*. When a peer finds a player's comment or explanation particularly helpful, they have the opportunity to award GP to that player. In the right-hand column of the Game Lobby (illustrated in Figure 1), "recent top player" leader-boards are displayed for XP and GP earned, and players frequently compete to appear on these lists.

Performance Statistics In addition to displaying XP and GP points achieved, student's can view (and opt to share) their performance statistics (see Figure 4). This data provides students with test-, section-, and skill-grained feedback on their performance (and can be restricted to include data from a specified time and/or difficulty range). Students can select a set of skills from the list, then review detailed explanations of the questions tagged with these skills.

Subsequent activity (Person count)	*Always available* (86)	*Every 20 questions* (100)	*Every 5 questions* (73)	*Never available* (101)	p-value
subsequently participated in a game	54.7% (47)	69% (69)	61.6% (45)	60.4% (61)	0.25
subsequently participated in a game with others	31.4% (27)	**55%** (55)	42.5% (31)	42.6% (43)	0.01 *
subsequently logged in again	43% (37)	**59%** (59)	47.9% (35)	38.6% (39)	0.03 *
subsequently participated in game discussion	24.4% (21)	**41%** (41)	27.4% (20)	24.8% (25)	0.03 *
subsequently reviewed questions	66.3% (57)	72% (72)	68.5% (50)	71.3% (72)	0.83

Table 1. Testing the effect of Quest availability on subsequent participation. The null hypothesis is that the four populations of students have the same true proportions, and the alternative is that the proportion is different in at least one of the populations. Starred p-values indicate significance at the $\alpha = 0.05$ level, two-tailed.

Diagnostics, Quests, and Badges By answering questions in collaborative games, players work towards "unlocking" certain fixed-duration solo activities (seen in Figure 3a). A *Diagnostic* includes a fixed set of questions designed to generate an initial assessment of the student's current ability level. A Rasch Model [3] is used to construct and evaluate this assessment. After completing a Diagnostic, *Quests* can be unlocked through subsequent collaborative game-play. Quests are designed to provide students with targeted practice, including questions for which the Rasch Model predicts a probability of response accuracy near $p = 0.5$. "Medium" difficulty challenges such as these have been found to increase intrinsic motivation [4] and to facilitate a "flow" experience [2]. Students are awarded *badges* (Figure 3b) for various accomplishments, such as the completion of Diagnostics and Quests.

One interesting recent finding came from a small randomized experiment run over a two week period in June, 2009 (shown in Table 1). Students who completed a Diagnostic were randomly assigned to one of four groups, determining if and when a Quest was available to them ("unlocked"). For three of the five outcome measures of interest, there was a statistically significant difference among the groups, with the group for which Quests were unlocked every 20 questions outperforming the others (visible in Figure 4a). Perhaps the added question spacing introduces an attainable goal that motivates increased participation. Game mechanics, such as this one and those outlined above, offer a rich toolset for motivating students in learning and collaboration, and help increase engagement in the virtual study group environment.

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