A Discussion on Introducing Half-Anonymity and Gamification to Improve Students' Motivation and Engagement in Classroom Lectures

Asako Ohno, Takahiro Yamasaki, and Kin-ichiroh Tokiwa
Osaka Sangyo University
Nakagaito 3–1–1, Daito-shi,
Osaka 574-8530 Japan
Email: {ohno,yamasaki,tokiwa}@eic.osaka-sandai.ac.jp

***Abstract*—Many university students, especially engineering students, hesitate to state their opinions or ask questions in front of other students during classroom lectures since they do not want to feel embarrassed or humiliated, or just because they need some practice speaking in front of an audience. In this study, we develop a gamified (arranged as a game), half-anonymized (incorporating only very slight clues to identify other users) education support system that can be utilized to improve classroom interactions and propose an educational methodology that encourages class members to engage simultaneously in both off-and online communication. Using the system, students take part in an online, mediated class-wide discussion, while also engaging in face-to-face verbal discussion with their neighbors. The system provides students with an interactive, cooperative learning environment free of the influence of real-world human relationships that can impede students' active engagement in class. The contribution of the paper is in its investigation of how to make students more proactive in class by harnessing the power of gamification and limited anonymity. We also report the findings from an experimental implementation of the system in a class of 17 university engineering students.**

I. Introduction

Due to the downward trend in birthrates in developed nations and the growing diversity of value systems seen among students, teachers need to reform instructional methods and delivery of class lectures to compensate, to the degree possible, for differences in academic ability and motivation among students. *Active learning* and *problem-based learning* are methods that have come under review for their possible utility in implementing a paradigm shift from a passive and unidirectional approach to lecture design to a proactive and interactive orientation. Active learning mainly implies the incorporation into lectures of active, student-oriented interactions, either among students or between students and a teacher. Lectures rooted in this notion are designed on the assumption that students will take the lead in class discussion or the overall procedure of the class. Problem-based learning is a leaning method that provides students the opportunity to learn a wide range of skills by grappling with a specific task or project; success in problem-based learning also requires an independent attitude on the part of the student. The feasibility of this type of education, which can be described by the umbrella term *student-centered education*, has increased significantly with the spread of the Internet and developments in information technology.

Audience response systems such as *Clicker* or web polling systems are often utilized to produce interactions between a teacher and his or her students, especially in large, "auditorium"-type classes, in which fruitful interactions can be hard to foster. An audience response system displays responses submitted electronically by students in a form such as a histogram, helping students see, for example, how many of them have answered a question correctly or incorrectly. Clicker [1][2] is an example of an audience response system: that is a TV-remote-control-like hand-held radio frequency (RF) transmitter. In a Clicker-based lecture, each student has his or her own Clicker device and submits answers by clicking buttons labeled numerically or alphabetically. Patry [2] investigated 516 students in 2006 and 2007 and reported that almost half of them supported Clicker, saying it helped them stay engaged in class and understand course content; however, some students showed dissatisfaction with the financial costs and technical difficulties of the technology.

Clicker seems likely to increase students' active engagement in traditional classroom lectures and facilitate a change in attitude toward classroom lectures in both teachers and students [1]. However, Clicker allows only monotonous interactions between a teacher and students. Students can see how many of their peers send in particular answers to a particular question on a real time basis, but they cannot observe the processes undergone by the other students to result in those numbers. To make our classroom lectures more active and interactive, we need to make further changes and introduce new challenges, fostering both teacher-to-student and student-to-student interactions. A new type of system that provides information to help students understand how their peers make decisions and what affects their opinions will be a good aid to achieving this. With the this proposed system, students will be able to observe other students' unset opinion-formation process, which may sometimes affect them in novel and useful ways and perhaps change their minds. Some students may feel proud of themselves when they post their opinion and see many of their peers changing their own answers as a result, after they post their opinions while some others may feel proud of themselves when they realized that they were the first ones that posted the correct answers which were correct.

At the same time, the notion of *gamification* or *game-based learning* has become a major trend in recent education reform efforts, especially with the growing appeal of computer

games. Both gamification and game-based learning aim to make learning more enjoyable and worthwhile through the introduction of game-oriented values, which is achieved by introducing game mechanisms or traits when constructing learning processes (gamification) or using games as a part of the learning process (game-based learning).

While online courses involve less interaction than face-to-face courses and have completion rates that barely reach 50% [3], digital games have secured the voluntary dedication of *K–16 (kindergarten to university) students* living in the digital age, who not only play games but also exchange information online, spending an immense amount of time in the digital realm. Games seem somehow to inspire people to take on difficult challenges by placing them in an enjoyable format [4]. Even with very little reward, players feel contented and motivated to challenge the next task. *Chore Wars* [5], a free online game, is one example. It attracts people with its role-playing elements. Players create fantasy warrior avatars in order to complete daily chores, treated as rewarding quests and presented in an adorable fashion, in competition with family or friends. This game's RPG format and system of small rewards in the form of experience points for the successful completion of discrete tasks may improve player self-efficacy; the idea of a continuous cycle of task completion and reward can be applied to education without major changes [6].

In the present study, we developed a quiz-show-like online educational support system to encourage passive or reluctant students to participate in class. The system thus enables students to see which options were chosen by their peers and to get a sense of their decision process. While answering questions via the system, students can also share their opinions or ask questions in class by sending a short message displayed as the speech balloon beside the corresponding avatar.

The rest of this paper consists of the following sections. In Section II, we share the basic idea of how to improve students' motivation and activeness. In Section III, we discuss topics related to our main research interests: 1) how to activate classroom discussion, and 2) how to gamify education; we also present survey results of the effects of the system described above among students. We consider the system in more depth and report the findings from a short evaluation and questionnaire conducted among university engineering students in Section IV. Finally, we conclude the paper in Section V.

II. Basic Idea

In this study, we develop a half-anonymized online quiz and discussion system. We also propose an education methodology that utilizes the system to improve students' active engagement in classroom discussion. Unlike many other studies, we do not intend to deal with distance learning or substitute the system for a real-world classroom lecture. Figure 1 is an overview of our education methodology. The main concept of the methodology is a blended interaction, that is, one consisting of both real-world interaction (Layer 1) and virtual-world interaction (Layer 2). This approach provides reluctant or passive students a special environment where they can feel less burdened than normally because of the well-tailored level of anonymity and the familiar game-like interface. Students can train themselves by making an effort to state their opinions either orally to their neighbors in class or in written form via the system.

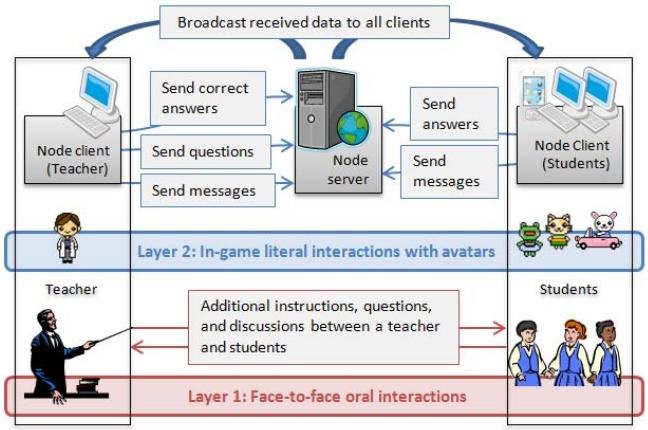

Fig. 1. An overview of the two-layered classroom interaction model of our educational methodology

One of the notable features of the system is that it provides a good opportunity for students to get to know each other's opinions, and to ask questions or broadcast opinions to all participants in the class without notifying them who the sender is. Many Japanese students, in particular, hesitate to state their opinions or to ask questions in front of other students because of shyness or humility, and may be encouraged to do so in a venue free of the inhibiting influence of real-world human relationships.

III. Discussions

A. How to Engage Students Actively in Learning and Activate Classroom Discussions

As Dufresne et al. [7] note, ongoing collective effort among students in a class and continuous experience of class-wide active discussion educe proactive participation on the part of students. In this context, how can we instigate this positive growth cycle? More specifically, how can we induce a reluctant student to be the first volunteer? In a former study, the first author conducted a questionnaire investigation among 107 Japanese university students that showed a positive correlation between anonymity level and student activeness in classroom discussions [8]. Students more positively actively share their opinions in a group of smaller size with familiar members. Another result showed that students prefer half-anonymity, for example, being identified by their own nicknames or avatars, to complete anonymity or being identified by their real names. Many students feel social anxiety that conceals their latent passion to learn, and it is important to reduce and manage this anxiety to help students achieve positive attitudes toward in-class communication.

Introducing a special environment for classroom interaction, as discussed here, is a promising approach to reducing students' anxiety. Boyle and Nicol [9] achieved class-wide discussion in large-sized classes. They conducted a questionnaire to investigate the effectiveness and the desirable form of massive classroom discussions. According to the survey, students showed more interest and deeper understanding of

class topics after their discussions, though they still required further instruction from the teacher. Dufresne et al. [7] developed a classroom communication system called *Classtalk*. The system has the capability to engage students in active learning, as well as helping classroom communications. In application in university science classes, 65% of non-math/science major students and over 80% of math/science major students were able to actively state their opinions in class discussions using Classtalk. The rest of the students showed a passive attitude, for several reasons. Some were too shy to speak up in a large group, not used to the large lecture hall, or not confident about their answers or opinions.

It is apparent that the teacher plays an important role in students' motivation and activeness in a class. Weaver [10] noted that anxiety control on the part of teachers is as important as managing students' anxiety and emphasized the importance of communication and of provision of a variety of teacher-student interactions to motivate students. Finally, self-efficacy also plays an important role in connecting students' learning to better outcomes.

B. Game-Based Learning and Gamification in Education

In the past few decades, video games have permeated many parts of our life and society across the world [11]. In particular, social games that run on smartphones and tablet computers have spread rapidly, alongside the improvement of the high-speed wireless Internet environment.

For example, the size of the Japanese market for social games in 2013 is estimated at 425.6 billion yen, which is up about 10% from the previous fiscal year at 387 billion yen-which in turn showed a 37% increase over the previous year [12]. *Puzzle & Dragons* [13], a fusion of a puzzle game and a role-playing game, is now becoming one of the most popular online games for smart phones in Japan. In the game, the player explores dungeons alongside a guest player, who can be either one of the player's friends or an arbitrary chosen player; they fight against monsters in a puzzle-game-like interface. Players can unlock rare characters and challenge new dungeons, and the game is popular with players of all ages.

Social games have several notable features and advantages, of which easy access and high extensibility are only two. They also provide opportunities for communication, community-building, and engaging in collaborative actions with other players as part of the goal-achievement process. This kind of interaction resembles some learning processes in classroom education.

What about other game genres? Amory et al. [14] reported that adventure games appear to be the best genre from which to develop educational resources. According to his survey of 20 university students, the skills required to play adventure games include logic, memory, visualization, and problem-solving, which are commonly recognized as fundamental skills for all learning. The US Military, the largest spender and user of game-based learning, has trained and educated its combat and non-combat personnel using video games, an approach that has had proven effectiveness in actual combat and peacekeeping missions [15]. The genre commonly used for these purposes is the simulation game, interestingly, the least liked genre among the students in Amory et al.'s survey [14]. Squire [11] noted that regardless of genre, good video games provide players with rich interactions and let them learn various things through virtual experiences. McGonigal [4] notes that across genres, games have the following four traits: *a goal, rules, a feedback system, and voluntary participation*. Needless to say, the same traits are present in traditional classroom lectures.

However, there have not been enough empirical studies to prove the learning effectiveness of game-based learning [16]. Many studies have reported that the game-based approach is better suited than traditional lectures for dealing with a diverse student body and helping motivate reluctant or struggling students [17]. As Klopfer [18] observes, though, it is of course possible to teach successfully without utilizing the latest technologies, such as digital games or other recent web technologies such as the real-time web. For instance, how can a teacher introduce gamification to his or her classes and make good use of it? Do educational games always make reluctant students more interested in their classes? Squire [3] reports that the introduction of commercial-quality educational games in his history class created as many motivational problems as it solved. Many students were puzzled by or unsure of the relevance of playing games, and experienced a drop in motivation. About 25% of the students had a hard time playing the games; however, another 25% found them to be the best way to learn history. Further, the game-based curriculum provided good opportunities for students to better consider and understand their lesson topics.

Gamification and game-based learning will continue to receive increased attention. Further investigation and discussion, including empirical studies, are needed to evaluate the effectiveness of this type of approach.

IV. A Gamified, Half-Anonymized Real-Time Education Support System

A. Server-Side JavaScript to Achieve a Real-Time Web System

We developed a gamified, half-anonymized real time education support system in JavaScript with the latest real-time web technology, WebSocket along with Node.js, a framework of server-side JavaScript and that implements WebSocket as a *Socket.IO* module [19]. By utilizing Socket.IO and other modules such as *Express*, one of the web application frameworks that simplifies the main processes of a simple web server construction, we can write both the server and client programs of a real time web system in one language. In addition to the light weight traffics of WebSocket, a Node.js-based WebSocket application is free by its nature as JavaScript program from so-called *C10K problems*, such as non-blocking I/O, single thread, and event-driven architecture. This is a great advantage for a real-time, multi-user online application. Furthermore, the system runs on a web browsers. That is, it can run not only on PCs but also on other devices such as smart phones and tablets.

B. System Architecture

As shown in Figure 2, the system consists of a server, a number of student clients, and a teacher client. All users log in to the system via this login screen shown in Figure 3. Students input their student IDs and select their avatars, while the teacher inputs the a predefined ID and does not need to

select an avatar. After a connection is established by HTTP, the WebSocket server and clients communicate with each other by short-headed WebSocket protocol. When a client socket establishes a connection to the server, the server registers the client ID and broadcasts the list of client ID and avatar images. Then the teacher UI updates its students list, which it uses to score students' answers. Without polling, WebSocket clients receive updates broadcasted from the server. All interactions, such as posting a question, answering the question, or sending messages, are treated as the paired elements, that are the pairs of a key and the a value of an associative array. When a WebSocket client receives the interaction array, a client-side JavaScript checks the key of each of the elements indicating the type of data, and updates the corresponding information on its UI according to the result.

Figures 6 and 7 show the user interfaces (UI) of our system. A teacher can post messages or questions with two alternative answers from the forms in the UI, as shown in (1) of Figure 6. The posted questions are displayed in (2) of Figures 6 and 7. Students answer the question by selecting appropriate alternatives from A and B, and can send messages from (1) of Figure 7. Messages posted by the teacher or the students are displayed in all UIs, with the avatar of the sender, as shown in (3) of Figures 6 and 7. As shown in (5-1) to (5-3) of Figure 4, when a student posted his/her answer, the WebSocket server broadcasts the ID, avatar image, and the answer, and the clients represent the answer of the sender as the position of the corresponding avatar, as shown in (4) of Figures 6 and 7. Interactions such as sending questions, answers, and messages can be continued until the teacher scores the students' answers.

This function provides a half-anonymized online discussion environment among for all participants in the class and informs students when other students make decisions or change their minds, on a real-time basis.

When a teacher sends a correct answer, as in from (5) of Figure 6, the system functions as shown in (6-1) to (6-3) of Figure 5, The teacher's avatar is displayed in the area under the correct answer. At the same time, the rate of correct answers for the current question is calculated and displayed on the students' UI with the number of the questions that the student answered and the number of the answers they got correct, as shown in (5) of Figure 7. To move to the next question, the teacher clears and saves the session, as seen in from (5) of Figure 6.

C. Evaluation

We conducted a short trial to evaluate the effectiveness of our system, that is, to check if the use of the system makes reluctant students participate more actively in class discussion. Table I shows the settings of the experiment. The procedure of the experiment was as follows. Verbally, the teacher gave a question and then the instruction for students to start verbal discussion among themselves. After several minutes, the teacher asked students to put up their hands and answer the question. Second, all participants logged in to the system and the teacher sent them a question via a form on the system. The teacher suggested that students discuss the question on the system instead of just talking directly with their neighbors, though talking to neighbors was not forbidden.

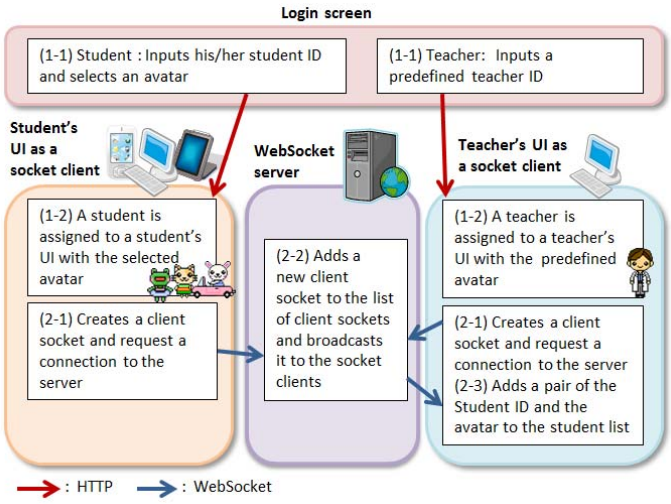

Fig. 2. Functions of the system (log in phase)

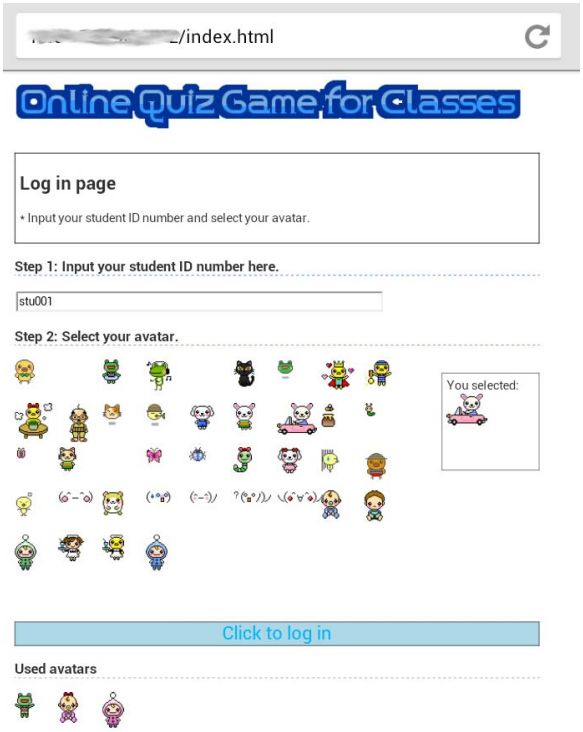

Fig. 3. Login screen on smart phone (Android)

Students could submit any number of answers while discussing the question over the system. After several minutes, the teacher asked the students to submit their final answers from their UI and scored the answer by submitting the correct answer.

D. Result

After the short trial, we conducted a questionnaire among the students, consisting of five questions: four yes/no questions and one free description question. Questions one to four were as follows: (Q1) Do you think anonymity is needed for the system to be effective? (Q2) Do you think you can ask more questions using the system than in general lectures?

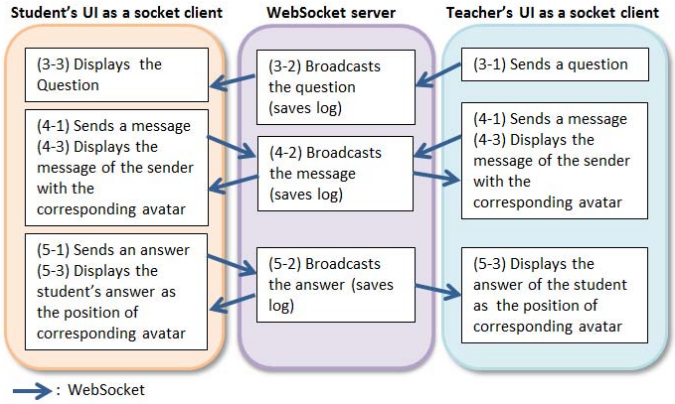

Fig. 4. Functions of the system (interaction phase)

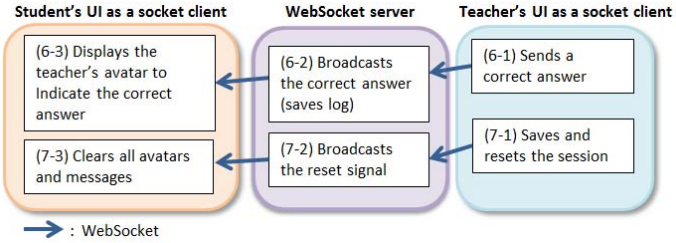

Fig. 5. Functions of the system (scoring phase)

Fig. 6. User interface for a teacher on PC (Windows)

Fig. 7. User interface for students on tablet (iPad 2)

TABLE I. MAJOR SETTINGS OF A SERVER AND CLIENT COMPUTERS

	Server	Client
Number	1	17
OS	64bit Windows 7 Pro. SP1	Vine Linux 6.0
CPU	Intel Core 2 Quad Q9650 3.00 GHz	Intel Core i7
Memory	8.00 GB RAM	8.00 GB RAM
Runtime environment	Node.js ver.0.6.18 / express ver.2.5.8 / socket.IO ver.0.9.10	Chromium ver. 26.0.1411.0

(Q3) Does the system seem to be interesting? (Q4) Do you want to participate in lectures using this system? For the free description question, we asked students for their free opinions on the system. The summarized results for Q1–Q4 are shown in Table II.

TABLE II. SUMMARY OF THE RESULTS OF THE QUESTIONNAIRE

	Yes	No	N/A
Q1	11	4	2
Q2	12	5	0
Q3	15	2	0
Q4	16	1	0

Over 60% of the students answered Yes to Q1 and Q2, and over 80% answered yes to Q3 and Q4. More than half of the students felt less burdened exchanging their opinions in the half-anonymized environment than in person, and the majority of students enjoyed being able to communicate in this way, answering the questions via the system, and participating

in the lectures utilizing the system. Though the evaluation period was short, the system seems to have potential to make students more motivated and active in discussions. In fact, one student who under normal circumstances rarely states his opinion assumed a leading position in this short discussion, and many students answered that the system made it easier for them to state their opinions.

However, one student worried about the chance that anonymity would cause students to answer questions in a frivolous manner, and another questioned whether the virtual discussion improved students' motivation to engage in verbal discussion. With regard to the first issue, the teacher can avoid abuse of the system by explaining to students that he or she can identify them from the interaction log on the server. With regard to the first and the second issues, the teacher should not leave the discussion uncontrolled, but should instead attend to both off-and online discussions, producing a positive discussion environment by giving additional information, encouraging, or warning students (as necessary). It is also preferable that students take turns in the role of discussion leader or organizer.

Overall, many students enjoyed engaging in class-wide discussion in the virtual environment provided by the system, and also had great interest in the face-to-face discussions with their neighbors.

V. Conclusion

Well-structured active learning fosters a proactive, enthusiastic attitude in both students and the teacher, which in turn produces meaningful learning outcomes. Both theoretical and technological improvements are needed, however, if we are to effectively integrate active learning in traditional lecture-based classes. In a previous study [8], the first author investigated the cause of reluctant attitudes toward classroom discussion on the part of students via a questionnaire investigation. At the same time, we noticed the effectiveness of gamification in motivating and improving the engagement of players in a variety of real-world problems, mentioning some actual successful cases in business and military affairs. The recent rapid spread of social games running on personal mobile devices has accustomed non-gamers to the presence of games or game-like objects in their daily lives. Thus, digital games are familiar to the majority of K–16 students, and they prefer to learn by utilizing gamified learning tools when exposed to them.

We developed a half-anonymized real-time quiz and discussion system with a game-like interface to improve students' engagement in class. The system provides a game-like user-friendly interface that is familiar to K–16 students and meets their needs [8]. It also provides limited anonymity that makes it less uncomfortable for students to join in classroom discussions and compare their understanding to that of their peers.

Further, we conducted a short evaluation of the system on a small class of 17 students; the evaluation confirmed the potential of our tool to motivate and improve students' engagement in classroom lectures. As for future work, we need to improve our teaching methodologies by empirical evaluation of the system and adjustment in light of the evaluation. We will also conduct some experiments in larger classes and report the outcomes at the presentation.

Acknowledgment

This research is supported by a grant from the Hayao Nakayama Foundation for Science, Technology and Culture.

References

[1] W. B. Wood, *Clickers: A Teaching Gimmick That Works*, Developmental Cell, 7, pp.796–798, 2004.

[2] M. Patry, *Clickers in Large Classes: From Student Perceptions Towards an Understanding of Best Practices*, International Journal for the Scholarship of Teaching and Learning, 3(2), pp.1–11, 2009.

[3] K. Squire, *Changing the Game: What Happens When Video Games Enter the Classroom?*, Journal of Online Education, 1(6), 2005. [Online]. Available: http://www.innovateonline.info/pdf/vol1_issue6/Changing_the_Game-__What_Happens_When_Video_Games_Enter_the_Classroom_.pdf.

[4] J. McGonigal, *Reality is Broken: Why Games Make Us Better and How They Can Change the World*, New York: Penguin Press, 2011.

[5] K. Davis, *Chore Wars*, 2007. [Online]. Available: http://www.chorewars.com/.

[6] P. R. Pintrich, *Motivation and Classroom Learning*, in Handbook of Psychology, W. Reynolds and G. Miller, Ed. New York: Wiley, pp.103–122, 2003.

[7] R. J. Dufresne, W. J. Gerace, W. J. Leonard, J. P. Mestre, and L. Wenk, *Classtalk: A Classroom Communication System for Active Learning*, Journal of Computing in Higher Education, 7(2), pp.3–47, 2003.

[8] A. Ohno, *Work in Progress: An Interactive Online Educational Support System Considering Real-World Human Relationships of Students*, Proceedings of the 42nd Annual Frontiers in Education Conference, 2012.

[9] J. T. Boyle and D. J. Nicol, *Using Classroom Communication Systems to Support Interaction and Discussion in Large Class Settings*, Association for Learning Technology Journal, 11(3), pp.43–57, 2003.

[10] R. L. Weaver and H. W. Cotrell, *Lecturing: Essential Communication Strategies*, New Directions for Teaching and Learning, 32, pp.57–69, 1987.

[11] K. Squire, *Video Games in Education*, International Journal of Intelligent Simulations and Gaming, 2, pp.49–62, 2003.

[12] *Social Gaming Market in Japan: Key Research Findings 2012* (in Japanese), [Online]. Available: http://www.yano.co.jp/press/pdf/1053.pdf.

[13] *Puzzle and Dragons Website* (in Japanese), [Online]. Available: http://www.gungho.jp/pad/.

[14] A. Amory, K. Naicker, J. Vincent, and C. Adams, *British Journal of Educational Technology*, 30(4), pp.311–321, 1999.

[15] M. Prensky, *Digital Game-Based Learning*, New York: McGraw-Hill, 2001.

[16] L. A. Annetta, *Video Games in Education: Why They Should Be Used and How They are Being Used*, Theory Into Practice, 47, pp.229–239, 2008.

[17] B. Gros, *Digital Game in Education: The Design of Games-Based Learning Environments*, Journal of Research on Technology in Education, 40(1), pp.23–38, 2007.

[18] E. Klopfer, S. Osterweil, J. Groff, and J. Haas, *Using the Technology of Today in the Classroom Today*, The Education Arcade, MIT, pp.1–21, 2009.

[19] George Ornbo, *Sams Teach Yourself Node.js in 24 Hours*, New York: Sams, 2012.