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Designing a Negotiation Mechanism to Engage Students in Learning Mathematics

Oskar Y. M. KU[a*], Willson LIN[b] & Tak-Wai CHAN[c]
[a]*Department of Computer Science and Information Engineering, National Central University, Taiwan*
[b, c] *Graduate Institute of Network Learning Technology, National Central University, Taiwan*
*ymku@CL.ncu.edu.tw

Abstract: Motivation is an essential element for successful learning, the process of goal setting can be an important source of motivation. On the other hand, video games can also motivate students' learning motivation. Thus, this study designed a negotiation mechanism in a game-based learning environment to increase students' learning motivation. Game was used to initiate students' learning motivation and provide feedbacks. The negotiation mechanism was used to help students set learning goals to maintain their learning motivation. The results showed that the game environment engage students in the learning tasks and helped low-confidence students improve their self-efficacy.

Keywords: negotiation, goal setting, confidence, motivation, self-efficacy

1. Introduction

Mathematics is an important subject in elementary schools. However, it is also a subject that students tend to avoid facing it. For example, a survey indicated that mathematics is the most unpopular subject among students in grade one to grade nine in Taiwan; more and more students had low motivation to learn mathematics with the increase of their age [4]. A possible way to improve a student's motivation in a learning task is helping them set up a goal. Past studies [1][14] indicated that the process of setting a goal actively can be an important source of motivation. Furthermore, providing a feedback after achieving the goal of a task raises self-efficacy [15] and improves performance on a task [7]. On the other hand, video game is considered to be another element that stimulates students' learning motivation [8]. Thus, this study proposed a negotiation mechanism which aims at helping students set up learning goals when learning mathematics in a digital game-based environment.

2. Literature Review

Motivation is regarded as a necessary condition for successful learning [9][10]. From educational point of view, motivation drives a student to participate in a learning process and directs the student to successful learning. In other words, it attempts to reinforce students' engagement to a learning task [2]. Thus, there is a need to evoke and maintain a student's learning motivation to produce a successful learning experience. Goal setting is one of the ways to induce a student's learning motivation.

2.1 Goal setting Theory

A number of studies indicated that goal setting enhanced self-efficacy [13][17], which is one's belief of capabilities to mobilize the motivation [18]. In addition, a specific goal pushes an individual to concentrate on the ongoing task, guide the individual to make effort to goal related activities, and neglect irrelevant events [16]. When the goal is accomplished, it would provide an invisible feedback to appreciate the individual's ability and effort; therefore the confidence of the individual is strengthened. Furthermore, Locke [6] found that specific hard goals resulted in better performance than easy goals, do-your-best goals and no goals.

Goal setting can be summarized into three different types according to how the goal was decided: (1) self-selected goals, (2) assigned goals, and (3) participative goal setting. A self-selected goal means an individual can select a goal for herself/himself based on the individual's confidence, ability, and prior knowledge. An assigned goal refers to the goal was assigned by people who is in higher position or authority. The participative goal setting usually occurs in a workgroup which allow members to join the process of deciding goals [3]. The comparison of these goal setting approaches is summarized in Table 1.

Table 1. Comparison of three types of goal setting

	Self-selected goals	Assigned goals	Participative goal setting
Goal quantity	Many	Usually one	Several
Intrinsic Motivation	Very high	Depends on the property of tasks	High
Possible advantages	People choice a goal based on their own ability	A challenging task may encourage subordinates to prove their ability	Members in the same team make efforts to maximize the common benefit
Possible disadvantages	People may decide a non challenging goal	People may lack intrinsic motivation	An individual may need to compromise to the common goal

In an individual learning situation, teachers often directly assign goals to students, however, students may not accepted the goal willingly. If students are allowed to choose their own goal, low-confidence students may set a goal that is below their ability. For participative goal setting, it is more suitable to apply for teamwork. Therefore this study designed an alternative method—negotiation mechanism to help students set learning goals.

2.2 Game-based learning

Digital game is another source to evoke student's learning motivation. Previous research showed that game can also enhance students' motivation when they carrying out learning tasks [11][12]. For example, Klawe and her colleagues launched a project, "E-GEMS", in which they designed some computer games for students to learn math and science [5]. The results showed that those computer games increased students' learning motivation.

From the aforementioned studies, the motivational benefit of goal setting is the process that a student makes a commitment to a learning goal. This process encourages the student to keep making efforts to attain the goals. On the other hand, digital games can attract students' attention and initiate their learning motivation. Thus, this study applied a negotiation mechanism in a game-based learning environment to trigger and maintain students' learning motivation and maximize their learning performance.

3. Design

3.1 Negotiation mechanism for goal setting

The negotiation mechanism was derived from the aforementioned goal setting approaches. More specifically, it is more closed to the participative approach. The differences between negotiation mechanism and participative goal setting are listed in Table 2.

Table 2. Comparison between negotiation mechanism and participative goal setting

	Negotiation mechanism	Participative goal setting
Participants	Two	At least two, usually a team
Method	One to one (student vs. virtual character)	One to many or many to many
Who leads the discussion	The student	Authority or the team leader
Relationship of participants	The virtual character plays as a suggestion provider	Hierarchical relationship

Two principles were considered in the design of the negotiation mechanism: (1) a specific and hard goal pushes a student to produce better performance; (2) the goal must be achievable for the student. Thus the student can really make a commitment to the goal and make efforts to complete the task [16]. The process of the negotiation goal setting contains four steps:

- Step 1: Choose a goal. The system shows a list of goals with different levels of reward. The student then selects a goal based on the self-evaluation of her/his ability and confidence. Meanwhile, the system predicts the student's performance based on the student's portfolio.
- Step 2: Negotiation. The system starts to negotiate with the student. If the student's goal matches the system's prediction (i.e. a bit higher than the student's ability), the student enters the execution step to solve problems. If the student overestimates or underestimates her/his ability, the system starts to bargain with the student to get a common goal which satisfies both sides. The student can, of course, neglect the system's intervention.
- Step 3: Execution. After the goal is set, the student then starts to work for the goal.
- Step 4: Reward: Students get feedbacks and reward from the system.

3.2 System

The system used in this study contains a learning portal, which serves as a Learning Management System. Two modules, pet nurturing module and learning module are coupled by tasks and reward. In order to raise the pet, students have to complete some assigned missions (learning tasks). The negotiation mechanism directs students to set a goal. After completing the mission, the students enter farms to collect materials as rewards, the quantity and quality of materials is generated depends on what level of goal they achieved. The flow of a goal setting process in this study is illustrated in Figure 1.

Preview the content and select a goal Negotiation Get rewards

Figure 1. Process of a round of task

4. Pilot Study

Eight primary school students participated in the pilot study. Their ages were between 9-10 years old. There are nine sub-tasks in the whole learning session; students had to set a goal for each sub-task. The pilot study lasted for 40 minutes. Students' data log was analyzed to investigate: (1) whether this negotiation mechanism enhances students' self-efficacy; (2) whether there are some patterns of goal setting for students with different level of ability and confidence.

5. Result

Students' data showed that they tended to accept system's suggestions when the system suggested them to heighten their goals. On the contrary, students tend to reject system's suggestion when the system asked them to lower their goals. The students' goal setting data were classified into four categories according students' ability and self-confidence.

- High ability-low confidence
  Two students were identified as high ability-low confidence. Students in this category usually set the lowest level of goal in the beginning. After finding that the students were able to challenge higher goals, the system intervened in the goal-setting process in next round. Then the student and the system come to a common goal. After completing the goal successfully, the students started to set the highest goal in following rounds. However, if they did not achieve the goal, their confidence then dropped to the lowest level in next round. The system again negotiated with the students and helped them to raise their goal.
- High ability-high confidence
  This type of students always set the highest goal, Even they did not attain their preset goal.
- Low ability-low confidence
  This type of students tended to set lower goals. They always set goals less than the medium value. However, the negotiation mechanism helped them to set higher goals. And the confidence of the students seemed to be improved gradually in the following rounds.
- Low ability-high confidence
  No student was classified into this category in this study.

6. Discussion

From the result of this study, students were classified into four categories according to their ability and confidence. For high-ability-high-confidence students, it seems that they had high self-efficacy originally. For low confident students in this study, especially for low-ability-low-confidence students, the negotiation mechanism seemed to help them establish their self-confidence gradually and meanwhile improved their self-efficacy. Since this study is in its beginning stage, and there were only eight students participated the pilot study. The data may not enough to conclude general rules. Further studies are needed to investigate the relationship among student's ability, self-confidence, self-efficacy, and motivation. More different level of contents are also needed to identify the goal setting behaviors of high ability students, since the content used in this study was too easy for them.

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References

[1] Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
[2] Bomia, L., Beluzo, L., Demeester, D., Elander, K., Johnson, & M.,Sheldon, B. (1997). *The impact of teaching strategies on intrinsic motivation*. Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED418925).
[3] Chin, W. R., & Chin, W. R. (2006). *The role of impression management in goal setting*. Unpublished Masters, University of Waterloo.
[4] Department of Statistics, Ministry of Education, Taiwan. (1988). *Report of "The proportion of disliked subjects of students in Grade 1 to Grade 9"*, Taiwan: Ministry of Education.
[5] Klawe, M. (1998). When does the use of computer games and other interactive multimedia software help students learn mathematics? *Proceedings of NCTM Standards 2000 Technology Conference*. Arlington, VA.
[6] Locke, E. A. (1968). Toward a theory of task motivation and incentives. *Organizational Behavior and Human Performance. 3*(2), 157-189.
[7] Neubert, M. J. (1998). The value of feedback and goal setting over goal setting alone potential moderator of this effect: A meta-analysis. *Human Performance, 11*(4), 321-335.
[8] Nussbaum, M. (2007). *Games, Learning, Collaboration and Cognitive Divide*. OECD. Retrieved May, 20, 2010 from http://www.oecd.org/dataoecd/43/39/39414787.pdf
[9] Paras, B., & Bizzocchi, J. (2005). Game, motivation, and effective learning: An integrated model for educational game design. In *Proceedings of Digital Games Research Association Conference (DiGRA2005)*, Canada.
[10] Prensky, M. (2003). Digital game-based learning. *Computers in Entertainment, 1*(1), 1-4.
[11] Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of the research. *Simulation and Gaming, 25*, 261-276.
[12] Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers & Education, 40*(1) 71-94.
[13] Schunk, D. H. (1985). Participation in goal setting: effects on self-efficacy and skills of learning-disable children. *The Journal of Special Education, 19*(3), 307-317.
[14] Schunk, D. H. (1989). Self-efficacy and achievement behaviors. Educational *Psychology Review, 1*, 173-208.
[15] Schunk, D. H. & Swartz, C. W. (1993). Goals and progress feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology, 18*, 337-354.
[16] Small, R.V. (1997). *Motivation in instructional design. Syracuse, NY: ERIC Clearinghouse on Information and Technology*. (ERIC Document Reproduction Service No. ED409895).
[17] Stock, J., & Cervone, D. (1990). Proximal goal-setting and self-regulatory processes. *Cognitive Therapy and Research, 14*, 483-498.
[18] Wood, R. E., & Bandura, A. (1989). Impact of conceptions of ability on self-regulatory mechanisms and complex decision making. *Journal of Personality and Social Psychology, 56*, 407-415.