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A Case Study of an Academic Achievement-oriented Student in Game-based Learning

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***Abstract*—VISOLE (Virtual Interactive Student-Oriented Learning Environment) is a teacher-facilitated constructivist pedagogical approach to empower game-based learning. In combination with scaffolding, situated cognition, reflection, and debriefing, VISOLE aims at providing students with opportunities to acquire subject specific knowledge in a multi-disciplinary fashion and sharpen their higher-order thinking skills for problem solving. Farmtasia is the first online game designed to facilitate the VISOLE approach. We conducted a qualitative case study, in the setting of formal curricular teaching in a secondary school, to look into the course of students' learning in VISOLE. This paper discusses a part of the entire study, focusing on delineating an impeding phenomenon, *arbitrary gaming*, which emerged in an academic achievement-oriented student's learning process. The findings provided insights into the issue of implementing VISOLE and game-based learning in general in school education.**

Keywords- game-based learning; educational games; virtual learning environments, constructivist learning

I. INTRODUCTION

Contemporary game-based learning researchers have been endeavouring to study how to harness games to facilitate constructivist learning [1]. In general, their work can be categorized into two initiatives, namely, *education in games*, and *games in education*. Education-in-game researchers (e.g., [2], [3], [4]) advocate the adoption of existing *recreational games* in the commercial market for educational use. On the other hand, game-in-education researchers (e.g., [5], [6], [7]) design their *educational games* based on particular learning paradigms and articulated with specific learning contents.

Nevertheless, in the course of game-based learning, students often have difficulties in making connections between games and the referent real-world systems that the games are intended to represent [8]. On top of that, simulations in games can never be exact reflections of the reality [9]. Even though a student invests considerable time in uncovering the "functional dependencies" of a game, successful game-playing per se may not generate insights into its underlying knowledge [10].

We realize that the discussion of game-based learning should not only focus narrowly on exploiting games into another type of "self-contained" constructivist learning environment. It is also important to explore how to articulate gaming and learning with teacher-facilitated pedagogy which assists students in transforming their gaming experience into learning experience. Regrettably, most of the recent game-based learning studies, either education-in-game or game-in-education, have no strong emphasis on this matter.

Using a game-in-education approach, we have initiated *VISOLE—Virtual Interactive Student-Oriented Learning Environment*, a teacher-facilitated constructivist pedagogical approach to empower game-based learning [11]. It aims at providing students with opportunities to acquire subject-specific knowledge in a multi-disciplinary fashion, and sharpen their higher-order thinking skills for problem-solving. Farmtasia [12], which is the first online game designed to facilitate the VISOLE approach, was developed based on a part of the senior secondary [1] Geography curriculum in Hong Kong. We will go into the details of VISOLE and Farmtasia in Sections II & III.

A. Initial Evaluation of VISOLE

In 2006, we carried out an evaluative study on VISOLE (with Farmtasia) in the form of a competition (as an extra-curricular activity), involving 28 teachers and 254 secondary-4 (K10) students from 16 schools in Hong Kong [13]. We adopted a quantitative-based treatment approach to investigate whether VISOLE could "yield" the new learning opportunities as its original design. We also conducted a number of post-treatment interviews with the students in each school so as to gain more understanding of their learning process in VISOLE.

Through the pre- and post-tests, we obtained positive results in terms of the students' advancement in the knowledge and higher-order thinking skills concerned. However, a significant amount of the interviewed students revealed that a number of impeding phenomena emerged during the course of their participation in VISOLE. A number of "plausible" student factors [2] leading to these impeding phenomena were identified; one of them was related to their perception of the effectiveness of game-based

[1] It corresponds to K10-11 of education in the United States, Canada, etc.

[2] Other plausible factors included students' interest in gaming, prior gaming experiences, and conception of learning.

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learning for helping them get good academic achievement in school exams. We named this factor *students' academic achievement-orientedness*.

Through this evaluative study, we gained some initial understanding of students' learning process in VISOLE, but the findings were far from being "in-depth." Furthermore, since we conducted the study in the setting of a competition, "what happens when VISOLE enters a 'real' classroom" was still unknown.

B. Aim of the Paper

Based on the finings of the initial evaluative study, we conducted further an in-depth qualitative case study on the "inner-workings" of students' learning process in VISOLE. Our focus was to probe into the impeding phenomena which emerged during their participation in VISOLE. We carried out this research in the setting of formal curricular teaching, involving 1 teacher and 40 secondary-4 students. This paper reports a part of the entire research, discussing an academic achievement-oriented students' learning process in VISOLE, and the insights we obtained therein.

II. VISOLE

Framed by the theoretical foundation of intrinsic motivation [14], situated cognition [15], reflection [16], and scaffolding [17], VISOLE is composed of three operable pedagogical phases as follows.

A. Phase 1: Multi-disciplinary Scaffolding

A VISOLE teacher assists VISOLE students in gaining some preliminary high-level abstract knowledge (as their prior knowledge to the next learning phase) based upon a selected multi-disciplinary framework through some face-to-face scaffolding lessons. In this phase, the students are equipped with "just enough" knowledge, and given only some initial "knowledge pointers." They have to go on acquiring the necessitated knowledge and skills on their own in the next learning phase, not only from the designated learning resources but also a wider repertoire of non-designated resources, such as the Internet.

B. Phase 2: Game-based Situated Learning

This phase deploys an online multi-player interactive game portraying a virtual world in which each student plays a role to shape its development. The missions, tasks and problems therein are generative and open-ended, and there is no prescribed solution. Since every single action can affect the whole virtual world, the students have to take account of the overall effects associated with their strategies and decisions on others contextually and socio-culturally. Being situated in this virtual world, the students need to acquire the subject-specific knowledge involved. Apart from that, they also need higher-order thinking skills to *analyze* problems occurring therein, as well as *create* and *evaluate* different possible solutions to solve the problems.

C. Phase 3: Reflection and Debriefing

This phase interlaces with the activities in Phase 2. After each bout of gaming, the students are required to write their own journal to reflect on their learning experience formatively. On the other side, the teacher monitors closely the progress of the students' development of the virtual world at the backend. He/she looks for and tries to act on "debriefable" moments to "lift" the students out of particular situations in the game. In this phase, the teacher extracts problematic and critical scenarios arising in the virtual world, and conducts case studies with his/her students through some face-to-face debriefing lessons.

III. FARMTASIA

Farmtasia [12] is the first online game created to facilitate Phase 2 of VISOLE. The content of the game was developed upon a multi-disciplinary topic, Agriculture, in the senior secondary Geography curriculum of the Hong Kong Certificate of Education Examination (HKCEE)[3] [18]. This topic involves eight areas of subject knowledge, including *natural environment*, *biology*, *economics*, *government*, *production systems*, *technology*, *natural hazards*, and *environmental problems*.

Farmtasia features interacting farming systems which cover the domains of *cultivation*, *horticulture*, and *pasturage*. In this virtual world, each student acts as a farm manager to run a farm. Each of them competes for two quantified outcomes, i.e., *financial gain* and *reputation*, with three other students who are also running their own farm simultaneously somewhere nearby.

Farmtasia operates in a bout-based manner (consisting of 12 bouts of gaming, 1 hour per bout), and in accelerated mode (every bout equates to 6 months in the virtual world). In this game, students have to formulate and implement various investment and operational strategies to yield both quality and abundant farm products for profit making (the financial gain) in the market. Besides, they should always keep an eye on the contextual factors (e.g., temperature, rainfall, wind-speed, etc.) of the virtual world so as to perform just-in-time actions (such as cultivating and reaping crops at appropriate time). In spite of the competition for the financial gain, the richest may not be the final winner. Students' final reputation in the virtual world is another crucial judging criterion. This reputation is governed by good public policies and is determined by students' practice in sustainable development and environmental protection.

For enabling teachers to review students' performance and extract their gaming scenarios for conducting debriefing lessons (Phase 3 of VISOLE), we implemented a *teacher console* in Farmtasia. When students are running their farm in the virtual world, the game server will *record* their every single gaming action. Through the teacher console, teachers can *replay* students' gaming proceedings in the form of video playback.

A *blogging platform* was developed to facilitate students' reflection exercise in Phase 3 of VISOLE. After each bout of gaming, students are required to "blog" their own reflective journal through this platform. By reading students' blogs, teachers can grasp more clues about each student's

[3] HKCEE is an important public examination in Hong Kong secondary education, equivalent to O-level examination in the United Kingdom.

gaming/learning progress. These clues can assist teachers in selecting more critical debriefing content (students' gaming proceedings) to be discussed with their students.

IV. RESEARCH DESIGN

In the present study, a critical beginning task was to invite Geography teachers who were experienced and willing to implement VISOLE in their teaching practice. This was not an easy task, because VISOLE (even game-based learning) has been a rather new pedagogical idea to the education community in Hong Kong.

Our initial invitation scope focused on the five Geography teachers from those 28 teachers who had participated in the prior evaluative study in 2006 [13]. Eventually, only one female teacher, *Tracy* (pseudonym), was willing to participate in this research. The reasons for the rejection given by the other four teachers were similar, and frank indeed. They did not want to take "risk" to teach the formal curriculum concerned with a new educational innovation. Owing to the practical constraint on recruiting additional suitable teacher participants, we adopted a single-case study approach. This case involved Tracy's implementation of VISOLE (with Farmtasia) in teaching her Geography class of 40 secondary-4 students on the topic of Agriculture.

A. Identification of an Academic Achievement-oriented Student

Three weeks before Tracy's implementation of VISOLE, we conducted a questionnaire-based survey to gather the 40 students' information related to the plausible factors (identified in the prior evaluative study) that might lead to the emergence of the impeding phenomena. The data collected helped us identify preliminarily a number of initial key student informants in the study. Furthermore, with the school principal's approval, we also gathered the students' exam results in the previous semester. This information enabled us to verify the survey data.

One week before the implementation, we visited the class twice to start developing a friendly rapport with the students. Besides, purposively, we chatted with the initial key student informants in an informal way so as to gain more understanding about their background and triangulate further the survey data. Finally, we selected *Carol* (pseudonym), a female student as one of the *focal units of analysis* [19] in the entire study.

Carol was an academic performance-oriented student, and one of the top-three academic achievers in the class. In the survey, she indicated that her most preferred teachers' pedagogical style was the one that could help her get excellent results in exams. In the chat with Carol during the class visits, she doubted the effectiveness of "learning through gaming."

B. Implementation Setting

There were two 70-minute Geography lessons every week in the school. Tracy used six weeks (namely, Weeks 1 to 6) to implement the VISOLE approach. It consisted of three scaffolding lessons (Phase 1), 12 bouts of gaming (Phase 2, namely Bouts 1 to 12), and four debriefing lessons (Phase 3).

The scaffolding lessons were completed in the first two weeks. The students started playing Farmtasia in Week 3. They played one bout every two to three days until Week 6. Tracy conducted the debriefing lessons respectively after Bouts 2, 4, 7, and 12. Due to the insufficiency of the lesson time, the students were asked to play the game at home mainly. Nevertheless, in order to facilitate us to observe their "physical" gaming behaviour, we required them to play some bouts (Bouts 2, 4, and 10) during some lessons (namely, gaming lessons).

C. Data Collection

During the VISOLE process, we adopted multiple data collection means to probe into the students' learning process. Apart from the participants' self-reported data and our own observational data, the documentary evidence also played a significant role in this research. Table 1 shows a summary of the data types (in the left column) and the corresponding collection means (in the right column) involved.

TABLE I. DATA COLLECTION

Data Type	Collection Means
Participants' Self-reported Data	• Just-in-time researcher-student and researcher-teacher chats • Multiple purposive student and teacher interviews • Tracy's think-aloud records after scaffolding and debriefing lessons
Observational Data	• Observations on scaffolding, gaming, and debriefing lessons
Documentary Data	• Students' gaming proceedings • Students' blog

V. FINDINGS

Fig. 1 shows the bouts that Carol participated in Farmtasia. From Bouts 1 to 7, she played the game in an on-and-off manner. Nevertheless, starting from Bout 8, she went on playing every bout until the end of the game (Bout 12).

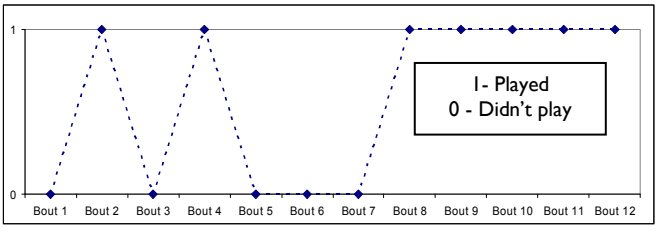

Figure 1. Bouts played by Carol

In this paper, we define *arbitrary gaming* as—

> *When a student is playing a game, his or her gaming acts are haphazard or even illogical, without caring about his / her gaming outcomes.*

The following will spell out how and why the arbitrary gaming phenomenon emerged in the course of Carol's participation in VISOLE.

A. *From Bout 1 to Bout 7*

In the first seven bouts of the game, Carol only played Bouts 2 and 4 which were scheduled to be played in the gaming lessons. She skipped all other bouts which were scheduled to be played at home. During the period of Bouts 1 to 7, carol did not write a single piece of learning reflection on her blog.

When reviewing Carol's gaming proceedings, we could identify her arbitrary-gaming acts easily. For example, in Bout 2, she bought milking machine with no cattle being kept in her pasturage. She commanded the workers to irrigate her cropland frequently even though the aqua-index of the soil was very high. Fig. 2 is a screen shot of Carol's farm captured at the end of Bout 2. As shown, the pasturage was idle, and the crops in the cropland withered away due to her over-irrigation. On top of that, both cropland and orchard were being attacked by nematode diseases.

Figure 2. Carol's arbitrary gaming acts in Bout 2

We triangulated further these arbitrary-gaming acts through a retrospective interview[4] with Carol after Bout 2—

> *[Why did you command your workers to irrigate the cropland 32 times during the second week of July (in the virtual time)?] Carol: Irrigation was simply the basic work in a farm …*
>
> *[Why was it 32 times?] Carol: … (irresponsive)*
>
> *[Why did you only do irrigation but no fertilization?] Carol: … (irresponsive) … to be true, I played the game recklessly…*

In Bout 4, again, she played the game arbitrarily. She employed 36 workers and bought 10 heads of cattle (see Fig. 2). However, she neither commanded the workers to conduct any farming-related work in her cropland / orchard, nor fed the cattle in her pasturage. She spent a lot of the time making the workers move back and forth in the farm.

[4] Before the interview, Carol was allowed to review her gaming proceedings (with the teacher console) for recalling her memory.

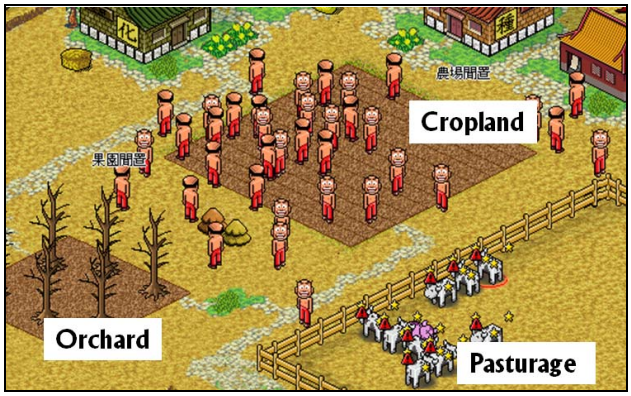

Figure 3. Carol's arbitrary gaming acts in Bout 4

B. *From Bout 8 to Bout 12*

After Bout 7, Tracy was aware that an increasing number of the students neither played the game nor blogged their learning reflection. Thus, Tracy launched an intervention. Starting from Bout 8, for those students who completed a bout and blogged a reflective piece, Tracy would award them two marks. These marks would then contribute to their continuous assessment performance in the semester.

After Tracy had launched the "2-mark intervention," Carol found that it was "justified" to continue her participation in VISOLE. She resumed her gaming and started her blogging since Bout 8. However, according to her gaming proceedings of the remaining bouts, she just kept her farm idle for most of the time. On top of that, all of the reflective pieces found on her blog were superficial—

> *I successfully completed Bout 8 ;-)*
>
> *I successfully completed Bouts 9 ;-)*
>
> *I successfully completed Bouts 10 ;-)*
>
> *I successfully completed Bouts 11 ;-)*
>
> *I successfully completed Bouts 12 ;-)*

C. *Discussion*

In Biggs and Moore's [20] terms, Carol was an "achieving student" whose studying strategy was to maximize the chances of obtaining good results in exams. In the interview with Carol after Bout 12, she told us that, during the period of the VISOLE process, she had been working hard to study the Agriculture topic with the textbook on her own. She believed that this was the best way to get a good result in the semester-end Geography exam. Carol did not embrace the learning opportunities offered in VISOLE. She realized the effectiveness of "learning through gaming" was low—

> *I don't see gaming as an effective learning approach … undoubtedly, it is more interesting than usual classes… however, in terms of getting good performance in exam, I am certain that gaming is not as effective as traditional lessons or even self-study, …*

A common premise of constructivist game-based learning is that, failure *(e.g., undesirable happenings)* in games will lead to discrepancies between what students understood in the past and what they have experienced in the games [11]. Learning is experience plus reflection [16]. By reflecting on the discrepancies, students will establish new learning goals for what they need to acquire in order to make sense out of those discrepancies. This constructivist process, however, was not witnessed in Carol's gaming proceedings or her blog. She played the game arbitrarily, without caring about the gaming scores or worrying about the undesirable happenings occurring in her farm. Compared with her classmates [21, 22], Carol had no significant learning progression in the course of Game-based Situated Learning (Phase 2) of VIOSLE.

VI. Conclusion and Further Study

Games do not appeal to all students [2]. Every classroom has academic achievement-oriented students [20] who might need "justifications" before investing their time and effort in participating in game-based learning activities. Could students' performance in game-based learning be treated as a kind of formal academic assessment at school?

Assessment is an important matter in education [23]. Apart from the purpose of providing academic achievement-oriented students with "justifications," it is also a crucial sort of learning feedback for students to improve / enhance themselves. However, assessing students' learning in gaming is not an easy job. In our experiences [21, 22], solely relying on students' gaming results to evaluate their learning performance may trigger the issue of assessment unfairness. It is because games often have exploits[5], and gamer students (who have rich gaming experiences) can usually create degenerate strategies[6] on those exploits and win the games effortlessly [24]. On the other hand, using students' reflective writing (in the case of Phase 3 of VISOLE) as a basis for assessment seems more sensible. Nevertheless, it may disadvantage students who are bad in language or hate writing.

In view of bringing VISOLE or other game-based learning initiatives into school education, assessment in game-based learning is a vital topic worthy of further study.

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References

[1] Hein, G. (1992). Constructivist learning theory. *Developing museum exhibitions for lifelong learning* (pp. 30–34). London: The Stationery Office.

[2] Squire, K. R. (2004). *Replaying history: Learning world history through playing Civilization III*. Unpublished dissertation, Indiana University.

[3] Kemp, J., & Livingstone, D. (2006). Putting a Second Life "metaverse" skin on learning management systems. *Proceedings of the Second Life Workshop at the Second Life Community Convention* (pp. 13–18). San Francisco.

[4] Antonacci, D., & Modaress, N. (2008). Envisioning educational possibilities of user-created virtual worlds. *AACE Journal, 16*(2), 115-126.

[5] Lee, J. H. M., Lee, F. L., & Lau, T. S. (2006). Folklore-based learning on the web—pedagogy, case study, and evaluation. *Journal of Educational Computing Research, 34*(1), 1–27.

[6] Shaffer, D. W. (2007). *How computer games help children to learn*. New York: Palgrave Macmillan.

[7] Aylett, R. S., Paiva, A., Woods, S., Hall, L., & Zoll, C. (2008). Expressive characters in anti-bullying education. In L. Canamero & R. Aylett (Eds.), *Animating Expressive Characters for Social Interaction* (pp. 161–176). Philadelphia: John Benjamins.

[8] Clegg, A. A. (1991). Games and simulations in social studies education. In J. P. Shaver (Ed.), *Handbook of research on social studies teaching and learning* (pp. 523–528). New York: Macmillan.

[9] Thiagarajan, S. (1998). The myths and realities of simulations in performance technology. *Educational Technology*, *38*(5), 35–41.

[10] Halverson, R. (2005). What can K-12 school leaders learn from video games and gaming? *Innovate*, *1*(6).

[11] Jong, M. S. Y., Shang, J. J., Lee, F. L., & Lee, J. H. M. (2010). VISOLE—A constructivist pedagogical approach to game-based learning. In H. Yang, & S. Yuen (Eds.), *Collective intelligence and e-learning 2.0: Implications of web-based communities and networking* (pp. 185-206). New York: Information Science Reference.

[12] Cheung, K. K. F., Jong, M. S. Y., Lee, F. L., Lee, J. H. M., Luk, E. T. H., Shang, J. J., & Wong, M. K. H. (2008). FARMTASIA: An online game-based learning environment based on the VISOLE pedagogy. *Virtual Reality, 12*(1), 17-25.

[13] Jong, M. S. Y., Shang, J. J., Lee, F. L., & Lee, J. H. M. (2010). An evaluative study on VISOLE—Virtual Interactive Student-Oriented Learning Environment. *IEEE Transactions on Learning Technologies, 3*(4), 307-318.

[14] Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 4*, 333-369.

[15] Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

[16] Dewey, J. (1938). *Experience and education*. New York: Macmullan.

[17] Vygotsky, L (1978). *Mind and society*. Cambridge: MIT Press.

[18] Hong Kong Examination and Assessment Authority (2008). *HKCEE Syllabus: Geography*. HKSAR: HKEAA.

[19] Yin, R. K. (2003). *Case study research: Design and method (3rd ed.)*. Thousand Oaks, CA: Sage.

[20] Biggs, J. B., & Moore, P. (1993). *The process of learning* (3rd ed.). Newe York: Prentice Hall.

[21] Jong, M. S. Y., Shang, J. J., Lee, F. L., & Lee, J. H. M. (2010). A case study of a non-gamer student's learning process in VISOLE. *Proceedings of the 3rd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2010)* (pp. 77-84). Kaohsiung, Taiwan.

[22] Jong, M. S. Y., Shang, J. J., Lee, F. L., & Lee, J. H. M. (2010). The Significance of Emotional Support to students in Game-based Learning. Proceedings of the 18th International Conference on Computers in Education (ICCE 2010): *Enhancing and Sustaining New Knowledge through the Use of Digital Technology in Education* (pp. 525-532). Putrajaya, Malaysia.

[23] Bransford, J. D., Derry, S., Berliner, D., Hammerness, & Beckett. (2005). Theories of learning and their roles in teaching. In L. Darling-Hammond, & J. Bransford (Eds*.), Preparing teachers for a changing world* (pp. 40-87). San Francisco, CA: Jossey-Bass.

[24] Salen, K. (Ed.) (2008). *The ecology of games: Connecting youth, games, and learning*. London: The MIT press.

[5] Exploits refer to weaknesses or loopholes in a game that allow players to advance in the gaming effortlessly.

[6] Degenerate strategies are ways of playing a game that ensure victory every time.