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Can "Stag-and-Hare Hunt" Behavior be Modeled using Interaction Data from a Mobile-Supported Collaborative Learning Application?

Rex BRINGULA[a*], Ma. Mercedes RODRIGO[a]
[a]*Ateneo Laboratory for the Learning Sciences, Ateneo de Manila University, Philippines*
*rexbringula@gmail.com

Abstract: Despite the call to develop culturally-aware educational technologies, very few studies were conducted in the Philippines. In order to contribute to this body of literature, this study has been conceived. This paper intends to model the "stag-and-hare" hunt behavior of students in the light of cultural orientation of the participants. It will use the interaction data that will be gathered through *Ibigkas! Math* – a mobile-supported collaborative learning application. Based on the developed model, the mobile application will be revised to make it more adaptive to students' academic needs. The proposed methodology and future works are discussed.

Keywords: behavior, collaborative learning, cooperation, mobile application, mobile game

1. Introduction

Computer-supported cooperative learning (CSCL) environment intends to instill cooperation among learners. Through this learning model, students are able to work together towards a common academic work, and, consequently, learn in a social group (Gillies, 2016; Gokhale,1995). However, it has to account that learners' cultural orientation influences their interactions within a group (King, Ganotice, & Watkins, 2014). Blanchard and Frasson (2005), and Blanchard and Ogan (2010) agree that there is a need to develop culturally-aware educational technologies. For instance, Bringula et al. (2018) found that students exhibited different degrees of engagement in a participatory design workshop: at one end, students were very competitive and outspoken, while on the other end, students were timid, shy, and afraid to commit mistakes.

One of the behaviors underrepresented in the CSCL literature is the stag-and-hare hunting behavior. Stag-and-hare hunting behavior refers to the tendency of learners to choose either a high-risk game mode but with higher payoffs (i.e., the stag) or a low-risk game mode but with lesser points (i.e., the hare) in a game-based mobile-supported collaborative learning environment. Since learners are in a collaborative learning environment, their cultural orientation (e.g., concept of shame and shyness) and personality types may influence their interactions with the system. A student, who is not ashamed to commit mistakes, may passively choose an answer for the sake to contribute to the group points. On one hand, a student, who avoids to be blamed when his/her answer is wrong, may select a question with lesser point. These types of student may not necessarily contribute to the overall welfare of the group, and ultimately, do not achieve learning. In order to fill-in this research gap, this study intends to

1. determine the features that could be utilized to model the "stag-and-hare" hunt behaviors of learners in a game-based mobile-supported collaborative learning environment, and
2. use the model in developing an automatic detector of stag-and-hare behavior in a CSCL.

2. Theoretical Framework

Students' cultural orientation influences their academic life (Jarvis, Holford, & Griffin, 1998). Understanding students' cultural orientation is important since bad assumptions about their learning behaviors could be avoided (Blanchard & Frasson, 2005). Furthermore, it enables teachers provide

relevant pedagogical approaches to the students from a culturally different background. For instance, several studies found that test anxiety (Cassady, Mohammed, & Mathieu, 2004), reward allocations (Fischer & Smith, 2003), and achievement (mastery and performance) and social goals (affiliation, approval, concern, and status) (King, Ganotice, & Watkins, 2014) vary among cultures.

As a collectivist society (Hofstede, 1980), students tend to find belongingness outside their family. They perceive that there is a need to be part of a group (Bernardo & Ismail, 2010) and to be able to establish a secure connection with that group (Mesurado, Richaud, & Jose Mateo, 2016). For Filipino students, engagement has different eight different levels (Santiago & Enriquez, 1976). These levels of interaction include: *pakikitungo* (transaction/civility with), *pakikisalamuha* (interaction with), *pakikilahok* (joinining/participating with), *pakikibagay* (in conformity with/in accord with), *pakikisama* (getting along with), *pakikipag-palagayang-loob* (having rapport with), *pakikisangkot* (getting involved with), and *pakikiisa* (being one with). It is apparent that learning in the Philippine context is more grounded on social features (Mesurado et al., 2016). Deviating from the expected roles in these social interactions may result to "*hiya*" (shame) (Lasquety-Reyes, 2016). Shame is a mechanism for social and individual control in a collectivist culture. It guides the actions of a person since he/she would seek to meet the expectations of the group (Pattison, 2000). Thus, in a collaborative environment, teachers must explicitly set the expectations on which level/s of engagement is/are desired.

Filipinos use "*hiya*" to control or regulate social behavior. It is defined as "a feeling of inferiority, embarrassment, shyness, and alienation, which is experienced as acutely distressing" (Guthrie 1968, p. 62). This perception of "*hiya*" has a negative connotation (Jocano, 1999). When applied in educational context, students exclude themselves in academic and extra-curricular participations (see Page & Zarco, 2001; Ordonez & Gandeza, 2004). Because of "*hiya*", students are not comfortable asking their teachers valid questions; instead, they ask their classmates when clarifying ideas or instructions (Ordonez & Gandeza, 2004).

In a recent study of Bringula et al. (2018), it was observed that Filipino students exhibited shyness and varying degrees of engagement in a participatory design workshop to elicit design guidelines for an educational game. There were six groups of students consisting of six members on each group with different academic abilities. The content of the game is about the English language. As a collaborative game, the scores of the team depend on group efforts and individual competency. While students were eager to participate in the game, students had varying degrees of engagement and exhibited shyness. The relationship between different personalities and sources of shyness, and their impact of group participation ("*pakikilahok*") in a mobile-supported collaborative learning environment and learning, are still untested hypotheses in the Philippine context. Furthermore, the impact of different personalities of Filipino learners on collaboration and learning is still unknown.

Considering the collectivist culture of the Filipinos, researchers are informed that learners may be more comfortable learning as a group. This can only be achieved if "*hiya*" (shyness) could be overcome by the participants. It is still not understood how shame and shyness influence the behavior of the students in a collaborative learning environment. The personalities of Filipino learners have to be understood in order to carry out successful interventions and achieve optimum learning experiences in a mobile-supported collaborative learning (MSCL) environment. Thus, this study aims to investigate the influence of cultural values of the students in the context of "*hiya*" and their personalities on their behaviors in a MSCL environment.

3. Proposed Methodology

3.1 Software to be Utilized

Ibigkas! Math will be utilized in the study. It is a mobile-based learning application for grades 1 to 6 students. It is a collaborative game that covers arithmetic problems (addition, subtraction, multiplication, and division of whole numbers). The application generates the arithmetic problems and it will be displayed in one of the team members' mobile device (see Figure 1). It will be read aloud by the player. The answers are presented in multiple choice. The correct answer will appear in one of the team members' device. This is the first version of the game.

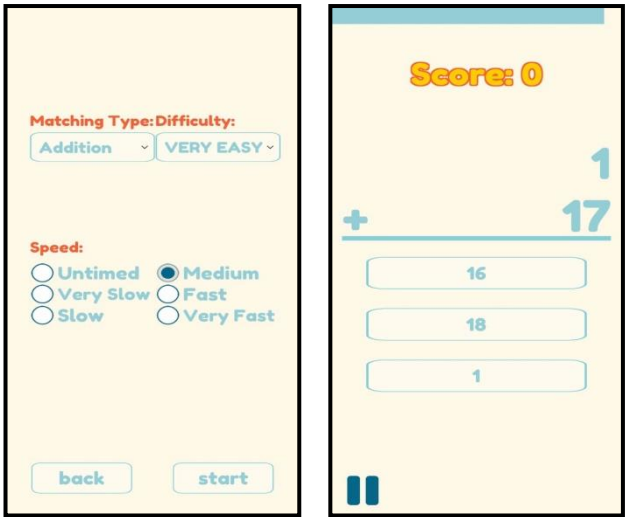

Figure 1. Ibigkas! Math

3.2 Experimentations

The study will consist of two experiments. In the first experiment, students of the same grade level from schools A (public school in Quezon City) and B (private university in Manila) will be grouped in teams of three members. Students of different mathematical competencies (struggling/low-, average-, and high-performing) will form a team. Teachers will be requested to select students based on these categories. Students will use the game for 20 minutes without any interventions from the software and facilitators. The first version of the game will be utilized in this experiment. The same sets of participants will be carried out both versions of the game throughout the succeeding two experiments where students will answer a demographic questionnaire (grade level, age, gender, and mathematics self-efficacy) and personality type inventory. During this process, interactions with the applications will be tracked and automatically recorded into a file. The feature selection and data analysis will be discussed in the next section.

A model will be developed based on the selected features. Based on the developed model, the application will be revised. This version of the application will be used in the second experiment. In the second experiment, the application will intervene if a student is passively choosing an answer or if a student is not solving more challenging questions. Individual textual feedback such as "*Refrain from guessing.*" or "*Would you like to try to answer a harder problem?*" will be incorporated in the application. A pretest and posttest will be administered during this experiment to determine the educational impact of the game.

3.3 Data Collection, Preparation, Feature Selection, and Data Analysis

The interaction logs will have 11 parameters (i.e., timestamp, types of problem solved, grade levels, difficulty levels, speed, choices, target problem, correct answer, incorrect answers, scores, and game ended). From these parameters, features will be selected. Incomplete records (e.g., incomplete or invalid data, outliers) will be removed from the dataset. Forward feature selection method using *k*-NN 10-fold cross validation will be employed using RapidMiner. Using the results of the feature selection, the dataset will be subjected to modeling. Decision tree modeling with accuracy criterion will be employed to determine the behaviour of the students in using the application. The results of the decision tree modelling will serve as basis in the development of an adaptive application.

4. Future Work

Although this study does not claim that Filipino cultural characteristics are unique, it intends to believe that the interactions of the students may vary depending on the context of the study. Students from a highly competitive class environment (e.g., Science High Schools) may display different learning

behaviors during the game. Hence, future research works in a western cultural setting and conducting the study with a different set of participants are desirable.

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