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An Investigation of Affect within *Ibigkas!*: An Educational Game for English

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Abstract: We investigated the affective states (both individual and shared emotions) of students using a collaborative and educational game for English called *Ibigkas!* Our goal was two-fold: (1) To determine the incidence and persistence of affective states exhibited by the students when working individually and in groups, and (2) to adapt the Baker Rodrigo Ocumpaugh Monitoring Protocol for collaborative learning situations. Our findings for this study are as follows: (1) in single-player mode, students exhibited greater engaged concentration, pride, and frustration and less excitement, delight, and confusion compared to the multiplayer mode; (2) that individual emotions can be distinct from group emotions; (3) that negative emotions like frustration and blame/guilt were only felt at the individual level and were not observed as shared by all the members of the group; (4) affective states tended to persist more within an individualized game setting compared to the collaborative game setting where there was a greater number of opportunities to experience a wider range of emotions, hence the low chance of persistence; (5) students within an individualized setting spent more time solving the game rounds, had fewer incorrect answers, even as they experienced more frustration, and finally, (6) students within a collaborative setting had fewer errors when they had a higher incidence of excitement and had more errors when they appeared to be concentrating due to the presence of the "gaming the system" behavior.

Keywords: *Ibigkas!*, BROMP, student affect, English language learning

1. Introduction

Collaborative games are activities in which players must work together as a team in order to share payoffs and outcomes (Zagal, Rick, & Hsi, 2006). They differ from cooperative games, in which players' goals may vary. In a collaborative game, players have a common goal. The consequences of each decision, be they positive or negative, are shared by all members of the group. Some research has shown that collaborative games are fun, engaging, and motivating (Wendel, et al., 2013); promote positive learning attitudes, motivation, achievement, and self-efficacy (Sung & Hwang, 2013); and encourage the development of prosocial skills (Hromek & Roffey, 2009).

Despite their potential, the literature on collaborative games for learning or affective states experienced by players is limited. A systematic review of literature by Connolley and colleagues (2012) identified only 18 quality papers on affective and motivational outcomes of games in general while a follow up review by Boyle and colleagues (2016) identified only 22, 7 of which were games for learning. Furthermore, most of the methods used for collecting the data in these studies tended to be survey research.

Given these gaps, there is opportunity to contribute to the literature by analyzing student affect while using a collaborative and educational game, using data collection methods beyond or in addition to survey research. To this end, this study compares the affective states that students exhibit as they play individual and collaborative versions of the same game. We aim to answer the following questions:

- How can we adapt BROMP, a widely used quantitative field observation methodology, to account for collaborative learning activities?

- What is the incidence and persistence of students' affective states when playing an individualized game?
- What is the incidence and persistence of students' affective states when playing a collaborative game?
- What are the similarities or differences between the two patterns of affective states?

2. Adaptation of BROMP for Collaborative Learning

BROMP is a field observation methodology that enables trained research staff to collect affect and behavior observations systematically (Ocumpaugh et al., 2015). The affective states of interest observed were engaged concentration, confusion, frustration, delight, excitement and pride. The descriptions are as follows:

- **Engaged Concentration**. This is the affective state depicting engagement with the task where there is intense concentration, focused attention and total involvement (Baker, D'Mello, Rodrigo & Graesser, 2010). This affective state's observable indicators include focus on the task at hand, mouthing answers/solutions, pointing to the screen, among others.
- **Confusion.** This is the affective state depicting difficulty with the game and how to play it (Ocumpaugh et al., 2015). Observed manifestations include scratching the head, repeatedly looking at the same interface elements, consulting with a group mate or a facilitator, asking questions and verbalizing that they are confused and do not know how what to do nor how to proceed. It is noteworthy, though, that specific to the deployments for this study, when students experience confusion they were mostly laughing and making fun of their mistakes.
- **Frustration.** This is the affective state that depicts distress or annoyance with the game (Ocumpaugh, et al. 2015). Behaviors include heavy tapping on the phone screen, pulling his/her hair, deep sighing, and utterances such as "This is annoying!", "I am so stressed!", etc.
- **Delight.** This is the affective state often expressed when a participant feels pleasure when doing the task at hand. This is characterized as an affect with positive valence and medium arousal. Observed behaviors include clapping, smiling and utterances like "This is fun!".
- **Excitement.** This is the affective state often expressed when a participant starts to become very engaged and overwhelmed. This is characterized as positive valence and high arousal. Observed behaviors include standing up, tapping of the feet, and louder voices in utterances like "Go, go, go!".
- **Pride.** This is the affective state often expressed when a participant feels pleasure when achieving a goal or accomplishing a task. Observed indicators include tapping a groupmate on the back and utterances like "We did it!", "I solved it!" or announcing their scores out loud.

2.1 Norming BROMP for Group Observations

BROMP was originally designed for use with students engaged in individual work. While students were free to speak to a teacher, facilitator, or peer, these interactions were not mandatory as the tasks they had could be accomplished independently. It was possible to use BROMP, as how it was originally designed by its creators in collaborative learning situations, but doing so would make it difficult to capture additional characteristics of affective states and behaviors, such as to whom the affective states were directed to, e.g. to self, to the entire group, or to specific team members. It was therefore necessary to adapt BROMP to include these other phenomena of interest.

We conducted pre-tests to norm BROMP for group affect and behavior observations. We recruited 45 first year college students, 16–18 years old. If they agreed to participate, they signed a consent form indicating their willingness to participate in this test while those under 18 also had to ask their parents to complete a second consent form allowing them to join the study.

In groups of three members each, they played the game *Overcooked*. *Overcooked* is a restaurant game in which players act as any of the kitchen staff that who prepare the ingredients, cook, wash plates, and serve dishes. A team-based game, the players needed to divide the work strategically to complete as many orders as they can within the time limit. *Overcooked* was also fast paced so observing a wide range of emotions across different stages of gameplay was more possible than a game that took longer to win or finish. The students had three rounds of gameplay that lasted for around ten minutes. As they

played, the first and second authors observed each member of the group and the group as a whole, i.e. after each member of the group was observed, we also took note of the group affect and behavior of the majority, if not all, of the group members.

2.2 Pre-test Results

In the course of the pre-test, we found that affect or emotions have directionality, either directed towards self, a particular group-mate or towards the rest of the group. We found that members exhibited affective states that had a social dimension, specifically, blame and guilt. Utterances that depict blame include "It is your fault!" or "Who did this? Now, we lost!". Utterances that depicted guilt include "Sorry, my bad!" or "Shame on me!". We noted that the same negative valence and medium to low arousal occurred towards self (guilt) and others (blame).

To further verify our observations, we interviewed the participants and asked them what their general feelings and/or emotions were during the gameplay. Responses to the open-ended questions were transcribed and we used thematic analysis, i.e. coded according to common themes and computed the frequency and percentage of each theme from the entire dataset of responses. Some responses were coded with more than one theme as different feelings/affect were reported. This thematic analysis of interview responses led to the following findings: the more common affective states experienced by the students were confusion (65%) towards the game and their group mates, frustration (46%) towards the game and towards self, excited (54%), delight (38%), pride (8%) towards self and their group and blame/guilt (towards self) (8%).

Given the pre-test results, BROMP resulted to the normed BROMP-collab to include guilt/blame and directionality of the affective states of interest. We made use of both the original BROMP and the normed BROMP for collaborative learning (BROMP-collab) respectively to observe students as they played the single player and multiplayer versions of an educational mobile phone game for English called *Ibigkas!*

3. Ibigkas!

Ibigkas! is a drill-and-practice style game that helps learners develop fluency in identifying rhymes, synonyms, and antonyms in English. It was developed (as discussed more fully in Rodrigo et al., in press) by the Ateneo Laboratory for the Learning Sciences of the Ateneo de Manila University in the Philippines. It is available free of charge for both Android and iOS. It was intended for use by disadvantaged under-resourced students in grades 4, 5, and 6 students in Philippine public schools, where English is an official language, but is not necessarily the language of instruction.

Ibigkas! allows both a singleplayer and multiplayer modes. To play in singleplayer mode, the player first selects a content mode: rhymes, synonyms, or antonyms. When game play begins, the player receives a target word and three choices (Figure 1). The player must click on the choice that is the rhyme, the synonym, or the antonym of the target word.

To play in multiplayer mode, each student must have one a mobile phone each, with the game installed. The game does not require Internet access, but each device must have wifi. Phones have to be connected to the same network hotspot in order to communicate. When the game round begins, a random player from the team receives a target word (in Fig. 2a, the target word is KIT). All players receive lists of words, only one of which is the correct answer. In this example, the list of words received are MISS, NO, WRONG, ANOTHER, HIT and BAD. The correct answer is HIT which rhymes with the target word KIT, in Figure 1.

The player presented with the target word must say it aloud, so that the other players can hear it. The requirement to say the word aloud is the origin of the game's name, as *ibigkas* is the Filipino word for "pronounce" or "say out loud". All other players then check their list of words to see if they have the correct answer. The player with the correct answer should say the answer aloud and tap it. Once the correct answer is tapped, the round is over and a new round begins.

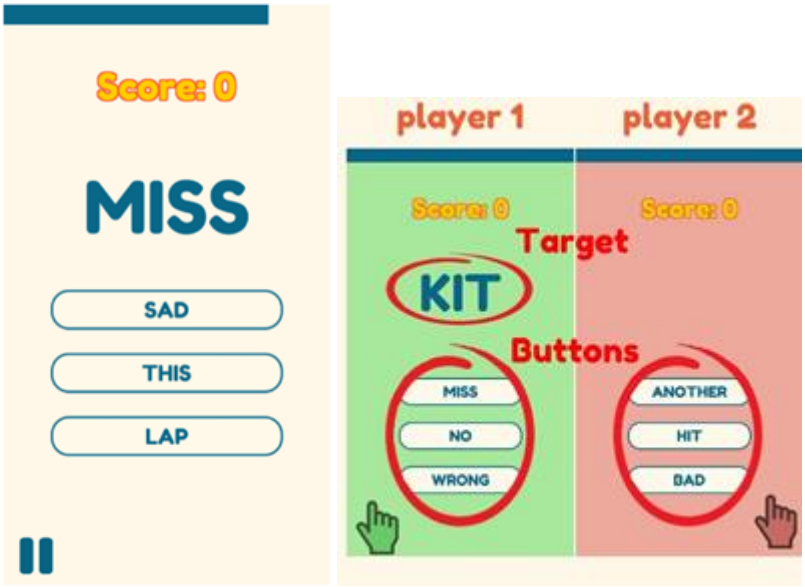

Figure 1. Sample screenshots of the game.

4. Field Study

The deployment and testing was conducted at Angels Here Abound (AHA!) Learning Center (ALC), a tutorial center in Makati, Metro Manila, Philippines that caters to public school students. Staffed in large part by volunteers, ALC is committed to providing supplementary holistic education to underprivileged children. The ALC staff selected students from Grades 4, 5, and 6 to participate in the study. A total of 32 students participated in the study: 12 from Grade 4, 12 from Grade 5, and 8 from Grade 6. These students were given informed consent forms that they and their parents had to complete in order to participate. During the study day, the participants were grouped by grade level. Each grade level had separate testing sessions because the research team had a limited number of cellular phones. The students were given 10 minutes to play *Ibigkas!* in single-player mode then 10 minutes to play in multiplayer mode. While they were playing in single-player mode, a trained observer recorded their affective states using the Baker Rodrigo Ocumpaugh Monitoring Protocol (BROMP). While the students were playing in multiplayer mode, the same observer used an adaptation of BROMP that included the collaborative nature of the game.

5. Analysis

5.1 Incidence and Persistence of Affective States

We computed the incidence of each affective state by dividing the number of times that a specific affective state has been observed by the total number of observations per student. We, then computed the overall incidence by averaging the incidence rates of the affective states across all students. We also did the same procedure for the observed group affect.

In the single-player mode, the students were mostly engaged (70.97%). They also exhibited the following affective states: pride in themselves when they are able to answer correctly (8.13%), delight (7.29%), confused (7.15%), and frustrated with either the game or themselves (4.79%). They were rarely excited (0.63%) and less likely felt blame (0.35%).

In the multiplayer mode, the students exhibited lesser engaged concentration (43.36%) than when they were in single-player mode. They also had more confusion (34.77%), felt more delight (9.07%), excitement (4.30%) and blame (0.78%). However, they exhibited no pride towards self but pride towards their group (0.39%). Frustration (1.95%) had fewer occurrences than when they were on single player mode. Also in multiplayer mode, when we compare the group emotions to the individual

members' emotions, we see that the group had around the same level of engagement (53.82%), confusion (35.59%), delight (7.47%), excitement (1.56%) and pride (0.30%). Blame and frustration were not present in the group emotions.

We used D'Mello's L (D'Mello & Graesser, 2012) as implemented by Karumbaiah (2018) to find out whether some of these states were more likely than chance to transition to each other. An L value of 0 means the transition occurs at chance. L values greater than 0 mean that a transition is more likely than chance to occur, while values less than 0 mean that a transition is less likely than chance to occur.

In the single-player mode, we found that the following affective states occurred more likely than chance: engaged concentration ($L=0.44$, $p<0.01$), delight ($L=0.29$,, $p<0.01$), confusion ($L=0.58$, $p<001$), frustration ($L= 0.49$, $p<0.01$) and pride ($L=0.43$, $p<0.01$). We also found that engaged concentration shifted to confusion ($L=-0.05$, $p<0.05$), engaged concentration shifted to frustration ($L=-0.03$, $p<0.05$) and vice versa ($L=-0.68$, $p<0.01$), delight shifted to engaged concentration ($p<0.05$), and pride shifted to engaged concentration ($L=-0.44$, $p<0.05$). These transitions, though, were less likely than chance.

In the multiplayer mode, we found that confusion ($L = 0.15$, $p<0.01$) persisted. and engaged concentration shifted to delight ($L = 0.05$, $p<0.05$) and vice versa ($L = 0.40$, $p<0.05$). Significant negative transitions found in the multiplayer mode are confusion to delight ($L = -0.13$, $p<0.01$) and vice versa ($L = -0.12$, $p<0.05$),

When we separated individual emotions and group emotions, we found that in a collaborative setting (multiplayer mode), individual emotions alone show that confusion ($L=0.15$, $p0<0.01$) persisted. Excitement to excitement ($L=-0.5$, $p<0.01$), although significant, occurred less likely than chance. Engaged concentration transitions to delight ($L=0.06$, $p<0.05$) and vice versa ($L=0.38$, $p<0.05$). Confusion transitions to delight ($L=-0.14$, $p<0.05$) but this is less likely than chance. For group emotions though, no significant transitions were computed because of the small size of the sample, i.e. there are only 8 groups with 7 observations per group. We noted, though, that the L-statistic for confusion and engaged concentration were above 0.

5.2 Aggregated Gameplay Logs

Ibigkas! produces logs of the gameplay. The logs contain information on the game, content mode and multiple rounds, including the type of content mode and difficulty. It also contains each player's attempts at all the rounds. The correct and wrong answers along with timestamps are captured in the said game logs. We aggregated the logs at the player level and summarized the incorrect answers, number of attempts at each round, and the time elapsed at every attempt.

For the singleplayer mode, the participants had an average of 1.73 (std dev = 0.94) seconds of gameplay and 0.41% error rate (std dev = 0.20).

For the multiplayer mode, the participants had an average of 9.81(std dev = 4.28) seconds of gameplay and 1.37% error rate (std dev = 0.65).

There were no significant difference between the groups of students or grade levels (grade 4, grade 5 and grade 6). Their gameplay performance based on the aggregated logs reveal homogeneity and grade level was not a factor that differentiated their gameplay results.

5.3 Correlating Affect Incidence Rates to the Ibigkas! Logs

We correlated the affect incidence rates during the singleplayer gameplay and the game logs also for the singleplayer gameplay. The only significant correlation was between frustration and wrong rate ($R= -0.51$) and average time and wrong rate ($R = 0.69$). Wrong rate, as previously mentioned, is computed as the total number of incorrect answers divided by the total number of attempts that the student made in the entire game. Average time is the average time that the student spent in answering all the rounds of his/her entire gameplay. For this study, when students spent more time in his attempts, they had fewer incorrect answers. This means that the students were spending more time solving the game rounds and were thinking of the correct answers when they were in single player mode.

For the multiplayer mode, we found that the wrong rate was significantly related to engaged concentration, ($R= 0.36$) and excitement (-0.45). Because the direct relationship between engaged

concentration and wrong rate seem to be surprising, we also computed the incidence rates of observed gaming behavior and found that gaming occurred 14.45% of the time during the gameplay. This could be the reason why the seeming engaged concentration was related to committing more errors/mistakes. Gaming the system has been observed among students even when they are engaged and concentrating (Pardos, et al., 2013). On the other hand, excitement being inversely related to the wrong rate corroborates prior research that positive emotions like excitement has been found to be related to knowledge acquisition and learning (Giannakos, 2013).

There were no significant relationship between the singleplayer and multiplayer aggregated logs.

6. Discussion

6.1 Incidence and persistence in individualized versus collaborative settings

Comparing the occurrence rates of affective states (see table 1) between an individual and a collaborative setting reveal that students were more engaged and concentrated more when working individually than when they were working with others. Confusion and excitement are also observably higher when in groups than within individual settings. Delight slightly increased while pride and frustration slightly decreased within the collaborative setting.

We observed that when a student works alone, he/she tended to figure out the answers and solve the games alone, hence explaining the higher engaged concentration, pride when successful, frustration when unsuccessful because he/she is accountable to only himself/herself and not to anyone else. On the contrary, within a collaborative setting, students interact with their groupmates, which make room for more instances of shared excitement, delight and fewer instances of focused concentration. Also, when failure happens, the students have other people to blame or feel more responsible when one fails.

Table 1

Comparison of Incidence of Affective States in a Singleplayer and Multiplayer modes

	Singleplayer (%)	Multiplayer (%)
Engaged Concentration	70.97	43.36
Delight	7.29	9.07
Pride	8.13	0.39
Confused	7.15	34.77
Frustrated	4.79	1.95
Excited	0.63	4.30
Blame/Guilt	0.35	0.78

For persistence, we observe that in an individual setting, there are more persistent affective states than in a collaborative setting. This may be due to the fact there are more interactions with a peer, making room for more transitions to other affective states. BROMP researchers have mentioned that coding affective states can become more challenging when there are interactions with other persons as

the conditions may not fit the typical BROMP scheme as some emotions, not originally part of the BROMP, may become more prominent (Ocumpaugh, et.al., 2015).

When we look at the transitions that occurred more likely than chance, we observe this only happened in multiplayer mode where engaged concentration shifted to delight and vice versa. This could be attributed to a more prominent feeling of delight when shared within a peer than alone.

6.2 Comparing individual emotions and group emotions

Differentiating the observations between individual participants and the group affect within the multiplayer mode, we found that frustration and blame/guilt was not among the group emotions observed. This can be explained by what prior research has shown that game goals matter to players but due to their "pretend/unreal" contexts, players are able to control or modulate negative emotions to (re)focus on game goals (Granic, Lobel & Engels, 2014).

We also found that, as expected, the group emotions occurrence rates were relatively similar to the occurence rates of the observed individual emotions but not all emotions at the individual level were observed at the group level.

This corroborates the operational definition of group emotions as a shared emotion and that not all individuals share the same group emotion (Smith, Seger & Mackie, 2007).

Blame/guilt and frustration being observed only at the individual level is also noteworthy. This can be explained by a previously researched phenomenon that the group dynamics within collaborative games promote positive feelings (Sung & Hwang, 2013), and for this study this has become more apparent given the observed incidence rates of affective states for both the individual and group modes of gameplay.

6.3 Relationships between affect and game performance in the singleplayer mode

From 5.3, we find that frustration has an inverse relationship to the student's wrong rate in the singleplayer mode. This implies that the more frustrated the student feels the fewer incorrect answers he/she had. At the onset, this relationship may appear to be counter intuitive but reviewing the observations involving frustration, we find that the students who have had episodes of frustration have actually exerted more effort to provide the correct answers. This phenomenon has been described as frustration-motivated exploration which may lead to learning (Wong, 1979) as frustration has also been previously found to be lesser associated to poorer learning (Baker, et al., 2010).

The multiplayer mode revealed that the wrong rate of the students while playing was significantly related to two affective states observed during this specific gameplay. Engaged concentration had a direct relationship to the wrong rate, which implies that, the more engaged the students were the more number of errors they had. Excitement was found to be inversely related to the wrong rate, i.e. the more excited the students became, the fewer errors they committed which corroborates prior work (Robinson, Murray & Isbister, 2018) that has found that pleasure and effort coexist or combine. Hence, with more positive emotion comes more effort and fewer errors.

7. Conclusion

We investigated the different affective states that the students go through during gameplay for *Ibigkas!* and normed BROMP to cover the recurring group affective states that occur in a collaborative and gamified learning environment. For the single-player mode of gameplay, the affective states that occurred more were engaged concentration and confusion and there were a few incidences of delight, pride, excitement, frustration and blame/guilt. For the multiplayer mode, the same affective states were most prominent, i.e. engaged concentration and confusion, while the other affective states were rarely observed. Within the multiplayer mode, we found that everyone in the group did not share frustration and blame/guilt. Hence, there was no incidence of frustration and blame/guilt in observations for group emotions. This work also reinforces the benefits of collaborative learning environments, in particular,

for educational game settings, i.e. it promotes positive emotion and removes negative emotions like frustration and blame/guilt.

Our findings corroborate prior work on collaborative games promoting engagement and positive attitudes and emotions like delight, fun and pride towards self and the group when they are able to achieve the game goals, i.e. answer the levels correctly. The results also show that while the pattern of emotions have some degree of similarity in terms of incidence (occurrence rates) and persistence, not all individuals share the observed group emotions and that group emotions are, indeed, distinct from individual-level emotions (Smith, Seger & Mackie, 2007).

In terms of recurrence rates, single-player modes had more persistent affective states (engaged concentration, delight, confusion, pride and frustration) as compared to only confusion as the persistent state in multiplayer mode.

We also found that frustration was more of an individual emotion than a shared or group emotion within *Ibigkas!* and that the more frustration there was, the student had fewer incorrect answers which implies that frustration may not be that undesirable within learning settings. With this finding, we corroborate studies about frustration having the potential to be a desirable affective state. Within the multiplayer mode or collaborative setting, we found that the more excited a student becomes, the fewer incorrect answers are given. Excitement, then, is a desirable emotion to have within teaching and learning settings.

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References

Baker, R. S., D'Mello, S. K., Rodrigo, M. M. T., & Graesser, A. C. (2010). Better to be frustrated than bored: The incidence, persistence, and impact of learners' cognitive–affective states during interactions with three different computer-based learning environments. *International Journal of Human-Computer Studies*, *68*(4), 223-241.

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Lim, T., Ninaus, M., Ribeiro, C.,& Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, *94*, 178-192.

Coates, D. J., & Tognazzini, N. A. (2012). The nature and ethics of blame. *Philosophy Compass*, *7*(3), 197-207.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & education*, *59*(2), 661-686.

D'Mello, S., & Graesser, A. (2012). Dynamics of affective states during complex learning. *Learning and Instruction*, *22*(2), 145-157.

Giannakos, M. N. (2013). Enjoy and learn with educational games: Examining factors affecting learning performance. *Computers & Education*, *68*, 429-439.

Granic, I., Lobel, A., & Engels, R. C. (2014). The benefits of playing video games. *American psychologist*, *69*(1), 66.

Hromek, R., & Roffey, S. (2009). Promoting Social and Emotional Learning With Games: "It's Fun and We Learn Things". *Simulation & Gaming*, *40*(5), 626-644.

Karumbaiah, S., Andres, J. M. A. L., Botelho, A. F., Baker, R. S., & Ocumpaugh, J. (2018). The Implications of a Subtle Difference in the Calculation of Affect Dynamics. In Yang, J. C. et al. (Eds.) (2018). Proceedings of the 26th International Conference on Computers in Education. Philippines: Asia-Pacific Society for Computers in Education.

Ocumpaugh, J., Baker, R.S., Rodrigo, M.M.T. (2015) Baker Rodrigo Ocumpaugh Monitoring Protocol (BROMP) 2.0 Technical and Training Manual. Technical Report. New York, NY: Teachers College, Columbia University. Manila, Philippines: Ateneo Laboratory for the Learning Sciences.

Pardos, Z. A., Baker, R. S., San Pedro, M. O., Gowda, S. M., & Gowda, S. M. (2013, April). Affective states and state tests: Investigating how affect throughout the school year predicts end of year learning outcomes. In *Proceedings of the Third International Conference on Learning Analytics and Knowledge* (pp. 117-124). ACM.

Robinson, R., Murray, J., & Isbister, K. (2018, April). You're Giving Me Mixed Signals!: A Comparative Analysis of Methods that Capture Players' Emotional Response to Games. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (p. LBW567). ACM.

Rodrigo, M. M. T., Ocupaugh, J., Diy, W.D., Moreno, M., De Santos, M., Cargo, N., Lacson, L., Santos, D., Aduna, D., Beraquit, J. I., Bringula, R., Caparros, M. R. M., Choi, A.T., Ladan, S., Lim, J., Manahan, D. M. A., Paterno, J. M. G., Saturinas, K., Tabanao, E., Tablatin, C., Torres, J., Porayska-Pomsta, K., Olatunji, I., & Luckin, R. (in press). Ibigkas!: The iterative development of a mobile collaborative game for building phonemic awareness and vocabulary. *Computer-Based Learning in Context*.

Smith, E. R., Seger, C. R., & Mackie, D. M. (2007). Can emotions be truly group level? Evidence regarding four conceptual criteria. *Journal of personality and social psychology*, *93*(3), 431.

Soller, A., & Lesgold, A. (2000). Knowledge acquisition for adaptive collaborative learning environments. In AAAI Fall Symposium: Learning How to Do Things (pp. 251-262).

Sung, H. Y., & Hwang, G. J. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. *Computers & education*, *63*, 43-51.

Wendel, V., Gutjahr, M., Göbel, S., & Steinmetz, R. (2013). Designing collaborative multiplayer serious games. *Education and Information Technologies*, *18*(2), 287-308.

Wong, P. T. (1979). Frustration, exploration, and learning. Canadian Psychological Review/Psychologie canadienne, 20(3), 133.

Zagal, J. P., Rick, J., & Hsi, I. (2006). Collaborative games: Lessons learned from board games. Simulation & Gaming, 37(1), 24-40.