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Analysis of Student Affect and Behavior while Playing a Mobile Game for English Comprehension

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Abstract: We discuss a field study in which 30 public school students from grades 4, 5, and 6 play *Learning Likha*, a mobile-based game for practicing English comprehension. Using self-report questionnaires, a comprehension test, BROMP observations, and game interaction logs, we assessed the extent to which students understood the game's contents and enjoyed playing the game. We also tried to determine any relationships between student achievement, affect, and behavior. Self-reported feedback about the game was positive, with students reporting interest, enjoyment, and sufficient challenge. Students across all grade levels exhibited engaged concentration and on-task activity while playing the game. However, post-test comprehension scores were low, especially for the younger participants. On-task conversation and confusion were negatively correlated with achievement. Additionally, on-task behavior and engaged concentration were positively correlated with number of interface taps.

Keywords: mobile-assisted language learning, English comprehension, Philippines, Learning Likha, BROMP

1. Introduction

In the Global South, the biggest impediments to the integration of technology in education include the lack of computer hardware in schools, the absence or unreliability of electricity, and the absence or unreliability of Internet connectivity (Nye, 2015). Teachers and students in resource-constrained countries are then hard-pressed to take advantage of online educational materials (Wolfenden, 2017), social networks and virtual communities of practice (Tondeur, et al., 2016), and other such resources.

In the face of these barriers and the threat of exclusion, teachers and students have turned to mobile technologies. The primary computing platform of developing countries is the mobile phone. As of 2018, the developing world had an estimated 102.8 mobile phones for every 100 people (ITU, 2018). 61 out of every 100 people had mobile broadband access, and while this is compared favorably against fixed broadband subscriptions (10.4 out of every 100 people; ITU, 2018), it still implied that data access is limited. Furthermore, there is a lack of educational software that targets these platforms and contexts (Nye, 2015). This refers to education content written in the local language and is adapted to reflect local norms, cultures, situations, motivations, beliefs, and environments.

Mobile-Assisted Language Learning is an area within mobile learning that focuses on language learning areas such as grammar and vocabulary acquisition (Sung et al., 2015). Language learning is said to be effective if the learner is exposed to the target language in meaningful contexts. In this paper, we describe a field study in which we deploy and test Learning Likha, a narrative-based mobile phone game that helps students practice their English language comprehension skills. Our goals are to measure (a) the extent to which students are able to understand the game's contents, (b) the extent to which the game engages the students, and (c) any relationships between students' achievement, behaviors, and affective states.

2. Methods

The deployment and testing was conducted at AHA! Learning Center (ALC), a tutorial center in Makati, Metro Manila, Philippines that caters to Makati City public school students from elementary to high school. Staffed in large part by volunteers, ALC is committed to providing supplementary holistic education to underprivileged children.

The staff selected students from Grades 4, 5, and 6 and they 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 of the limited number of cellular phones and earphones. Upon settling down in the venue, they were oriented on the objectives. Then, they completed a demographic questionnaire to determine their level of access to mobile phones. The questionnaire also tried to determine their usage, attitude, and perceptions towards the English language by giving them 8 statements to which they would indicate their level of agreement (1 = Strongly Disagree to 5 = Strongly Agree). A sample statement is "I speak English at home."

2.1 Learning Likha

After the questionnaire, each participant was lent a mobile phone with earphones. Each of them was asked to play Learning Likha for 20 minutes with the use of the earphones for full auditory attention.

Learning Likha is a narrative-centered English-language digital game intended for Filipino learners between 9 to 12 years old. Designed like an interactive storybook, it targets the literacy skill of noting explicit details through reading, listening and viewing. In the tradition of old-style adventure games, it follows the main character Likha, and her friend Taro the tarsier, as they help their bandmates prepare for town festivities by fetching various indigenous Filipino musical instruments from different shops in the town. As the game unfolds, learners are asked to interact with the game by selecting shops and instruments (Figure 1) based on the characters' instructions. A text box on the upper right corner of the screen contains instructions and important details that may help the player find the correct shop or object. The text box at the bottom contains the dialogue. Each time the learner finds the correct instrument, the learner has an opportunity to play the instrument by tapping on its image within the game. The game is available free of charge from both the Google Play Store and the Apple App Store.

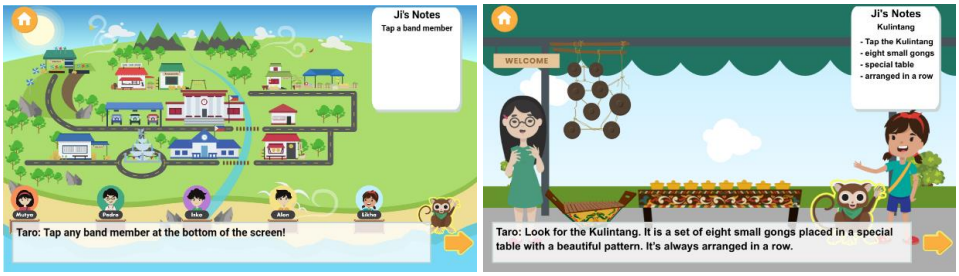

Figure 1. Map scene with the different shops and merchant scene with the instruments.

Learning Likha logs user interactions. It collects the participant's user ID, the scene or context with which the participant is interacting, the coordinates of screen taps, and the time stamp. Because the participant cannot advance without correctly accomplishing the task of each scene, the participant's last tap is always the correct move or answer.

2.2 BROMP Observations

Using the Baker Rodrigo Ocumpaugh Monitoring Protocol (BROMP), a trained observer recorded the participants' affective states and behaviors while playing Learning Likha using the Human Affect Recording Tool (HART) mobile application. BROMP is a protocol for quantitative field observations of participant behavior and affect (Ocumpaugh et al., 2015). Within BROMP, participants are repeatedly coded individually in a predetermined order. Both affect and behavior are recorded simultaneously, but separately. The affective states of interest observed were engaged concentration, confusion, frustration, and boredom. The descriptions (Ocumpaugh et al., 2015), are as follows:

- Engaged Concentration. This is manifested by focused attention to playing *Learning Likha*. It is shown through leaning closer to their phones and miming as they are reading through the dialogues. Those who were asking their peers what part of the game they were playing as if it were a competition on who finishes first were coded with this affective state.
- Confusion. This is manifested when a participant seems to have a difficulty understanding the game. Indicators include scratching the head, consulting with a peer or facilitator, and statements like "Why is this not working?" or "How do I get pass this?"
- Frustration. This state expresses feelings of distress or annoyance. Behaviors include heavy tapping on the phone screen, hair pulling, deep sighing, and statements such as "This is annoying!".
- Boredom. This is often expressed as complete disengagement from the game. It is characterized by fidgeting, slouching, yawning, and statements such as "This is boring!" or "Are we done yet?"

The behaviors observed were on-task, on-task conversation, and off-task. The descriptions (Ocumpaugh et al., 2015) are as follows:

- On-Task. This refers to participants focused on completing the game tasks of *Learning Likha*.
- On-Task Conversation. This refers to participants who play while engaging in a conversation with a facilitator or his/her fellow participant. The conversation must be related to *Learning Likha*.
- Off-Task. This refers participants who are doing tasks other than playing the game such as browsing through other applications in the phone or using a different application altogether.

For each test session, at least one observation of affect and behavior was coded for each participant per minute in 5 to 8 second intervals. For instances where the participant seemed to exhibit two or more distinct states during his/her respective observation period, the first state was coded. If a participant finished before the 20-minute allotted time, a "no further activity" state was recorded by coding '?' for affect and '$' for behavior in the HART application. This notation was agreed upon by the research team in anticipation of those who will finish early.

2.3 Post-Tests

After the participants completed the game, or when the 20-minute allotted play time had elapsed, a 21-item multiple choice post-test was administered to gauge how much they remembered and understood the details from the story. Below is a sample question:

1. What is Taro?
   a. a monkey b. a dog c. a cat d. a tarsier

The participants were asked to complete one final questionnaire composed of two sections, adapted from the Game-Based Learning (GBL) Engagement Metric (Chew, 2017) and the Intrinsic Motivation Inventory (IMI) (Ryan, 1982). The GBL questionnaire tried to determine how engaged students were with Learning Likha by posing 8 statements and asking participants for their levels of agreement (1 = Strongly Disagree to 5 = Strongly Agree). A sample statement is "I listened carefully to the instructions given to carry out the Learning Likha tasks." The IMI questionnaire posed 9 statements that asked participants to indicate if the statements were not at all true (1), somewhat true (4) or very true (7). A sample statement is "I enjoyed playing Learning Likha very much."

All procedures and materials used for this study were reviewed and cleared for implementation by the University Research Ethics Committee of Ateneo de Manila University.

3. Analysis

3.1 Participant Profile

A total of 32 students participated in the study: 12 from Grade 4, 12 from Grade 5, and 8 from Grade 6. Data from one student from Grade 5 and one student from Grade 6 were removed because they were incomplete. The remainder of the analysis will use data from the 30 remaining students only. Of the 30 participants, 19 were male, 11 were female (Table 1). Some students owned cell phones. The majority, especially those from Grades 5 and 6, played cell phone games, some of which were educational.

Table 1.
Demographics of the study participants.

	Grade 4		Grade 5		Grade 6	
Sex	M	F	M	F	M	F
N	8	4	7	4	4	3
Age Range	8 - 9		9 - 10		10 - 11	
Had their own cell phones	4 (33%)		10 (91%)		4 (57%)	
Played games on cell phones	5 (42%)		11(100%)		6 (86%)	
Played educational games on cell phones	3 (25%)		7 (64%)		3 (43%)	

When asked about their usage, attitudes and perceptions towards the English language, students said they did not speak English at home (2.7/5.0) or with their friends (2.5/5.0). They did like learning English (4/5) and reading in English (3.7/5.0). They expressed a desire to learn English (3.9/5.0), and agreed that it is important (4/5). In summary, the participants did not typically use English as a medium of communication, but enjoyed learning and were interested in improving their English language skills.

3.2 Incidence of Student Behavior and Affective States

The number of observations per grade level varied: We collected 15 observations per student for Grade 4, 14 for Grade 5, and 21 for Grade 6. To obtain the incidence of student behaviors and affective states, we divided the number of times a student was observed to exhibit a state by the total observations for that student. To obtain the overall incidence of a behavior or affective state, we took the average of the incidences of each state across all students.

Table 2 shows that students were predominantly on-task, working independently (66%) or in conversation with another student (11%). Off-task behavior was relatively rare (1%), though many students finished before the allotted time expired. Table 2 also shows that engaged concentration (65%) was the most often exhibited affective state, followed by confusion (10%). The students did not exhibit boredom often (2%). These findings are consistent with some prior studies that used BROMP observations. As summarized in Baker et al. (2010), the incidence of engaged concentration averaged 60%, confusion averaged 13%, and boredom averaged 5%.

Table 2.
Overall incidence of behaviors and affective states. Standard deviations are in parenthesis.

	Behaviors				Affective States			
	On-Task	On-Task Conver-sation	Off-Task	No Activity	Bored	Confused	Engaged Concen-tration	No Activity
Incidence	66% (16%)	11% (14%)	1% (2%)	22% (17%)	2% (4%)	10% (14%)	65% (18%)	22% (17%)

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.

Because the number of observations per grade level varied, we split the population by grade level and perform the computation on each subset of the observations. We found that engaged concentration and on task behavior tended to persist across all grade levels (Table 3). These findings imply that students attended to the application. When they were focused on it and actively using it, they tended to continue to remain so.

Table 3.
D'Mello's L means. Standard deviations are in parentheses.

Transition	Grade 4	Grade 5	Grade 6
Engaged Concentration to Engaged Concentration	0.28 (0.36), p = .03	0.41 (0.28), p < .01	0.60 (0.12), p < .01
On Task to On Task	0.25 (.30), p = .03	0.41 (0.10), p < .01	0.61 (0.13), p < .01

3.3 Game Engagement

Students self-reported positive feelings and attitudes towards the game. In the GBL questionnaire, they responded that they listened carefully to instructions (4.5/5.0) and tried their best to find solutions (4.2/5.0). They could relate what they were learning to prior knowledge (4.3/5.0) and could see links of the concepts shown to real-world skills (4.1/5.0). They said the game interested them (4.1/5.0), that they looked forward to completing the game (4.4/5.0), and that they were sufficiently challenged (4.1/5.0).

The IMI results were similar. They said that they enjoyed playing the game (6.4/7.0) and that the game was fun (6.4/7.0) and interesting (5.0/7.0). They confessed to being uncertain about how skilled they were in the game (4.8/7.0). Some thought that the game was boring (3.7/7.0).

3.4 Analysis of Affect, Usage, and Comprehension Scores

Despite the high level of engagement and on-task behavior, and despite the positive feedback about the game, comprehension scores were low. Grade 4 students' post-test scores averaged 48%, grade 5 students averaged 65%, while grade 6 students averaged 66%. A single-factor ANOVA showed that differences between groups were significant ($F(2,27)=3.91$, $p=.03$). A pairwise comparison showed that grade 4 students' post-test scores were marginally significantly different from those of grades 5 ($p=.06$) and 6 ($p=.07$). This implies that the older students understood more than the younger students did. This is something to be expected. Also, there was a very strong significant correlation between on-task conversation and confusion ($r=.91$, $p<.01$). This may be a consequence of the way that confusion was operationalized, i.e. asking for help or advice from a peer or facilitator. However, it is interesting to note that on-task conversation and confusion both had a moderately strong and significant negative correlation with score ($r=-.42$, p.02 and $r=-.40$, $p=.03$ respectively). This implies that conversation in this context may indeed be indicative of cognitive challenges. In terms of in-game behavior, the total number of taps had a weak, significant positive correlation with on-task behavior ($r=.37$, $p=.046$) and a moderately strong, significant correlation with engaged concentration ($r=.41$, $p=.02$).

4. Conclusions, Limitation, and Further Work

In this paper, we discuss the deployment and testing of Learning Likha, a narrative-based mobile phone game to help with practicing English comprehension. The participants found the it interesting and enjoyable. They professed to exert effort in understanding the contents and completing the game tasks. Observations concur that participants were on-task and engaged. These may be attributed to the contextualized and story-based nature of the game, as well as opportunities to simulate playing the musical instruments. Following the narrative and contributing to the progression of the story by completing game tasks may have enabled such favorable experiences.

Despite these positive self-reports and observations, the test scores were low especially for the younger participants. It is possible that these low scores were an artifact of the their backgrounds. They were not native English speakers. They were interested in learning English, but lacked practice as they did not use English at home or with their friends. One limitation of the study is that the research team did not have a baseline assessment of the participants' pre-existing English language skills. Future work should include an equivalent comprehension pre-test to enable measurement of learning gains.

Nonetheless, this work contributes an exploration of a narrative-driven mobile game specifically designed for Filipino learners. As previously mentioned, there is a dearth in the availability of mobile applications with contextualized education content (Nye, 2015). Learning Likha is an effort to address this barrier by providing young Filipino learners the opportunity to practice English comprehension in a platform accessible to them through a story-based game familiar to their context.

In the broader context, the correlations that we found between in-game behavior and affective states may assist with the development of automatic detectors of feelings and emotions within specific cultural contexts. Because culture influences the way affective states manifest, datasets from diverse populations can increase generalizability of detectors. These detectors contribute to personalization. They can prompt in-game interventions when student behavior indicates negative affective states, or can cue a teacher to approach a student who might be having difficulty.

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