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Towards the Development of a Computer-based Game for Phonemic Awareness

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Abstract: In this paper, we discuss some of the results of a participatory design workshop used to elicit design guidelines for an education game for phonemic awareness intended for use by disadvantaged students. Using a grounded theory approach, we analyze facilitators' observations from the workshop and related findings to well-established game design guidelines. We were able to align facilitators' observations with these guidelines in order to prescribe ways to support student participation, mitigate student disengagement, support various team roles and dynamics, and accommodate a variety of game play strategies.

Keywords: Game design guidelines, participatory design phonemic awareness, Philippines, rhymes

1. Introduction

A digital educational game is supposed to provide users with instructional content in an interactive, playful learning environment (Law, Kickmeier-Rust, Albert, & Holzinger, 2008). However, designing an educational game that balances fun and learning can be a challenge. It is possible to design an engaging and motivational game without addressing curriculum (Gros, 2007). It is also possible to design educational experiences that follow course content but are not engaging or fun (Royle, 2008).

In this paper, we explore the results of a participatory design activity intended to arrive at design guidelines for a computer-based English language learning system tentatively named JOLLY. PD is defined as

> A process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective "reflection-in-action." The participants typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users' situation while the users strive to articulate their desired aims and learning appropriate technological means to obtain them (Simonsen & Robertson, 2012).

This paper limits its scope to findings related to phonemic awareness and attempts to answer the following research questions:

1. What are the game play experiences of the participants in a paper-based game (PBG)?
2. What themes can be derived from the game play experiences in the PBG?
3. What game design guidelines can be drawn from the themes?

We refer to Gee (2014) and Lim, Comings, Lee, Yuen, Hilmy, Chua, and Song (2018) for educational game design guidelines against which to cross reference our findings. Gee (2014)

discusses 36 principles for designing instruction, drawn from design principles for video games. The work limits its scope to narrative-based games in which "a fantasy character [moves] through an elaborate world, solving various problems". Other than the game genre, Gee does not limit his prescriptions to a specific audience or domain, hence his prescriptions, are broad and applicable to learners and subject areas of all kinds.

In contrast, the work of Lim et al. (2018), is an aggregation of educational game design guidelines that refer specifically to literacy as taught to children in developing countries. While Lim et al (2018) discuss content-related guidelines, e.g. setting appropriate levels of difficulty, they also discusses process-related guidelines such as visiting target communities and creating rough prototypes as early as possible in order to test these with the stakeholders.

2. Methods

Students in this study were enrolled in two state elementary schools (Schools A and B) in Quezon City in the Philippines. These schools had comparable student populations (7,419 students in School A, 6,377 in School B), with most students coming from a low socio-economic bracket, with parents employed in blue-collar jobs.

We asked the schools to invite 36 students per school—12 each from Grades 4, 5, and 6—to participate in our Saturday Participatory Design Sessions. We requested the school to select four students from a high achievement, mid-achievement, and low-achievement sections. The students who were selected may or may not have been among the survey respondents.

A total of 73 students participated in the participatory design sessions. However, some students were not able to attend both sessions. Students with incomplete data were excluded from the analysis, leaving only 57 students in all. Of the 57, 27 were from School A and 30 were from School B.

Each school was scheduled for two Saturday morning sessions during which the PD activities took place. Students were grouped in teams of six, two per grade level. Each group had a facilitator. Team assignments were permanent. The first session consisted of a pre-test (to be described in 2.3) and the first learning activity while the second session consisted of three additional learning activities (to be described in 2.4) and a post-test. The pre- and post-tests were accomplished individually but the activities were accomplished by group.

The pre- and post-tests used an identical format but asked students to identify rhymes in different songs. They were then asked to listen to each song and to write down groups of perfect and imperfect rhymes (e.g. *guess* and *mess* vs. *like* and *life*). The pretest asked them to identify rhymes in Katy Perry's *Roar*, Jessie J's *Flashlight* and *Price Tag*. Students were provided with copies of the song lyrics. The post-test, repeated this procedure with 3 different songs: Bruno Mars's *Uptown Funk*, Lukas Graham's *Seven Years*, and Lin-Manuel Miranda's *Hamilton*.

Facilitators supported 4 different group learning activities that tested the engagement of tasks designed to help students better learn to identify English rhymes, each of which built on the rules in the preceding activity.

In Activity 1, students were given cards with letters (see Figure 1) and were asked to form pairs of perfect or imperfect rhyming words with the cards. In Activity 2, the same cards were used. Students were once again asked to form rhymes, but once a rhyming pair was formed, they then had to change one letter in one word so that the pair would no longer rhyme.

Activity 3 built on the modification rules of Activity 2, asking students to choose a song from the pre-test and to substitute rhymes for the original lyrics (i.e. "Rice Bag" could substitute for the title of the song "Price Tag"). The students then performed the song. Finally, in Activity 4, students were asked to create their own rules for forming rhymes, (e.g., nouns only, verbs only, must have a minimum of 4 letters, and so on).

Seven of facilitators (one per team and one overall coordinator) kept students on task and provided occasional support during the learning activities. At the end of each activity, the facilitators queried their groups: Did you have any difficulties? How did you overcome them? What is your understanding of a perfect/imperfect rhymes? What made the game fun/not fun? The facilitators noted the students' answers and any other observations and submitted them to the authors for analysis.

Figure 1. Rhyming Activity Materials.

3. Grounded Theory Approach

To determine the emerging themes among the facilitators' reports, we used the grounded theory approach. Grounded theory refers to "a set of inductive strategies for analyzing data." (Charmaz & Belgrave, 2007) Researchers begin by examining individual cases or experiences and then develop more and more abstract conceptual categories in order to synthesize, explain, or understand the data and its patterns.

The grounded theory approach has four general steps: open coding, axial coding, selective coding, and the constant comparative method (Corbin & Strauss, 1990). A code represents a reality or phenomenon reflected through words, phrases, events, or actions (Price, 2010). Open coding is the process of putting labels or names to the interview responses of the participants and the observation notes of the facilitators. The labels themselves are called *open codes*.

Axial coding is a process of clustering the related codes forming a larger concept of category. A central phenomenon (the axis) is a label that it unifies open codes that have causal relationships, similar outcomes, or related concepts (Wicks, 2010). The unifying labels that emerge from this step are called *axial codes*.

Upon completing the open and axial coding phases, the first author presented the coded texts to the facilitators, who either validated the codes or suggested revisions.

During the selective coding phase, the axial codes are again grouped together and labelled, based on concepts from existing, relevant literature (Price, 2010). The categories formed in this coding stage are the *themes* of the study. We selected the themes from educational game design guidelines discussed in (Lim, Comings, Lee, Yuen, Hilmy, Chua, & Song, 2018). A theme was retained if it was consistent with an axial code. If it was not, then an alternative theme was proposed.

In the last stage, the constant comparison method, previously uncategorized texts from the second game session were fitted against the generated themes. If no good fit was found, the whole process starting from open coding was repeated. For this paper, the second and third authors reviewed the codes again and derived the final coding system.

4. Validated Open and Axial Codes

We found 6 validated axial codes denoting phenomena that occurred during the PD sessions. The axial codes, the open codes that fall within them, and samples of facilitator observations that were classified within each open code are as follows:

1. Internal Factors that Increased Participation – These refer to cognitive or affective states that the students exhibited that boosted to their involvement in the game.
    a. Engagement – Students were excited about the game. They thought hard and focused in order to find rhyming words, especially during the third activity. They persevered

throughout the tasks that they found challenging. Some said that the game would be fun even if there were no prizes involved.

b. Competence – Students knew what a rhyme was and what distinguished a perfect from an imperfect rhyme. They were proud of their work and were confident of their answers.

2. Internal Factors that Decreased Participation – These refer to cognitive or affective states that discouraged student involvement from the activities.
   a. Boredom – Some students were disengaged. They did not seem interested in the activity
   b. Confusion about rules of the game – Some students exhibited confusion about what it was they were supposed to do.
   c. Limited competence or cognitive-based difficulties – Despite the research team's verbal introduction about what rhymes were, some students did not have a clear understanding of rhymes and how to identify them. This sometimes resulted into a reluctance to participate.
3. External Factors that Increased Participation – There were some circumstances outside of the student that fostered greater involvement
   a. Easy aspects of the game – Some students found the game easy because they were able to word templates that would enable them to generate many rhymes in a short period of time.
   b. Challenge – The students found the game and its rules challenging, but this was considered to be positive rather than discouraging.
   c. Funny rules –Activity 3 required students to alter the lyrics of one of the songs. In doing so, the resulting song did not make sense. Students found this game mechanic funny. Since they were also required to sing the song in front of the group, they laughed as they practiced.
   d. Cooperative learning – Working in a group was a large part of what made the game fun. They were able to help each other and they were able to make new friends.
   e. Game-based learning – The game format was both novel and engaging. It allowed them to learn in a way that was enjoyable.
   f. Scaffolding – The facilitators occasionally provided clues, hints, or encouragement in order to move the team along or else to bring in a team member that was otherwise staying at the peripheries.
   g. Prizes – The availability of prizes pushed students to earn more points.
4. External Factors that Decreased Participation – This refers to factors outside of the student that impeded participation in the game.
   a. Difficulties with the manipulatives – The number and variety of cards available to the students made it difficult to find specific cards needed to form a word.
5. Team Dynamics – Students took on different roles in the group. The roles led to different patterns of interaction that changed over time.
   a. Leaders – Some students—either the older students or the students who were already friends—tended to take the lead in the forming of words.
   b. Supporters – Other students took on the supporting roles of finding the letters that the leaders needed.
   c. Lurkers - A few students chose to remain along the sidelines. They neither led nor supported.
   d. Changes over time – The team dynamics evolved. If students were strangers in the beginning, they established a rapport and learned to work together as the hours passed. If the group began slowly, they tended to work more quickly later on.
6. Game Play Strategies – Students adopted a variety of strategies in order to form words and earn points.
   a. Low-Hanging Fruit – Students found easy ways to form pairs of rhymes. They sometimes chose to form only perfect rhymes because the concept of an imperfect rhyme was harder to grasp. They formed words with only three to four letters and formed plural forms of words.
   b. Breaking rules/Guessing/Inventing words – Students also tried to bypass rules by creating nonsense words.
   c. Delegation – There were instances in which teams divided-and-conquered. They assigned specific tasks to specific members.
   d. Choice of manipulatives – There were some cards that had combinations of letters, e.g. "EER" or "OAR". Students found these difficult to use and tended to avoid them.

5. Game Design Guidelines

As mentioned in the Introduction, the publications of Gee (2014) and Lim et al. (2018) were intended to serve as guides to educational game designers and educators in the construction of learning games. Gee's (2014) book provides general guidelines intended mostly for learning games that follow fantasy adventure formats, while Lim et al (2018) gives checklists for design of early literacy games for children in developing countries.

While it is not possible to manipulate students' cognitive or affective states directly, a good game is an environment that can promote states that support learning. JOLLY should provide a game environment that requires active participation (Gee, 2014; Lim, et al., 2018) and an investment of effort to practice their literary skills (Gee, 2014; Lim, et al., 2018). The symbols, instruments, and artefacts of the game must have some meaning that is connected to the game's learning objectives (Gee, 2014). Similarly, the game's activities, rules, and mechanics should be connected to the learning goals (Lim, et al., 2018).

Because students have varying levels of competence, JOLLY should try to match difficulty levels with the students' individual cognitive levels (Gee, 2014; Lim, 2018). This may mean dividing the domain into smaller subsets (Gee, 2014) and then adding to the scope in increments (Lim, et al., 2018).

JOLLY needs to be able to intervene when students are disengaged by addressing the cause of the disengagement. Facilitators provided hints and clues as well as words of encouragement in order to draw in students who tended to stay along the peripherals. JOLLY may have to adapt these strategies by provide just-in-time or on-demand knowledge (Gee, 2014) or scaffolding.

The students found Activity 3 particularly entertaining as it required them to create a version of the song that was nonsensical and then sing the new lyrics before the rest of the group. The success of this activity points to several of Lim et al.'s (2018) game design guidelines—engaging students in an activity that requires them to build something and share the creation with an out-of-game audience.

Finally, a major factor that increased participation was the cooperative nature of the activity. Some students liked working in teams because it enabled them to score more points and to make friends. JOLLY should therefore look into collaborative or cooperative learning as a game format (Lim, et al., 2018). For the benefit of those who were shy or scared, the game should also have a single-player mode.

The cards used in the PBG introduced additional difficulty to the game that led students to prefer single letter cards or blank cards on which they could write the letters they needed. The use of cards or their equivalent in the design of JOLLY therefore requires some critical examination and rationalization. Because it is preferable for the artefacts within the game to be related to the game's content (Gee, 2014; Lim, et al., 2018), we, JOLLY's designers, should therefore ask ourselves whether this format of using cards caries content related to the game's learning goals. If the cards introduce difficulty for difficulty's sake, then the format should be replaced with closer to the content and goals of the game. If, on the other hand, the format itself has an instructional message, that message needs to be articulated clearly so that both learners and teachers can process it.

Gee's (2014) identity principle refers to games' ability to allow students to create and play with different identities, and reflect on them and the ways in which they interact with each other and with the virtual world. When combined with the need to support cooperative learning, found both in Gee (2014) and Lim et al. (2018), JOLLY may consider creating varying roles per group member. The existence of leaders and supporters implies that JOLLY might assign different group members different tasks, each one of which contributes to the team's overall success.

JOLLY needs to provide students with several paths to success. There should be easy ways to form rhyming word pairs—by using homonyms, plural forms, and so on. At the same time, the game needs to guard against guessing and the formation of nonsense words. These observations are aligned with several of our sources' principles already mentioned previously, e.g. matching skill levels of students with levels of difficulty, providing varying levels of assistance, and so on. An underlying principle from Gee (2014) is that games should provide a safe environment for learners to take risks—the psychosocial moratorium principle. Within games, real-world consequences should be mitigated.

6. Conclusion and Future work

The purpose of this paper was to arrive at game design guidelines for JOLLY, a game for teaching phonemic awareness to children from disadvantaged backgrounds. To this end, we analyzed facilitators' observations using the grounded theory approach in order to identify the various game play experiences of the participants. We labeled these experiences using open codes. We then grouped related open codes that were related to arrive at larger categories labeled with axial codes. Game design guidelines for early literacy were then examined in the context of the findings, to arrive at the guidelines that seem most salient to the overall project objective. Finally, by supplementing the grounded theory approach with educational game design principles we have been able to arrive at some design prescriptions for JOLLY.

Ongoing work delves deeper into several related and supporting topics. These include but are not limited to the use of popular songs as motivation to develop phonemic awareness; the use of popular songs as inventories of phonemes against which we can check student mastery; and the intelligent prescription of songs with varying sets of phonemes in order to cultivate unmastered skills; the specific needs of students with varying skill levels; and developing world contextual information such as curriculum, availability of Internet connectivity, school resources, teacher readiness, and other factors will have an impact on if and how the game is used.

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References

Charmaz, K., & Belgrave, L. L. (2007). Grounded theory. *The Blackwell Encyclopedia of Sociology*.

Corbin, J. M., & Strauss, A. L. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3-21. doi: 10.1007/BF00988593

Gee, J. P. (2014). *What video games have to teach us about learning and literacy*. Macmillan.

Gros, B. (2007). Digital games in education: The design of games-based learning environments. *Journal of research on technology in education*, *40*(1), 23-38.

Law, E. L. C., Kickmeier-Rust, M. D., Albert, D., & Holzinger, A. (2008). Challenges in the development and evaluation of immersive digital educational games. In *Symposium of the Austrian HCI and Usability Engineering Group* (pp. 19-30). Springer, Berlin, Heidelberg.

Lim, K. Y. T., Comings, J., Lee, R., Yuen, M. D., Hilmy, A., Chua, D., & Song, B. H. (2018). *Guide to developing digital games for early grade literacy for developing countries*. Quezon City, Philippines: Foundation for Information Technology Education and Development and World Vision.

Price, J. M. C. (2010). Coding: Open Coding. In A. J. Mills, G. Durepos, & E. Wiebe (Eds.), *Encyclopedia of Case Study Research* (Vol. 1, pp. 155-157). Thousand Oaks, CA: SAGE Reference. Retrieved from http://link.galegroup.com/apps/doc/CX1562500066/GVRL?u=phadmu&sid=GVRL&xid=5eb6d559

Royle, K. (2008). Game-based learning: A different perspective. *Innovate*, *4*(4), Article 4.

Simonsen, J., & Robertson, T. (2012). Participatory Design: an introduction. In *Routledge international handbook of participatory design* (pp. 21-38). Routledge.

Wicks, D. (2010). Coding: Axial Coding. In A. J. Mills, G. Durepos, & E. Wiebe (Eds.), *Encyclopedia of Case Study Research* (Vol. 1, pp. 153-155). Thousand Oaks, CA: SAGE Reference. Retrieved from http://link.galegroup.com/apps/doc/CX1562500065/GVRL?u=phadmu&sid=GVRL&xid=566027d8