

Student Attitudes towards Using Culturally-Oriented Educational Games to Improve Programming Proficiency: An Exploratory Study

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Abstract. This exploratory study investigates student attitudes towards culturally-oriented educational games for practicing computer programming, where the mainstream culture appeals to all of the students irrespective of their cultural background. We show that a shared appreciation of culture along the lines of humour promotes positive student attitude towards culturally-aware game based learning which in turn is useful for developing proficiency in specific programming skills such as error detection and correction. Details of the exploratory study undertaken using culturally-oriented educational game prototypes are described, along with the results of the study.

1 Introduction

Recruitment and retention are among the top reasons for using games in introductory Computer Science courses. With high drop-out and failure rates among first year programming students in many universities, a lot of attention has been given to finding better ways of improving student performance with particular emphasis on the use of educational/serious games. According to Bayliss and Bierre [2], games have been used to strengthen students' computing skills through practice and for gaining skills in software engineering with 'the common result of...more motivated students'.

Design principles for effective digital game based learning have been described in the literature from various perspectives and these principles have been used to guide the development of many educational games. Well defined learning goals, immersive storylines, achievable challenges, informative feedback, principled pedagogy, proper player profiling, and sound game mechanics are some of the frequent design recommendations advocated by researchers which align with mainstream ideas in instructional design and game design. The impact of each of these design considerations on the quality and the extent of learning resulting from these games has been the focus of many experiments and research projects; however one important dimension has not received as much scrutiny: the player's/learner's cultural background.

Culture is rapidly becoming an important consideration in the design of educational software firstly because of the increase in the number of users accessing soft-

ware over the Internet, and secondly because of the sheer diversity in the cultural backgrounds of these users. Furthermore, culture significantly affects the way students learn, it defines their attitudes, strategies and general learning styles, and above all it gives insight into the source(s) of their motivational triggers ([5], [7], [16]). Despite these connections to the learning process, culturally aware learning environments are limited in practice largely because of the complexities in representing culture computationally since current instructional designs lack cultural sensitivity ([12],[18]). Consequently, few educational games (with the exception of games for language learning [9] and development of intercultural skills [10]) take advantage of the utility of culture when leveraging and prolonging motivated student behaviour.

Computer Science has been traditionally considered to be culturally-neutral field [17] and as such, the large majority of the games developed for teaching/learning programming has been culturally-neutral as well. New studies in the upcoming field of Ethnocomputing, such as the work by Duveskog et al. [4], show that a culturally relevant context increases student motivation and triggers the creativity and self-directed learning of the students in a Java programming class in a Tanzanian secondary school. Eglash et al. [6] report similar increases in self-initiated learning when culturally-situated learning environments are used to teach students in African-American, Native-American, and Latino contexts. So far most of these studies leverage the benefits of computer-based instruction but very little (if any) work has been done using culturally-oriented educational games. Furthermore, most of these studies have focused on underprivileged or minority groups in societies where the mainstream culture clashes with the traditions and practices of these groups.

In light of this, we intend to investigate student attitudes towards culturally-oriented educational games for practicing computer science programming, where the mainstream culture appeals to all of the students irrespective of their cultural background. We believe that a shared appreciation of culture is useful for promoting positive student attitude towards culturally-aware game based learning which in turn is useful for developing proficiency in specific programming skills such as error detection and correction. The study focuses on the first year programming students at the University of the West Indies (U.W.I.), St. Augustine campus, and examines the issues involved in designing and developing cultural game prototypes which were used to evaluate these ideas. Details of the exploratory study undertaken, using these prototypes, are described along with the results of the study. The significance of these results in relation to our ideas regarding culture and learning is analysed, and the next set of steps to be taken to advance these ideas and the prototypes are discussed.

2 Cultural Context

The University of the West Indies is a multiple-campus institution spread across three Caribbean islands: Jamaica, Barbados, and Trinidad and Tobago. The majority of undergraduate students enrolled in the Computer Science degree program at the St. Augustine campus in Trinidad and Tobago are therefore native to the English-speaking Caribbean region with a predominant percentage originating from Trinidad

itself. Many of these students are technological savvy indicated by their widespread usage of mobile phones, and constant preoccupation with online social networking tools and games. Their digital native status works to their disadvantage however since the first year programming courses employ traditional instructional methods such as lectures, written coursework and final exams. Consequently, these courses have very low pass rates of less than 60%. In addition, few of these undergraduate students have prior programming experience, and many exhibit underdeveloped problem solving skills along with a halfhearted attitude towards practice. The cultural background of the students gives some explanation for this since rote teaching methods are commonly used in secondary/high school which discourages independent thought and creates an overindulgent reliance on oversimplified instruction. Furthermore, Trinidadian and Tobagonian (referred hereafter as Trinbagonian) culture encourages an easy-going attitude towards work which can be detrimental to the learning process, and often results in frustration for many of our first year students who expect the same or better academic results as in high school.

In spite of these challenges, there are useful aspects of Trinbagonian culture which, when harnessed properly, enhance and promote learning. The local vernacular is of particular interest since influences from the languages and cultures of East Indian, Chinese, African, Spanish, French, Amerindian, and British populations (as a result of colonization and indentureship) have been integrated to form a unique language, formally referred to as Trinidad English Creole (TEC), which sounds comical and is often satirical in a humorous way. The phonology of TEC adds even more dimension to the language since the pronunciation of a word can change its meaning. When TEC is used to describe the customs and everyday events characteristic to Trinidad, the local culture can be represented as a narrative that has comedic appeal especially when represented as an educational game.

Humour plays an important role in learning environments because it promotes a lighthearted and memorable learning experience, enhances a student's mood through affective learning and also commands the student's attention and encourages retention of material as a result of comical moments [3]. Humour also promotes greater student interaction and social discussion of amusing anecdotes used in the learning process. Dormann and Biddle [3] go on to add that humour can be used to diffuse frustration and hostility because it decreases the pressure (on the student) to learn and perform. This is valuable especially for the Computer Science discipline where academic competition is stressful and where the material being learnt is difficult or abstract. Cultural humour, featured in an educational game, therefore opens up many possibilities for stimulating motivation, and increasing interest.

3 Game Design

Three designs were created for testing student attitude towards culturally-oriented learning games. Familiar aspects of Trinbago culture, such as real-life events, were selected for the designs based on how easily they could be implemented in a game with an acceptable level of authenticity. Believable and convincing mimicry of cul-

tural events is important because it stimulates player engagement by appealing to the player's curiosity [11]. Queiroz [14] states that by using gameplay rather than graphics, the cultural elements in a game become more authentic. Consequently, references to comical cultural behaviour were chosen for developing the humour of the games, and this mainly took the form of phrases and terminology expressed in TEC language.

The learning objectives featured in the game designs were restricted to developing specific programming skills such as attention to and recall of proper syntactic details through continuous practice. This decision was based on research suggesting that games are helpful for developing accuracy and fluency in analytical skills [1], and also because of the weak error detection and error correction skills possessed by the target student audience. Therefore, the learning activities were structured as snippets of code riddled with syntactic errors which students had to repair. Now since most educational game designs stand the risk of becoming boring drill exercises, Habgood et al. [8] suggest that the most enjoyable parts of the games should be used as the learning activities. This advice was followed in our designs, and the learning activities were delivered in such a way that the outcome of the activities had a direct effect on the events in the games. All three game designs had different cultural elements, different storylines, and different game objectives. The learning objectives however were maintained across the designs, as were the overall structure and form of the learning activities. A brief description of the ideas behind the three designs is given below.

3.1 Game Design Ideas

Food, language, and local events are the main cultural elements in these designs which are based on a larger design described in [13].

KFC Delivery Driver. In this game, the player has to deliver Kentucky Fried Chicken (KFC®) food products to a customer by programmatically controlling the features/functionality of his/her vehicle. In Trinidad and Tobago, KFC® is a popular fast food choice, and a common discussion point is the tardiness/absence of local delivery drivers. In this game, the player is guided to the customer's location by a series of navigational instructions, and along the way the player must try to avoid road obstacles or risk damage to his vehicle's functionality. When programming exercises related to a specific car operation are completed correctly, the respective functionality of the car is activated otherwise it is deactivated or partially restored. Common road obstacles in Trinidad include animals crossing the road randomly (cows, goats, dogs), large potholes (often filled with strange debris to alert drivers of the impending danger), and abrupt stops made by local taxi drivers.

Lazy Earl. In this game, the player takes on the role of Earl, a young boy who has to search for and collect items on a shopping list given to him by his mother. Local items with laughable uses and amusing names are featured on the list. Earl is a forgetful, lazy child so his mother hires a taxi to drive Earl around, help with the collection of the shopping, and then bring him home safely. Earl being far lazier than his mother

believes equips himself with a faulty audio device which speaks on his behalf when certain buttons are pressed. (This is a reference to the improvisational, behaviour of Trinbagonians where short cuts are often taken to reduce the amount of work to be done.) Not having a clue as to where to find the items, Earl goes to the market, the grocery and the hardware store where he has to interact with the shopkeepers in order to get the items. In the game, Earl poses questions to the shopkeepers using his audio device if he wants an item or if he wants to know where to find the item, or the price of an item. TEC language is featured strongly in this game, and players must fix the device when it speaks incorrectly by fixing the errors in the code controlling the functionality of the specific buttons; the respective functionality of the device is restored otherwise it remains faulty and produces garbled phrases.

Home Food. In this game, players have to collect food items by programmatically controlling the features/functionality of their game character (hero) in a side-scroller game. Players must fight thieves and collect items which are presented at the end of the game to the chef. With these items, the chef prepares a home cooked meal for the player. In order to control the behaviour of their character, errors in the code controlling a specific hero operation must be repaired correctly so that the respective functionality of the hero is activated otherwise it is deactivated. Local food and raw ingredients are the main cultural elements in this game; the various combinations of the ingredients collected by the player result in unexpected dishes which are amusing but authentic. In addition, the behaviour of the chef reflects the cultural attitude of Trinbagonian in rewarding and admonishing the player with bantering comments.

4 Development of Game Prototypes

4.1 Game Programming Course

From September to November 2008, the game programming course, COMP3900, was run at U.W.I. with 16 final year undergraduate students. The batch of students enrolled in the course were proficient Java programmers and so they were required to build games for the course and many succeeded in creating two complete non-educational games for their first and second assignments within a short period of time. Their third assignment focused on building an educational game based on the game designs described in the previous sections. Using Java, the students were given three weeks to build a fully functional game based on any of the three designs described earlier. In addition, the students were given the choice of modifying the designs so long as the presence of cultural elements and the design of the learning activities were maintained. Only two students were able to deliver complete, working games suitable for testing. These prototypes are described in the next subsection.

4.2 Prototypes

Caribbean Conquest. This single-player, turn-based game features two islands of the Caribbean, where the player (representing Trinidad and Tobago) has to conquer unsettled islands before the enemy (Barbados) by sending people to settle the island within a specific time as shown in Figure 1 below. For this game, the student developer chose his own game design which incorporated the desired learning activity design. However, the use of culture was too subtle and failed to establish the humour required as in the original designs. Nonetheless, the graphics and use of sound produced a high quality gaming experience. Players have to solve the programming problems during the game and if they succeed their islands' defenses are strengthened otherwise the enemy gets a boost in defense. The problems followed the design criteria by testing the player's skill in error detection and correction of C code where the player has to select the line of code with an error and then type in the correction. Figure 1 also shows a sample of the exercises presented to the player.



Fig. 1. Caribbean Conquest screenshots: Example of a learning activity (left) and Uncaptured islands being settled by Barbados (right).

Lazy Jim. As shown in Figure 2 below this game closely follows the design laid out in Section 3.1 with some modifications introduced by the student. Here, the student opted to have the main protagonist (Jim) speak clearly at times and distortedly at times. The TEC language phrases are used in the game to give feedback to the player concerning the location of the shopping items. The grocery scene in Figure 2 illustrates the use of a common Trinbagonian expression, “Ehh?” by the shopkeeper after Jim asks a garbled question which in this context means “What did you say?” The shopkeeper in the hardware scene also uses TEC when he says “I doh have that here nah” which means “I don’t sell any of that here”. The word ‘nah’, also a common expression, is used for emphasis in this context. The student combined some of the design features of the games described in Section 3.1 in this game since some of the shopping items in *Lazy Jim* are clearly referred to using local terms. Examples include a jooking board (a wooden washing board used for scrubbing clothes), conchs (shellfish), Crix (a local biscuit/cracker), Powermint (a local brand of mint candy) and so on. Pictures of some of these items were even included in the game as shown

in Figure 2. The learning exercises in *Lazy Jim* are similar to those of *Caribbean Conquest* where the player has to identify the line of code with an error and then suggest the correct substitution. Incorrect answers did not have any disadvantageous effects on Jim's abilities in the game other than not getting any additional information from the shopkeeper in question. As such this game was more slowly paced than *Caribbean Conquest*.



Fig. 2. Screenshots of the grocery (left) and hardware (right) scenes in the culturally-oriented educational game, *Lazy Jim*. In these scenes, Jim and the shopkeepers interact using the local dialect of Trinidad and Tobago.

5 Exploratory Study and Evaluation

An exploratory evaluation of the two game prototypes was conducted with the first year programming students in order to evaluate their attitudes towards the use of culture for practicing programming. The study was broken up into two parts: participation in a game day, and completion of a questionnaire. Twenty-four students, 21 males and 7 females, aged between 18 to 22 years were involved in the study. Of these students, 13 were of East-Indian descent, 3 were of African descent, 7 were of mixed ethnicities, and 1 student did not specify her ethnicity on the questionnaire. This student stated that she never played video games while the remaining 23 students indicated that they played games several times monthly confirming the digital native prevalence among our students.

5.1 Method

A game day was scheduled on November 27, 2008 where the students were allowed to play, from 1 p.m. until 4 p.m., with all of the games developed by the game programming students. Over thirty non-educational games were showcased that day along with the two cultural prototypes described in Section 4. Questionnaires were

given to the students who participated in the game day to gauge their interest in digital game based learning, to find out what they thought about using culture and games, and to get their opinion concerning the effectiveness and utility of the culturally-oriented game prototypes. Demographic data and details about the students' gaming behaviour were also collected. The questionnaire consisted of a series of close-ended questions patterned as five-point Likert items along with several open-ended questions and space for additional comments

5.2 Evaluation Results

Student Prototype Preferences. Analysis of the information collected in the questionnaires revealed several interesting results. Nearly all of the players who played with *Lazy Jim* liked the game whereas almost half of those who played with *Caribbean Conquest* did not like the game. This happened even though *Caribbean Conquest* had better graphics and sound compared to *Lazy Jim*. Students liked to play *Lazy Jim* because it was entertaining, comical, and they took delight in the dialect (use of TEC). Some even gave examples of what they found to be funny, citing “Chan is d man” which is an advertisement slogan for a local hardware store (referred to in the game) made popular by a Trinidadian comedian. One student rated the use of culture in *Lazy Jim* as ‘very enjoyable’ and elaborated that “my friend learned what a jooking board was”; this shows that the students’ curiosity about their own culture promotes an enjoyable experience especially when in a group. Another student reported that she liked *Lazy Jim* the best but the programming problems could have been more challenging (she rated her programming proficiency as somewhat strong). This student however enjoyed the problems in *Caribbean Conquest* but the confusing gameplay caused her to discontinue playing. In fact, a survey of the responses of all of the students who did not like *Caribbean Conquest* indicated that the main reasons were the confusing gameplay and difficult learning activities even though tutorial and instruction menu options were included in the game by the student developer. Despite this, most students said that the game helped with syntactical error detection which was one of the original instructional objectives. In general, the students highlighted *Lazy Jim* as being more enjoyable for this activity though.

Student Attitudes towards Culture and Learning. The graphs in Figure 3 illustrate student opinions expressed in the questionnaire regarding the use of culture and learning and their preferences concerning the extent to which culture should be used. Few students (less than 10%) were actually opposed to using culture and most of the students were either neutral to the use of culture (33%) or enjoyed the use of culture (42%) as shown in the upper graph. The lower graph in Figure 3 gives further support for this observation where the large majority of students (83%) approve of the use of culture in an educational game whereas only a small minority (8%) disapproves.

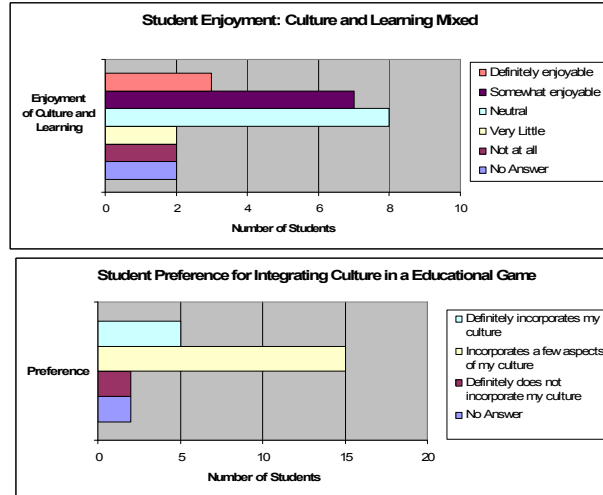


Fig. 3. Two graphs showing student opinion concerning mixing culture and learning (top) and student preference for integrating culture in an educational game (bottom)

Table 1 Percentage of student responses for and against using culture in an educational game

Student reason	Responses
I would feel proud to see my culture represented in an educational game	30%
My culture enriches my learning experience and I would remember things more	23%
My culture makes me laugh	20%
I would enjoy my learning experiences more	14%
There are more interesting characters and storylines for a game than my culture	2%
Culture has nothing to do with learning	2%
Culture doesn't go well with a game	2%
My culture has its merits, but some of its aspects are better left out of the classroom	0%
I am ashamed of everything in my culture	0%

A finer-grained analysis of reasons behind the students' preferences for and against the use of culture is summarised in Table 1. Consistent with the trends shown in the graphs above, the table reinforces the observation that the majority of students support the use of culture. 87% of the responses stemmed from positive student attitude towards the relationship between their culture and their learning experiences. Enriching learning experiences, national pride, and humour were the top reasons cited by students for which they would use a culturally-oriented educational game. 7% of the students did not respond at all, but 6% opted against using culture in an educational game mainly because of the perceived disconnect between culture and an educational game.

6 Discussion of Results

When designing a culturally-oriented educational game, design issues relevant to the introduction of cultural elements need to be examined. Particular attention must be paid to the authenticity and relevance of the cultural elements to the target audience. In the case of *Caribbean Conquest*, the use of culture was too general to have any lasting effect on the first year students. *Lazy Jim* on the other hand featured specific cultural aspects which had considerable impact because of their familiarity to the students. Simple use of small elements of culture such as a common expression of puzzlement (“Ehh”) and images of everyday items gave *Lazy Jim* an edge over *Caribbean Conquest* because of the subtle use of humour. Furthermore, since these games were educational, the learning exercises affected the students’ gaming experience. Unlike in *Lazy Jim*, poor performance in the learning activities in *Caribbean Conquest* strengthened the player’s opponent which was not the best design choice since the odds of the player achieving success in the game were reduced. It was very much like a penalty for getting an answer wrong. This clearly reduced the students’ interest to continue playing as reported in subsection 5.2. Though not a cultural design consideration, this result stresses the importance of maintaining the core feature of a game: games should be fun to play. With respect to the confusion experienced by the students when playing *Caribbean Conquest*, admittedly the gameplay was somewhat difficult to follow primarily because of the strength given to the opponent when the player gave a partially correct answer or an incorrect answer. Nonetheless, the students who played both these games all noted that the games were helpful for increasing their error detection and correction proficiency; this is a purely self-reported observation but it is a useful indicator for future study. Although the ethnicity range in the sample was not a true representation of the diversity in Trinidad and Tobago, generally the use of culture had broad appeal across ethnicity. No ethnic group showed a stronger or a weaker preference for culture over another. Gender preferences for culturally-oriented learning were slightly skewed towards female students who all reported either neutral or positive attitudes towards culture. Male students had a larger variation in their attitudes to culture and learning which ranged from mostly negative to very positive. However, we must state that this evidence is anecdotal at best because of the small sample size.

Another weakness in this study related to the sample size is that a small number of students played with the cultural prototypes because of the sheer number of games available during the game day. A restriction should have been placed on the students so that they would all have been exposed to the cultural prototypes. One of the questionnaire items asked the students to identify their favourite educational game, and many students named several of the non-educational games showcased on the game day. An interesting side-effect of this flaw was that several students identified a non-educational game, Space Rasta (shown in Figure 5 below), as their favourite. This game is filled with cultural Rastafarian symbols (commonly understood in Trinidad and Tobago) used in an entertaining, witty manner which attracted the attention of more than a few students who ended up laughing. For example, power-ups for the hero in the space ship (a Rasta complete with dreadlocks and the representative Ethiopian colours in his hat) took the form of ‘spliffs’- bundles of marijuana ready for

smoking. Although this game was not meant to be evaluated in the study, it provides further evidence that our students already have the propensity towards developing and using culturally charged material since the use of culture in this game's design was entirely voluntary on the part of the student developer. In addition, the student built this game for an earlier assignment prior to the introduction of the cultural game designs. This raises some interesting questions concerning the extent and the reasons for which our Computer Science students currently integrate cultural aspects into their learning experiences on a purely self-regulated basis.



Fig. 5. Side-scroller action game: Space Rasta

7 Conclusion and Future Work

The exploratory study revealed that the first year programming students at U.W.I. are receptive and interested in the use of culturally-oriented games for practicing and gaining skill in programming. Over 80% of the students appreciated the use of culture in the game prototypes and were especially engaged when humour was involved. The feedback received on these prototypes gives encouraging evidence that culture can indeed be represented with an acceptable level of authenticity in an educational game. Since the primary aim of this study was to evaluate student attitudes towards culturally-oriented educational games and not measure actual learning gains at this time, future work is planned for the refinement of these prototypes to measure and track learning gains resulting from cultural influences during gameplay. Specifically, improvements are planned for the learning activities, game mechanics, and motivational tactics used in the game. A limited amount of cultural elements were used in the prototypes, so expansion of the cultural coverage in the games is also necessary. Studies will also be conducted using larger sample sizes in order to confirm the results of this exploratory study. We will also like to examine whether culturally-oriented games have an impact on student learning gains in comparison to culturally-neutral games, and whether certain aspects of culture produce greater effects than others.

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