Gender and Cultural Differences in Game-Based Learning Experiences

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Abstract: Games have been successfully used in educational settings for many years. Still, it is not known in detail which factors influence the use and effectiveness of educational games. The game environment, its technology, and other game mechanics are factors directly linked to the game itself. The player's experience with the subject of the game and/or games in general, his or her motivation and expectations towards the gaming experience influence the outcome of a game-based learning experience. Some of the personal aspects, like age, were already addressed in earlier research. Cultural and gender differences though, were not a main object of study in educational gaming so far. This study started from certain assumptions about differences in game play, related to players' cultural backgrounds and gender. Literature suggests that gender plays a role when it comes to game performance. This paper introduces outcomes of a study with a so-called Microgame, a brief game used to raise the awareness of interdependent planning operations. It shows that in this game, gender and culture make a difference in relation to the learning experience of the players, measured by game performance.

Keywords: Microgames, learning, gender, culture

1. Introduction

Games are played by the young and old, males and females, and across the whole world. People play violent games, sports games, puzzle games, and action games. Games help players think, force audiences to be active, are social, and engage the body (Shaw, 2010). Since games have become an accepted instrument in educational settings, researchers in the field of game-based learning are constantly in search of factors that affect player motivation and acceptance, as well as challenges of the usage of games for learning (Kirriemuir & McFarlane, 2004). Several studies have identified an influence of social factors such as gender, cultural identity, or ethnicity on the acceptance, usage and performance of digital games used for educational purposes (Raessens & Goldstein, 2011; Yee, 2006). However, empirical studies that confirm these findings are still quite scarce (De Freitas, 2006).

In the gender field, for example, many studies try to investigate the preferences of male and female players for certain game types (Gros, 2007; Klimt & Hartmann, 2006; Greenberg, Sherry, Lachlan, Lucas, & Holmstrom, 2010), or the representation of gender within video games (Dietz, 1998; Cassell, & Jenkins, 2000; Beasley & Collins Standley 2002; Williams, Martins, Consalvo, & Ivory, 2009), while the effect of gender, or the feminine culture, on game performance was poorly researched so far. Most studies show better performance by male players, mainly explained by their more extensive media use, or better computer skills of male players (Imhof, Vollmeyer, & Beierlein, 2007; Kafai, Heeter, Denner, & Sun, 2008). At least, most studies of gender and video games take it for granted that 'girls' and 'boys' play differently and that finding ways of dealing with that can help make video game culture more accessible to female players (Cassell & Jenkins, 2000), maybe leading to 'better' games for learning for both groups.

Culture in general is another interesting, yet underexplored factor in games-based learning. Culture in itself is a concept under debate (Shaw, 2010). Many learning and working contexts nowadays are intercultural contexts (Hofstede & Pedersen, 1999). We follow a conceptualization of culture describing people having certain beliefs and values that can be influential towards the acceptance and comprehension of media like simulation games. Research on the possible effects of culture on performance in games-based learning environments is a poorly developed field. Culture in gaming contexts is often used to describe 'the' gamer in the context of the medium, and often shapes a picture of the one or other 'subculture' (Shaw, 2010). Only one newspaper article addressed different preferences for games in culture (Schiesel, 2006). Gamers seem to be

differently affected by game worlds. The well-known series Grand Theft Auto for example, with its scenes of glamorized urban American violence, has been tremendously popular in the United States but has largely failed to resonate in Asia and in many parts of Europe (Schiesel, 2006). Hofstede & Pedersen (1999) showed that different cultural backgrounds can hinder players in using games as a universal language, as proposed by Duke (1974).

The main objective of this study is to understand the role of gender and culture on the game-based learning experiences of participants reflected by their game performance. In our study, we used two short single-player and multi-player simulation games, so-called Microgames, called Yard Crane Scheduler (YCS) 1 and YCS3 respectively. For this study, we quantified the learning experience in terms of the game scores of YCS1 and YCS3, and used the results of a post game survey where participants reported on the aspects they learnt from the game. The scores reflect the game performance that acts as a proxy for the learning experience of the participants. We will describe the YCS1 and YCS3 games in the following section.

2. Yard Crane Scheduler games – Microgames to increase awareness for integrated planning operations in individuals and teams

2.1 The YCS1 game

We use the term 'Microgames' for the approach of using brief, situated learning games to address complex problems. These games are grounded on pedagogical considerations (see for more detail Kurapati, Lukosch, Verbraeck, & Brazier, 2015; Lukosch, Groen, Kurapati, Klemke, & Verbraeck, 2015a; Lukosch, Groen, Kurapati, & Verbraeck, 2015b). Due to their shortness, Microgames can only represent a limited part of reality. Still, we could prove that they are capable of being meaningful learning tools (Verbraeck, Kurapati, & Lukosch, 2016; Lukosch, Kurapati, Groen, & Verbraeck, 2016). The design of a Microgame in our approach followed the Triadic Game Design Philosophy (TGD) (Harteveld, 2011), which looks at the aspects Reality, Meaning, and Play. When designing a Microgame in this way, we started from an actual problem in the *reality* of a complex system as the first aspect of the game. Together with stakeholders, we decided which aspects of the real system should be represented within the game, e.g. what are the biggest challenges in the field, or the most critical elements. For YCS1, it became clear that the interdependent nature of planning operations in a container terminal is a huge challenge for all stakeholders involved. The functions that were transferred into the game are the vessel planning, the yard planning, along with the quay and yard crane handling. In the game, deep-sea vessels arrive to load and unload containers in the terminal. A screenshot illustrates the main screen of the game (see Figure 1).

**Figure 1:** Partial screenshot of the Yard Crane Scheduler 1 Game

In the game, the yard is one container high and loading and unloading of ships is not done simultaneously, which is different to reality, and implemented for the sake of playability. The second aspect addressed in the design process is the aspect of *meaning*, or (learning) purpose of the game. For YCS1, we decided that players of the game should become aware of the multiple functions of planning operations and their integrated nature. Especially the de-briefing phase of the game is used to exemplify and discuss different strategies of integrated planning. Thus, gaining insights in alternative planning strategies is another meaning of the YCS1 game. As the third dimension of the game, we decide about the *play* aspects of the game during the design process. The play aspect relates to the engaging and fun elements of the game to support the learning process. For YCS1, we decided on a scoring mechanism and a leader board to carefully foster the competition amongst players of YCS1 (not necessarily related to a certain group of players). The objective for the player to win the

game is to make sure the ships are serviced as soon as possible, while making efficient use of terminal resources. Additionally, we followed the approach of designing a game that is easy to play but hard to master. The game's challenge invites to try over and over again in order to gain a higher score.

2.2   The YCS3 game

YCS3 is a multi-player extension of the YCS1 game. It is similar to the single player YCS1 game in terms of layout and game play but it has some variations regarding roles, especially that of the additional role of the vessel planner. In YCS1, the role of the vessel planner was not visible to the player. In YCS3, the role of the vessel planner is to plan the unloading order of the containers.

In the YCS1 game, the individual player could view all plans and operations of all the roles, whereas in the YCS3, each role has a different access to various planning and operational tasks. The berth planner can only access the quay cranes, while the controller can only access the yard cranes. The yard planner can plan the containers from the ship on the yard, while the vessel planner needs to decide on the order in which the containers need to be unloaded. There is also a sequence of actions that has to be followed by the players. The controller cannot allocate yard cranes before the yard planner finalized the yard plan, and the berth planner cannot unload the ships until the vessel planner created an unloading order. The learning goal of this game that the players understand the need to communicate and collaborate with each other to align their plans with each other. Only by doing so, they are able to reach a high individual and group score. Two screenshot of the YCS3 game are shown in Figure 2.
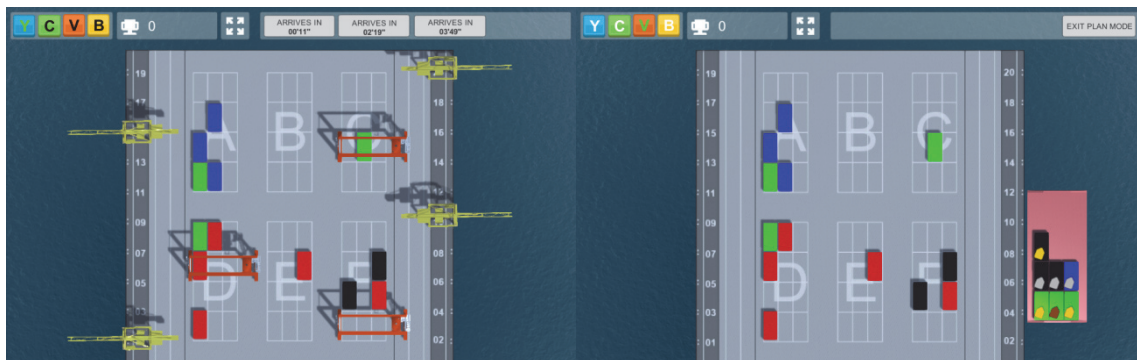
Figure 2: Screen shots of YCS3

2.3   Participants

The case studies were conducted in a quasi-experimental controlled setting, with classes of bachelor and graduate students from universities in the Netherlands, the United States and Germany. Although a total of 172 students participated in the actual study, we could only use only the data from 169 students for the gender study and 164 students for the cultural differences study, due to incomplete surveys or student refusal to provide data to the study. Among the students considered for the gender study, 95 students were male, and 74 students were female. Among the 164 students considered for the culture study, the nationalities of the students included Dutch (42), Chinese (39), American (37), German (16), Indian (9), Taiwanese (5), Vietnamese (3), Colombian (2), Pakistani (2), Greek (2), South Korean (2), Costa Rican (1), Ecuadorian (1), Finnish (1), French (1), Syrian (1). 41 additional students participated in a pre-test of the experimental sessions. Their results were excluded from the reported data, as they played a pre-final version of the game to support the development of the game itself. 26 students from a Dutch University participated in the YCS3 study. Of the 26 students, 11 were female and 15 were male. The mean age of the participants was 23.3 with a standard deviation of 1.7. The majority of the participants were Dutch (20), followed by three Chinese students, and one each from Belgium, Mexico and Greece. We received the approval of the Institutional Review Board of the University of Maryland and the Human Research Ethics Committee of Delft University of Technology to conduct this research study with students.

2.4   Methods and Materials

Participation in the experiments was voluntary. The participants were encouraged to perform well by the possibility of winning a small prize through a weighted lottery method based on their task performance score. Each experimental session took about 2hr 15 minutes to execute. Participants were asked to complete a pre-

survey that collected their demographic information. After that, the participants were presented with a briefing lecture on container terminal planning operations, and they received a tutorial and practice session for the YCS game that was used to assess their planning task performance (Kurapati, Lukosch, Groen, & Verbraeck, 2014). Two exercises with varying levels of difficulty (mission 1 and mission 2) were provided to the participants after the tutorial session. The scores of mission 1 were not counted for the data analysis. The participants then had to complete the more difficult mission 2 twice. The highest score of mission 2 was considered for evaluating the planning task performance or the game performance of each participant. YCS1 was played individually; YCS3 was played in teams of four players. After playing YCS, the facilitator conducted a de-briefing session to gather the players' insights and strategies related to YCS and to discuss the challenges in container terminal planning operations.

For the experiments, the researchers provided the needed hardware and software to the students. All experiments were held within a classroom setting. One teacher was involved in this study and at least two more researchers for observation and technical support participated in each of the sessions.

3. Results

3.1 Gender and game performance in YCS1

We chose to use the highest score per participant for mission 2 in the YCS1 game as an indicator of learning experience to make sure that players had a certain, comparable level of proficiency in playing the game before we counted their scores for our study. The overall maximum score of YCS1 in mission 2 was 12819 and the minimum score was -364.

In mission 2 of YCS1, the mean high score of female participants was 6502.56 and the mean high score for male participants was 4322.26. In order to check the significance of this difference, we employed the Mann-Whitney U test, a non-parametric statistical test, to compare the YCS1 game performances between male and female participants. We chose the Mann-Whitney test because we found that the YCS1 score was not normally distributed among male and female participants in our study.
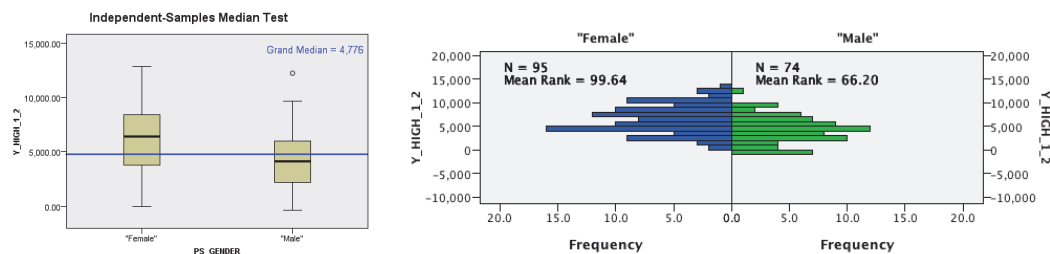

Figure 3: Comparison of YCS1 game performance based on gender

Figure 3 illustrates the results of the Mann-Whitney test. The y-axis denoted by YCS_HIGH_1_2 represents the distribution of scores of the female and male participants, while the x-axis represents the frequency. We can observe that the mean rank of female participants (99.64) is higher than the mean rank of male participants (66.2). This difference is also statistically significant as the Mann-Whitney standardized test statistic is -4.4 with a p value of 0. Therefore we can confirm that female participants outperformed their male counterparts in the YCS1 game performance in mission 2.
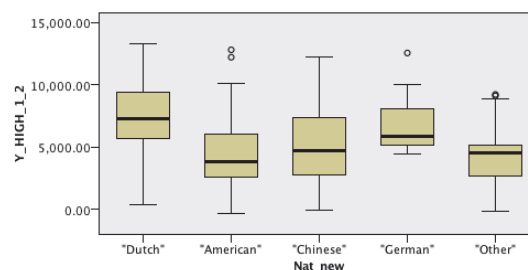
3.2 Culture and game performance in YCS1

Figure 4: Comparison of YCS game performance based on nationality

To compare the cultural differences in the game performance, we classified the participants based on nationality. The 4 major groups turned out to be Dutch (42), Chinese (39), American (37), German (16) and Other (30). We employed the Kruskal Wallis test, which is a non-parametric statistical test to compare different groups. We can observe from figure 4, which represents the YCS1 mission 2 high score on the y-axis and the nationality on the x-axis that the Dutch, and German participants outperform their counterparts. This observation is further fortified by examining the pair-wise comparisons of each of the 4 groups represented in Table 1. We can observe that the pair-wise comparisons of "Other"-"Dutch", and "American"-"Dutch" are statistically significant. This also holds true to "Other"-German" and "American"-"German". The other pairwise comparisons did not yield statistically significant differences. Therefore we can state that Dutch and German participants performed significantly better than their American counterparts. Since the "Other" group doesn't represent a particular culture, we don't consider this group in our results.

Table 1: Pair-wise comparisons of the game performance of different nationalities

Pair-wise comparisons	Std. Test Statistic	Significance level (p)
"Other"-"American"	.026	1.000
"Other"-"Chinese"	1.023	1.000
"Other"-German	2.871	0.041*
"Other"-"Dutch"	4.223	0.000**
"American"-"Chinese"	-1.054	1.000
"American"-"German"	-2.949	0.032*
"American"-"Dutch"	4.448	0.000**
"Chinese"-"German"	-2.157	0.310
"Chinese"-"Dutch"	3.422	0.006
"German"-"Dutch"	.411	1.000
*p<0.05, **p<0.01		

3.3 Gender and Culture

We conducted an analysis of the relationship between gender and culture in our study population. The results of the descriptive cross tabulation data representing the count and percentage of male and female students of each of the nationalities are presented in Table 2. The valid data points amounted to 164 because the culture study had only 164 valid responses. The table shows a relatively even distribution of male and female players in all groups, expect of the Dutch and the German, where more female than male players can be found.

Table 2: Cross tabulation data: Gender vs. Nationality

			Nationality					
			American	Chinese	Dutch	German	Other	Total
Gender	Female	Count	18	19	28	11	17	93
		Percentage	48.6%	48.7%	66.7%	68.8%	56.7%	56.7%
	Male	Count	19	20	14	5	13	71
		Percentage	51.4%	51.3%	33.3%	31.3%	43.3%	43.3%

Both gender and nationality are categorical variables. Therefore we performed the Pearson's chi-square test also known as the chi-square test for independence between these variables. The results of the chi-square test are presented in Table 3.

Table 3: Chi-Square Test: Gender vs. Nationality

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.635	4	.327
Likelihood Ratio	4.691	4	.321
Linear-by-Linear Association	.149	1	.699
N of Valid Cases	164		

From Table 3, we can notice that the Pearson chi-square value $\chi(1) = 4.635$, with $p = .327$. The high p value shows that there is no statistically significant association between gender and nationality. In addition to the chi-square test, we also performed the Phi and Cramer's V tests to test the strength of association between gender and nationality shown in Table 4. We can see that the strength of association between the variables is very weak with very high p values of .327.

Table 4: Tests for the strength of association between gender and nationality

		Value	Approximate Significance
Nominal by Nominal	Phi	.168	.327
	Cramer's V	.168	.327
N of Valid Cases		164	

From the above tests we can conclude that gender and nationality are sufficiently independent as their association is statistically insignificant and weak.

3.4 Culture, gender and game performance in a team in YCS3

We conducted the non-parametric Mann-Whitney U test to test if the YCS3 scores were different for male and female participants within one team playing the game. The null hypothesis of the Mann-Whitney U test is that there is no difference in YCS3 scores across gender. We compared the scores of three difficulty missions of YCS3. The results of the Mann-Whitney U test for mission 1 were $U = 68$, $z = -.753$, $p = .474$, for mission 2 they were $U = 50.5$, $z = -1.661$, $p = .097$ and for mission 3 they were $U = 60$, $z = -1.168$ and $p = .259$. None of these results is significant. Therefore we can retain the null hypothesis and state that the distribution of the individual scores of YCS3 was the same across both the male and female participants. The majority of the participants, 20 out of 26, were Dutch. The sample population was quite small (26) to draw any significant conclusions based on the quantitative data analysis. Therefore we chose to use video analysis as a qualitative measure to analyse the teams in terms of their gender and cultural diversity. We transcribed the video based on the information flow, communication and interaction patterns among team members and related them to their overall team performance.

We compared two teams—Team A with 2 male, 2 female participants all from the Netherlands and Team B with three Dutch male participant and one Chinese female participant. Team A showed a uniform information sharing pattern among all members and they collaborated efficiently to align their plans. In Team B, we noticed that a Dutch male player who played the role of the yard planner constantly advised the Chinese female participant who played the role of a controller. She followed the advice without much questioning. From the qualitative analysis we observed that team A with a balanced gender composition and a uniform nationality performed better than team B with three Dutch males and one Chinese female. Nam, Lyons, Hwang & Kim (2009) support the notion that homogeneous teams perform better than heterogeneous teams, because their common background helps them to show agreement, give opinions, and demonstrate both positive and negative emotions with minimal inhibitions. In our study the behaviour of the Chinese female can be attributed to the fact that the likelihood of Asian team members criticising the decisions of other team members assuming leadership roles is very small (Militello, Ormerod, Schraagen, & Lipshitz, 2009).

3.5 Summary of the results

Our results indicate that gender and cultural differences can be an important factor affecting game performance. We discovered from our results that female participants outperformed male participants in a difficult level of the YCS1 game, which was measured as an indicator for learning experience of planning tasks in container terminals. Similarly, cultural differences had an important influence. Our results showed that Dutch and German participants outperformed their American counterparts in a difficult level of the YCS game. The qualitative analysis of the multi-payer YCS3 game showed that homogenous teams performed better, but we could not find significant relations between gender and culture aspects and the learning results. Overall, we could show that in our study population, gender and culture were two independent aspects. With this, our study showed the effects of gender and culture on game performance. In the following section, we will relate our results to theory.

4. Discussion and Conclusion

4.1 Gender differences in game performance

Already for a long time, researchers are interested in gender differences in cognitive abilities. This interest stems from the wish to explore 'appropriate roles of men and women' from the early 19th century (Hyde & McKinley, 1997). As these differences could also have implications for preferences and different uses of games by men and women, game designers and researchers are looking into gender differences as well. In gaming

literature, male culture is usually related to better game performance (Imhof et al., 2007; Kafai et al., 2008), while our study showed that female players outperformed the male population on average for a planning task in a technical environment. Studies show that in general, male individuals perform better in virtual environments and games and use them more often. For example, differences in spatial abilities in VR are shown in the studies of Astur, Ortiz, & Sutherland (1990), Sandstrom, Kauffman, & Huettel (1998), Cutmore, Hine, Maberly, Langford, & Hawgood (2000), and Castelli, Corazzini, & Geminiani (2008). In these studies, male test persons performed better in spatial orientation than female participants. One reason for this is found in the level of anxiety that test persons show when learning to navigate through a virtual environment, with a higher level of anxiety within the female population (Bryant, 1982; Lawton, 1994; Lawton, 1996). Results from another study indicated that gender differences in game play could also emerge from a different ability in the use of interfaces (Waller, 2000). A collection of game-related studies showed that, while the number of female players of digital games has increased over the past decades, the content of games still seems to address male players (Kafai et al., 2008). Gender differences in socialization towards the use of computers were also shown by (Whitley, 1996) and could be one reason for actual differences found in the studies mentioned above. In summary, the focus on computer use and simulation game performance does not provide us with an explanation for the gender differences we found in our study.

As the YCS game is about planning performance, and gender studies on game-play differences cannot serve as an explanation for our findings, we looked into research on planning performance itself to find some elucidation of the phenomenon found in our study. Naglieri & Rojahn (2001) found better performance of girls in planning and attention tasks scales as result of a test based on the Planning, Attention, Simultaneous, Successive (PASS) cognitive-processing theory. Cognitive research seems to yield consistent findings from studies on gender differences related to specific patterns of intellectual abilities. Women in these studies perform better on verbal and memory tasks, while men do better on spatial cognition and spatial learning (see for an overview Boghi, Rasetti, Avidano, Manzone, Orsi, D'agata, Caroppo, Bergui, Rocca, Pulvirenti, Bradac, Bogetto, Mutani, & Mortara, 2006). The same study showed that men and women use different strategies in a planning task, which was represented by their brain activity. It cannot be said whether this is a biological or a social phenomenon, with both genders learning different approaches towards complex planning tasks throughout their life (Boghi et al., 2006). From these studies, we can draw the conclusion that different cognitive approaches towards planning tasks could be an explanation for the differences found in our study. Still, there is plenty of variance between the performance of men and women that might rather be related to individual differences than to gender differences (Unterrainer, Ruff, Rahm, Kaller, Spreer, Schwarzwald, & Halsband, 2005).

In summary, we can say that planning ability could be one explanation for the difference in scores between males and females we found in our study. This is at least more probable than the influence of the test instrument being a computer game. Nonetheless, being able to provide a clear statement on the gender differences in general would mean to conduct further analyses thoroughly grounded on related theories, to include both neurological and sociocultural aspects that could partially explain the differences found (Naglieri & Rojahn, 2001). We are aware of the fact that being a woman or a man does not necessarily mean that the one or other performs better or worse based only on her or his biological sex, but that social and individual differences play a very important or even more important role as well (Unterrainer et al., 2005).

4.2   Cultural differences in game performance

In our study, we made use of the model of Hofstede that contains six dimensions of national cultures (Hofstede, 1984; 2011). Hofstede conceptualizes culture as the collective programming of the mind that distinguishes the members of one group or category of people from others (Hofstede, 2011). Following this concept, culture is always a collective phenomenon, which can be connected to different collectives, or nationalities. Very broadly speaking, culture is the way one is brought up, making it a collective phenomenon (Hofstede & Pedersen, 1999). Culture includes certain beliefs and values, and rules of behaviour. Hofstede identified six dimensions, along which cultures can be classified (Hofstede, 1980; 2011): large vs. small power distance, individualism vs. collectivism, achievement-orientation vs. cooperation-orientation, uncertainty avoidance vs. uncertainty tolerance, masculinity vs. femininity, and long-term vs. short-term orientation. Especially the last two are heavily related to planning performance, as planning is a symbolic activity, which may or may not have an impact on what happens in the future (Hofstede, 1984).

Along these dimensions, German culture can be characterized as being a culture of a rather small power distance, being more collective, uncertainty tolerant, and rather achievement-oriented. The Netherlands show a similar rather smaller power distance, being more individualistic, with a slightly higher level of uncertainty tolerance, but being mainly cooperation-oriented. The culture of the USA is characterized with a comparable power distance, being highly individualistic, having less uncertainty tolerance than Germany and The Netherlands, while being achievement-oriented (Hofstede, 1984). Therefore the main cultural difference between the Western-European (German, Dutch) and the American participants is that of uncertainty avoidance. Cultures with low tolerance to uncertainty are more rigid in their behaviour, while cultures with high tolerance are more flexible (Hofstede, 1984). With respect to the YCS game, to achieve a good score, a player needs to adopt a flexible planning strategy, where he/she needs to pay attention to the arriving ships, and has to constantly reallocate containers and resources. This could be one possible explanation of the effect of cultural difference on the YCS game performance, which showed that Western-Europe (German, Dutch) students outperformed the players with a US-American cultural background.

While some studies explored the role of cultural differences in team and group performance and behaviour (Earley, 1994; Cox, Lobel, & McLeod, 1991), we were not successful in finding studies that explained individual performance and behaviour related to culture. After all, culture is a collective phenomenon (Hofstede, 1984). However, we do acknowledge that culture is a complex artefact not limited to nationality alone. The Merriam-Webster dictionary defines culture as "beliefs, arts, customs of a particular group, place or time", "a particular society that has its own beliefs, ways of life, art, etc.", "a way of thinking, behaving or working that exists in a place, group or organization". We haven't considered culture in such a complex and wide range, so it can be attributed as one of the limitations of the study. We hope to study culture in game-based learning contexts in a more holistic manner in future studies. Additionally our sample population consists of students from different universities with different study programs and we haven't considered the effect of such diversity in our study. It is also a possible topic for future work. We will now provide our overall conclusions of this study in the following section.

4.3   Overall conclusions

In conclusion, we would like to highlight that educators, instructional designers and policy makers need to consider factors like gender as well as several social, demographic and cultural aspects regarding the design and use of technology-enhanced learning systems such as games to nurture independent, thoughtful, resourceful and responsible students (Chen, Mashhadi, Ang, & Harkrider, 1999). In a study conducted by Militello et al. (2008), a Chinese interviewee was quoted saying "As a team member, you must accept and support the leader's decision even if you do not agree with it and even if it leads to a bad outcome" [p.149]. This observation is also consistent with the hierarchical nature of Asian cultures that rate high on the power-distance scale of Hofstede and Pedersen (1999). Although diversity in teams has been valued as a positive performance enabler in a team due to the rich new perspectives it brings into the team, it should be noted that this positive effect has been observed only in the long term (Nam et al., 2009). For ad-hoc teams, it could be that a highly diverse backgrounds of team members hinders effective collaboration, as team members first have to develop a common language to understand each other. As Duke (1974) proposes, games can serve as a means to support this development. For educators and trainers this means that they should be aware of the challenges of heterogeneous teams to learn and work towards effective team task performance in socio-technical work organizations, potentially with the help of games. We believe that our study made first steps towards identifying such factors, by empirically studying the role of gender and culture in game based learning.

Acknowledgment

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