# Culturally Personalised Approach in the Teamwork Design System

Wesam Shishah
School of Computer Science
University of Nottingham
Nottingham, UK
Email: wesam.shishah [AT] gmail.com

*Abstract*— **this paper proposes a new approach to personalisation within system design to support teamwork activity, which is based upon individual differences in culture cognitive processing. The definition of culture in this paper is limited to the individualism–collectivism dimension. The approach aims to increase the satisfaction of students participating in teamwork, as well as enhancing the use of human computer interaction during technology-supported teamwork. Postgraduate computer science students participated in a user study, interacting with the IdeasRoom system that had adaptations to its interface to include two different versions of design: individualist version (IND) or collectivist version (COL) based upon the user culture cognitive type (individualism or collectivism). The results provide initial evidence of those differences in culture cognitive processing at an individual level that have an impact upon user design preference of online teamwork systems. The study suggests that improving the design of current teamwork systems should aim to incorporate both individualist and collectivist approaches.**

***Keywords-component; Human Computer Interaction (HCI); Computer Supported Cooperative Work (CSCW); Culture; Adaptive Design; Teamwork; Personalisation***

## I. INTRODUCTION

Societies worldwide are becoming increasingly culturally diverse, and specifically in Western Europe. Universities are increasingly embracing multiculturalism, demonstrated by diversity in cultural traditions and religion [12]. The increasingly multicultural profile of students entering higher education leads to the requirement for designers of online course material to recognise the role of culture within higher education. Educators are increasingly using group work activities within coursework, which is in line with current thinking that teamwork is an essential skill for students to understand [4]. One of the main challenges faced by educators within higher education and designers in the field of computer support cooperative work (CSCW) is working within multicultural teams. The 'one size fits all' approach in current user interfaces is a critical limitation in teamwork technology, since it ignores cultural differences in design. Although technology increasingly offers localised versions of content, such localisations tend to be related solely to date/time formats and language adaptions. This paper challenges this view and suggests that user interfaces should adapt their presentation to a user's culture cognitive style, which can best accommodate their personal preferences.

A culturally adaptive group-based system called IdeasRoom was used to implement cultural additions. IdeasRoom is a novel computer-supported cooperative work (CSCW), which has the facility to adapt its interface to the users' cultural cognitive style. The research examines the effect and value of adding the personalising approach to teamwork systems by evaluating IdeasRoom, a group brainstorming system, for this research. A new approach was used for adapting interfaces to cultural cognitive styles, together with a cultural modelling component, which is an algorithm for clustering users based on a cultural cognitive style, together with a user interface adaptation component.

## II. RESEARCH BACKGROUND

The preference of individuals for the type of information representation and organisation is defined as cognitive style by [11]. There is support from research findings within the fields of both anthropology and psychology that culture is strongly linked to these cognitive styles, which have a critical relevance to overall cognitive processes [9,10]. Therefore, information is organised by individuals into forms of patterns based on concepts of plans, strategies and solving problems over a period of time, so that there is a development of learning processes that is influenced contextually. When individuals from different cultures face a similar problem, the processes applied to overcome the problem often use procedures of inference, but these procedures of inference are different for different cultural backgrounds [9].

Within this study, individualist and collectivist cultural dimensions are the theoretical cultural frameworks of interest. Individualist cultural societies have loose ties between individuals, where it is expected that everyone will ensure close family members would be cared for by the individuals within that family, and who would also be expected to ensure that they would take care of themselves. In contrast, people who live in societies defined as collectivist tend to be integrated within family groups that demand loyalty without question, but grandparents, uncles, aunts and parents tend to offer unquestioned protection for family members throughout

their lives, so that family groups in collectivist society are normally cohesive and strong [5,14]. In this research, cultural cognition refers to different perceptions of information, recall of information, thinking and believing in different ways within both individualist and collective cultures [7].

The reference [6] argues that technology designers need to consider aspects of users' culture in terms of their day-to-day life when technology products are adapted and designed to recognise different preferences, so that these strategies could be applied to such products and shown to be embedded within the design. However, the current pattern in higher educational institutions of using teamwork approaches to learning with technology products often tends to apply the same interface for all users that reveals critical limitations, as there are many students with multi-cultural backgrounds, and there are insufficient design differences in technologies used in teamwork activities that take account of cultural diversity. Therefore, there is a challenge for designers of online courses and technology products to overcome potential negative attitudes of some students who could lack encouragement when working in group activities, so that designers can create effective environments for learning within a group. Designers are encouraged to recognise that the perceptions of different users are likely to be different to others due to diversity of cultural backgrounds and experiences, which is a critically important element that should be considered when designing technology products [13]. If designs of technology products used for teamwork approaches to learning in higher educational institutions matched different cultural perceptions of users, then these technology techniques could have increased effectiveness, because users would have a better focus on the learning activity, anxieties would be lowered, and they would experience enhanced perceptions of comfort when interacting with the technology product.

## III. Personalised Approach Based Upon Cultural Cognitive Factors

The main components of the culturally personalised mechanism are presented in this section, which include three main components, which are:

- The User Modelling Component, which is responsible for collecting and processing user information;
- The Personalisation Component groups users into a particular culture cognitive style cluster and identifies the rules of adaptation;
- The Adaptive Interface Component provides a particular type of system interface to the user: individualist type (IND version) or collectivist type (COL version).

### *A. Component 1: User Modelling*

A personalised interface is provided by applying a component that exploits methodologies for processing data and collecting data that forms a basis for modelling users.

**User data collection:** Initially, data about the users must be collected in order to personalise and adapt the interface. Users are requested to provide a unique username i.e. student name, student ID and email. The cultural cognitive styles of users are identified by using the Scenario Questionnaire of Cultural Orientations [3]. This has the advantage of deploying questionnaire parameters that are not arbitrarily selected, but chosen on the basis of earlier theoretical and empirical research. It is important that research studies into topics with cross cultural relevance should ensure that potential bias is removed or reduced, so the scenario format was selected, because this is a valid approach that is able to ensure bias is reduced [8]. This questionnaire also determines a domain that is specific, rather than a domain that is general, which could provide a cultural context assessment; for example, a setting within an educational or academic institution. A further advantage is domain specificity, because within a specific setting of the boundaries of individuals within an educational institution in terms of their behaviours and social life, this can be predicted more precisely. Twelve scenarios are included in the scale, where a situation is described concisely for each scenario, along with 4 options. Every two options represent one cultural orientation (Individualism or Collectivism). The scale is based upon the five point Likert-type scale, where strongly agree (5) ranges to strongly disagree (1) to reveal the level of agreement. Each scenario was modified, so that the context of the university could be adapted for teamwork activities. For example see Table 1.

| **What are the most important behaviours to demonstrate within a student team?** |
|---|
| a) To share thoughts and emotions with other students (C). |
| b) To be loyal to the team and obedient to a leader (C). |
| c) To be self-reliant and able to think for oneself (I). |
| d) To compete with other students and achieve higher status in the class (I). |

**TABLE 1: EXAMPLE OF A SCENARIO MODIFIED TO THE CONTEXT OF TEAMWORK**

**Data processing:** In this stage, processing data first involve cleaning the responses of the users to the psychometric tests. Then, two values are calculated for each user. For the first value, those values corresponding to the user's selection for the two options representing individualism in twelve scenarios are calculated. For the second value, values are calculated that correspond to the user's selection for the two options representing collectivism in twelve scenarios. The ratio between the value on individualism and collectivism is then calculated.

### *B. Component 2: Personalisation*

This component executes cluster analysis for dividing users into two groups based on culture cognitive style (Individualists or collectivists), that is further linked to a specific type of interface (IND or COL). This process of using cluster analysis for the cultural cognitive style ratio of each user calculates the fraction of the user's value response of the

individualism stimuli in the user-modelling component, and the value response of collectivism stimuli. Users that are placed in the group defined as collectivist generally represent a cognitive style ratio that has a low value, when comparing responses with stimuli based on an individualist perception. In contrast, users that are placed in the group defined as individualist generally represent a cognitive style ratio that has a high value, when comparing responses with stimuli based on a collectivist perception. The purpose of these processes of grouping users has the intention of separating users into cluster groups with others who have similar perception values, according to the culture cognitive style ratios. Individualists receive an IND interface mechanism, whilst a COL interface mechanism is given to those placed in the group defined as collectivist. Reference [15] suggests that algorithms applied to investigate clustering need to be reliable and efficient, which justifies the adoption of the k-means clustering algorithm. Previous findings indicate that a cognitive-based cluster could be used to divide users into groups by cognitive style elicitation test data, and provide further validation for applying data with k-means clustering [1]. Therefore, by identifying a specific cognitive style, users could be divided and formed into groups by the alternative methodology of clustering mechanisms, according to results obtained, which effectively deals with the uncertainty of available information, such as ratio, when locating groups of users. This method provides an alternative to using strictly based rule mechanisms, where precise thresholds are able to highlight variations of cognitive style [1]. Before the algorithm can be run, a specific number of k clusters is required to apply the k-means clustering algorithm. Collectivists and Individualist are the specified groups used in this study, so k = 2 is applied for this algorithm, which also needs cluster centres associated with initial data points. Reference [15,1] argue that the algorithm could be improved in terms of its efficiency to choose initial cluster centres effectively by considering various modified k-means clustering algorithms. The calculation of the appropriate culture cognitive style ratio adopted for this study used the psychometric test to reveal how individualist-collectivist scale could allocate users into an initial collectivist cluster for the lowest culture cognitive style ratio, and allocate users into an initial individualist cluster for the highest culture cognitive style ratio. Figure 2 in the appendix represents the k-means clustering algorithm that is the version modified for this investigation, where the collectivist cluster is represented by the first cluster that has the lowest ratio value for setting the data point, and the individualist cluster is represented by the second cluster that has the highest ratio value for setting the data point or k=2. The Euclidian distance is used to calculate the distance of each data point from the centre of the cluster that should be the minimum for all cluster centres, so that calculation is possible between cluster centres and between data points. Therefore, new cluster centres are recalculated when the newly created cluster mean of all data points is measured. This is followed by recalculations of newly obtained cluster centre distances and each data point distances that stop when data point reassignment is completed with an iterative approach. Collectivists are identified by a culture cognitive style ratio that has low values in the first cluster by the mapping mechanism that assigns the COL interface system to these users. Individualists are identified by a culture cognitive style ratio that has high values in the second cluster by the mapping mechanism that assigns the IND interface system to these users.

### *C. Component 3: The Adaptive Interface*

It was intended that this study use IdeasRoom, which is a web based tool designed to promote electronic group brainstorming for students to generate ideas, as an experimental tool based upon a discussion forum format. IdeasRoom offers six main components, which include: 'add idea', 'add sub-idea, 'ideas list', 'membership levels (gold, silver, bronze and blue)', 'interface themes' and a 'leader board'. It is a tool that allows for by designing several versions, such as one that would appeal more to individualist users (the IND version) and another designed to appeal to collectivist users (the COL version). Both versions were informed by a set of culturally relevant group-based technology design strategies (R.I.N.G), which were informed through insights from interviews designed to explore cultural factors within academic teamwork, as well as findings from cross-cultural psychology literature on behavioural tendencies of individualists and collectivists [13]. Table 1 summarises both versions of R.I.N.G strategies (IND and COL), and described below

| R.I.N.G STRATEGIES | Individualism (IND) | Collectivism (COL) |
|---|---|---|
| **R** – In-Group Relationships | Competition | Harmony |
| **I** – Identity (of the student) | Self-identity | Group identity |
| **N** – Assessment Norms | Equity based | Equality based |
| **G** - Superordinate Goals | Individual goal | Sharing goal |

TABLE 2: R.I.N.G DESIGN STRATEGIES

**IND Interface:** This version incorporates sub-strategies for R.I.N.G. for individualist cultures that are independent goal strategy, equity strategy, individual-identity strategy and competition strategy. The sub-strategy of individual identity promotes an independent view of self, independence and uniqueness that is represented by a member theme, user name and picture, membership identification, display of members' points and a welcome personal message. The sub-strategy of competition promotes peer-to-peer comparisons and recognition of self-achievement. There are two forms to represent virtual personal achievement, where personal membership levels are represented by blue, bronze, silver and gold levels as members move from one level to another, and indicate personal feedback and enables comparisons of participation levels with others, and personal rewards associate completed activities with points given. There are also two forms for the equity norm, where self-earned points determine each member's theme that is personalised, so personal

membership and personal themes represent users' participation (see Figure 1 - a), and reward of points identifies the second form, where quality and quantity of participation determine users' rewards. The sub-strategy of independent goals is promoted by increasing users' participation to change personal membership levels, changing personal themes and changing leader-board positions for personal and independent goals.

**COL Interface:** This version incorporates sub-strategies for R.I.N.G. for collectivist cultures that are interdependent goals, equality, group identity and harmony strategy. The sub-strategy of group identity promotes interdependent views, fitting in and belonging to gather group information with group themes, group names and pictures, group membership, points displaying total for each group and for each member of the group, and group identity is promoted by a welcome message for the group. To motivate a sense of belonging blue, bronze, silver and gold colours are associated with group themes for interdependence and sense of belonging. The sub-strategy of harmony promotes in-group cooperation as a technique to encourage between-group competition [2] where the leader board represents between-group competition, so that all groups could simultaneously a first ranking when groups compete. Blue, bronze, silver and gold colours represent levels of group membership when moving from one level to another, and provide feedback for the group about participation levels when compared with other groups. There are two forms for the equality norm, where group membership and group themes represent group participation feedback for all members, so that team members' collective participation earns collective points for the same theme for all group members (see Figure 1 - b). In addition, the collective participation in terms of quality and quantity by all members of the group rewards group reward points. The sub-strategy of interdependence goals promotes increased group participation by changing group membership levels and group themes, and group leader board positions to achieve collective goals.

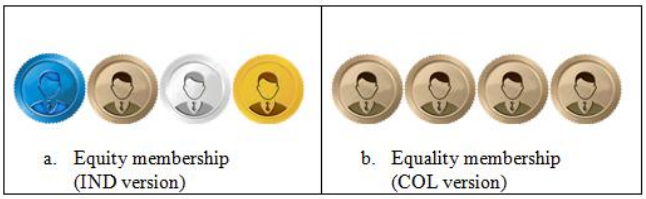


FIGURE 1: DIFFERENCE BETWEEN IND AND COL IN THE DESIGN OF MEMBERSHIP LEVELS

## IV. EXPERIMENTAL EVALUATION

The initial evaluation of adopting this methodology relates to a developed personalisation mechanism, where two types of interface that are different are available for users that recognise cultural differences.

### A. *Participants*

The sample population consisted of postgraduate students from the University Computer Science School based in the UK who demonstrated previous experience with group work, This sample population involved a total of 33 participants and included 15 females and 18 males to determine the gender balance, and when the study started, all participants were invited to complete the psychometric test, and all agreed, but focus group sessions only involved 8 participants. The researcher invited participants to become involved in this research study through an HCI module. An online psychometric test was used for those that were willing to participate in this investigation, who were then asked to leave their contact details for forwarding the link to the test. When the test was completed, participants were asked if they would be interested in being part of a focus group, and the researcher selected 8 individuals to join the focus group from those who expressed an interest to achieve a balance of culture types based on the responses to the psychometric test to identify 4 collectivists and 4 individualists.

### B. *Procedure*

The computer science university participants were given an IdeasRoom tool to experience a web-based personalisation approach, and this procedure and evaluation involved three stages, shown below:

**Stage 1 -** User modelling: Users' culture cognitive styles were determined when the research investigation began by using a psychometric test. Participants were also asked for personal information, such as student ID, email address, current degree course, nationality, gender and age to gather demographic data, which was replaced with a coded system or destroyed after a specific period. All personal information about the participants remained confidential, and the link between the coded information that could link to identify participants was securely maintained by the researcher. To determine culture cognitive styles, participants completed a psychometric test with their approval, and by completing the user modelling stage, the researched collected culture cognitive style ratios for all participants to be able to carry out cluster analysis in stage 2.

**Stage 2-** Personalisation: By using the culture cognitive styles of the 33 participants gathered in stage 1, the clustering algorithm was applied. A COL version or IND version type of interface was mapped by a personalisation mechanism based on each participant's cluster assigned by their responses from the psychometric test.

**Stage 3** – Focus Groups: The researcher conducted two focus group sessions to examine the added value of personalising the interface based upon individual differences in cultural cognitive styles in teamwork system. Two versions of the design were used with the IdeasRoom tool for participants' interaction, and their perceptions and subjective preferences

when interacting with the interfaces were explored during the focus group sessions. Each focus group included 2 collectivists and 2 individualists, and all four were asked to work together as one group, and the brainstorming activity involved two tasks. These tasks required them to generate ideas associated with the HCI topic, and each task lasted for 15 minutes. To apply group competition strategies, the focus group sessions involved them working with simulations of three other groups. The first task involved half the participants interacting with a mismatched condition or non-personalised interface version, and the other half interacting with a matched condition or personalised interface version, as decision rules were applied to the mismatched and matched conditions. Some users received the opposite interface type recommended by the system that produced a mismatched condition, and some users received the recommended interface type through the personalisation stage. Balanced conditions were applied for all cognitive style groups, as allocating individuals had a random and cultural cognitive style basis. Participants' preferences for a specific type of interface were revealed by the second task that changed the interface types, so those who had used a mismatched condition in the first task were then exposed to a matched condition, and those who had used a matched condition in the first task were then exposed to a mismatched condition. This ensured that all participants could engage with both interface versions. Participants' data was collected by the use of notes taken by the researcher and audio recordings, and to determine users' preferences when working in groups, the focus groups were invited to consider the types of interface and rank these two versions. Questions included whether participants preferred to work with others in a group with specific interface, and why.

## V. Results And Discussion

### A. Clustering results

Culture cognitive style ratios were the basis for separating participants into two clusters to enable cluster analysis based on Collectivists (n = 18, f = 54.5%) and Individualists (n = 15, f = 45.5%). Based on participants' culture cognitive style ratios, it was important to maximise variability between the clusters and minimise variability within the clusters, which was the main purpose of the clustering algorithm. The differences between the two clusters in terms of their culture cognitive style ratios were the focus for evaluation and analysis, and to understand mean differences between the two cluster groups created in terms of culture cognitive style ratios, it was important to carry out a sample t-test that was independent. The Levene Test for Equality of Variances (P = 0.238) showed homogeneity of variances. Between the two clusters, significant differences were shown by the results for culture cognitive style ratios (t (31) = 7.27, P <0.001). This indicates that the two different clusters had been effectively grouped by the personalisation mechanism, and could be applied for analysis of the data in this research study. Also, these results support previous finding indicate that k-means cluster algorithm could be applied effectively in forming users into groups based on cognitive style elicitation tests [1].

### B. Focus groups

The first and second choices for ranking the two interface designs by participants are represented by 1 or 2, and first choices of participants are shown in the table below with comments for both sessions. Participants P5, P6, P7 and P8 are in session 2 and participants P1, P2, P3 and P4 are in session 1.

| P | User Type | Design Preferred | User Comments |
|---|---|---|---|
| **P1** | IND | IND | *"It is fair …Everyone got points based on what they really deserved."* |
| **P2** | IND | NA | *"I feel both are ok. I enjoyed both."* |
| **P3** | COL | COL | *"Because our productivity will be better when we work together and we got higher membership without stress. Also, it is fair to all for our shared work and no one will be embarrassed."* |
| **P4** | COL | COL | *"Because there is a competition between the team members, which is something not supposed to be. I like more team-to-team competition."* |
| **P5** | IND | IND | *"There is no chance for anyone in the group to be lazy."* |
| **P6** | IND | IND | "*It is fair enough, especially in the way that we receive the points and this motivates all members to work, while the second session could give an opportunity to the member to work less than others and just wait for them to complete the task."* |
| **P7** | COL | COL | "*It will motivate team members to work together as one team to achieve their goal*." |
| **P8** | COL | IND | "*I think it is not fair in the assessment because all have the same level while we made different efforts. We should have different memberships to be motivated to work harder."* |

TABLE 3: Participants' first choices of the design preferred and comments provided that explain their preferences

Previous findings [13] are supported by these results, and there is greater significance in the collectivist perspectives for in-group relationships (R) than individualist perspectives. This contrasts with assessment norms (N) with a greater significance

for individualist perspectives and less for collectivist perspectives. Examples of this analysis include comments regarding in-group relationships (R) when collectivist participants P7 and P4 express their opinions. P4 indicates a preference for team competition rather than individual competition, and demonstrates a dislike for team members to compete between themselves. P7 indicates a preference for teamwork with team members working together. The individualist participants P1 and P6 suggest that participants should be rewarded according to their individual efforts when working in teamwork activities, and indicate a preference for the IND version due to the strategy of rewards. The approach proposed in this study could influence the problem of free riding and fairness perceptions based on these results, as P1, P3 and P6 indicate a match with their culture cognitive type and suggest perceptions of greater fairness when interacting with their matched interface. Analysis of the comments of P5 and P6 indicate that when their culture cognitive type is matched with their interface, there are perceptions of reduced free riding. However, further studies are needed to investigate the effectiveness of online teamwork for learning activities to gain a better understanding of how a cultural personalised approach can influence perceptions of freeriding and fairness. These results indicate a greater preference for participants to interact with an interface that is personalised to their cultural type, and could result in more effective teamwork experience when compared with current practices in many educational institutions. The analysis of these results indicates that when offered alternative interface designs for teamwork learning activities, the culture cognitive styles of participants appear to contribute to a preference for a matched interface design. The findings of this research suggests that team working systems currently adopted in many educational institutions should include both collectivist approaches and individualist approaches to meet the preferences of students with a different cultural background. Therefore, personalised interfaces that recognise the culture cognitive styles of specific users have a positive impact on their preferences, so from a user experience and usability point of view, there are significant positive implications.

## VI. Conclusion

This study proposes that teamwork learning activities should be promoted by effective and usable tools and techniques based on a cultural personalised approach. This approach was developed as a prototype by using IdeasRoom, which is a web-based system to encourage effective group brainstorming activities online that recognise specific differences in cognitive processing abilities and culture cognitive styles within a personalised design. These findings suggest that by understanding interface design preferences, user satisfaction is influenced by a personalised interface for collectivist and individualist users involved in teamwork learning activities that recognise users' cognitive processing abilities and culture cognitive styles. Although the sample size of this current study poses a limitation on the findings, it nonetheless demonstrates that cultural inclinations and users' participation in teamwork can be supported by the design of a system such as IdeaseasRoom. This study shows users' preferences for experiencing a system is matched to their cultural inclinations, and the participants' reasons for these preferences are strongly tied to the theoretical underpinning of this research; for example, the importance of individual effort was something the IND participants found to be supported in the IND interface. Whilst the importance of working as a cohesive group was also supported in the COL interface and demonstrated by the qualitative data obtained from those who preferred this interface. Therefore, the focus for the next study involves a large-scale study to explore how user perceptions of freeriding and fairness could be influenced by culturally personalising group-based tools.

## Appendix

**Algorithm 2:** Modified K-means clustering (**Clustering users based on culture cognitive styles**)

**Input:**
A set of users' culture cognitive style ratios obtained from psychometric test $u = \{u_1, u_2, \ldots, u_n\}$,
A set of cluster centres (culture cognitive style) $p = \{p_1, p_2, \ldots, p_k\}$ and k = 2 the total number of clusters to create (Individualist and Collectivist clusters)
**Output:** A set of clusters = $\{c_1, c_2, \ldots, c_k\}$

```
1:  procedure Cluster_Users_Culture_Cognitive_Styles(u, p, k)
2:      p1 = min(u); p2 = max(u);
3:      Do
4:          reiterate = false;
5:          for i = 1 to n do begin
6:              if (|ui − p1| > |ui − p2|) then
7:                  if (ui ∈ c1) then
8:                      delete_from_cluster(ui, c1);
9:                      add_to_cluster(ui , c2);
10:                     reiterate = true;
11:                 end if
12:             else
13:                 if (ui ∈ c2) then
14:                     delete_from_cluster(ui , c2);
15:                     add_to_cluster(ui , c1);
16:                     reiterate = true;
17                  end if
18:             end if
19:         end for
20:         for i = 1 to k do begin
21:             x = count(ci);
22:             sum = 0;
23:             for j = 1 to x do begin
24:                 sum+ = ci[ j ];
25:             end for
26:             pi = sum/x;
27:         end for
28:     while (reiterate);
29: end procedure
```

FIGURE 2: THE MODIFIED K-MEANS CLUSTERING ALGORITHM

## Acknowledgment

Many thanks to all participants involved in this research. This research is supported by Saudi Arabia Cultural Bureau in London, UK, Saudi Electronic University in Jeddah, Saudi Arabia and University of Nottingham , UK.

## REFERENCES

[1] Belk, M. et al., 2013. Modeling users on the World Wide Web based on cognitive factors, navigation behavior and clustering techniques. Journal of Systems and Software, 86(12), pp.2995–3012.

[2] Cárdenas, J.C. & Mantilla, C., 2015. Between-group competition, intra-group cooperation and relative performance. Frontiers in behavioral neuroscience, 9.

[3] Chirkov, V.I., Lynch, M. & Niwa, S., 2005. Application of the scenario questionnaire of horizontal and vertical individualism and collectivism to the assessment of cultural distance and cultural fit. International Journal of Intercultural Relations, 29(4), pp.469–490.

[4] Drury, H., Kay, J. & Losberg, W., 2003. Student satisfaction with groupwork in undergraduate computer science: do things get better? In Proceedings of the fifth Australasian conference on Computing education-Volume 20. Australian Computer Society, Inc., pp. 77–85.

[5] Hofstede, G.H., 2001. Culture's consequences: Comparing values, behaviors, institutions and organizations across nations, Sage.

[6] Khaled, R., 2008. Culturally-Relevant Persuasive Technology. Pt Design, p.256.

[7] Kim, J.H., 2013. Information and culture: Cultural differences in the perception and recall of information. Library and Information Science Research, 35(3), pp.241–250.

[8] Kitayama, S., 2002. Culture and basic psychological processes--toward a system view of culture: comment on Oyserman et al. (2002). Psychological bulletin, 128(1), pp.89–96.

[9] Nisbett, R. & Norenzayan, A., 2002. Culture and cognition. Stevens' handbook of experimental psychology.

[10] Nisbett, R.E. et al., 2011. Culture and systems of thought: comparison of holistic and analytic cognition. Psikhologicheskii Zhurnal, 32(1), pp.55–86.

[11] Rayner, S. & Riding, R., 2002. Cognitive styles and learning strategies.

[12] Tielman, K. et al., 2012. Collaborative learning in multicultural classrooms: A case study of Dutch senior secondary vocational education. Journal of Vocational Education and Training, 64(1), pp.103–118.

[13] Shishah, W. and FitzGerald, E., 2016. Incorporating Cultural Factors into the Design of Technology to Support Teamwork in Higher Education In: CSEDU 2016, The 8th International Conference on Computer Supported Education.

[14] Triandis, H.C., 2001. Individualism-collectivism and personality. Journal of personality, 69(6), pp.907–924.

[15] Wu, X. et al., 2007. Top 10 algorithms in data mining. Knowledge and Information Systems, 14(1), pp.1–37.