Imparting The Importance Of Culture To Global Software Development

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ABSTRACT

Professional software development is normally team based and is recognised as a socio-technical activity. In recent years this has been coupled with the increasing popularity of outsourcing and offshoring software development. These are two significant issues, which need to be considered and recognized. As educators it is important that we prepare our students, at both the undergraduate and postgraduate level to make informed and meaningful contributions to the industry they plan to enter. To facilitate this we need to consider providing modules which outline the benefits and problems associated with globally distributed software development. As research has identified, a key element of any such module is the importance and impact that cultural diversity plays. To facilitate understanding in this area, students can benefit from knowledge of the literature on culture. This can provide essential information which allows them to understand the broader aspects of this important topic. In this paper global software development and culture are placed in context. A summary of relevant literature with respect to culture is presented and discussed. Details of modules on the topic of global software development for both undergraduates and postgraduates, which utilised this literature, are outlined. The results from an inductive study carried out with some of the students who undertook these modules are also presented and discussed.

Categories and Subject Descriptors

D.3 [**Software Engineering**]: Management,

General Terms

Culture, Education, Global Software Development, GSD, Distance, Distributed Software Development, Virtual Teams, Software Project Management

Keywords

1. INTRODUCTION

The importance of understanding culture and the key role it plays in the software industry has substantially increased over the last twenty years. This can be directly attributed to the popularity of organizations implementing Global Software Development (GSD) strategies [12]. The advent and sustained popularity of this approach has been facilitated by a number of technical and commercial factors. These include the technical revolution in communication which has resulted from the development of the Internet [3]. This has been coupled with the availability in large numbers of software engineers situated in low cost economies [18, 30] who are willing and able to undertake outsourced and offshored software development projects [36].

The economic imperatives driving the globalization of software development are based on capitalizing on what many consider the advantage of labour arbitrage offered by utilising partners or staff at low cost locations [5]. This is often linked with the possibility for the implementation of '*follow the sun*' strategies [3]. It is believed that this approach offers the opportunity for continuous software development by leveraging temporal differences between software engineers in distant geographical locations [19]. These factors are seen as a mechanism to reduce software development costs [36, 38] and gain and maintain competitive advantage [44, 51]. While this may be the objective many organizations who have implemented this type of strategy have discovered offshoring to remote divisions or outsourcing software development to other organizations is not a simple or straightforward task [3, 30, 36]. The problems which have been experienced have been directly attributed to the difficult and complex nature of software development [53].

Research in this area has highlighted a number of difficulties which have been encountered when implementing a GSD strategy. These include establishing and managing globally distributed teams [10, 14] and the effective coordination of these types of projects [3, 7, 29, 35, 53]. These difficulties are further compounded by cultural [16] and linguistic differences, lack of communication, geographical and temporal distance from fellow developers and customers [7]. In this context distance has been identified as a key problem and by its very nature introduces barriers and complexity into the management of globally

distributed software projects [1]. The need for effective coordination, visibility, communication and cooperation are key variables for the success of all software projects [4, 36]. However, these variables are negatively impacted by distance and this increases the barriers and complexity faced by those managing GSD projects and/or virtual software teams [10] (See Figure 1).
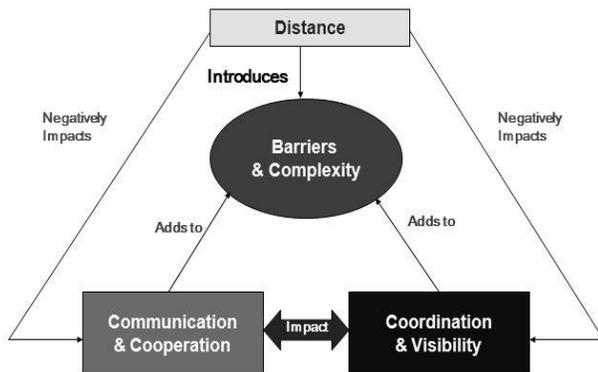

Figure 1. The Impact of Distance in the GSD Environment [8]

Four key elements have been identified which are inherent to distance in these circumstances. Geographical distance introduces physical separation between team members [44]. Temporal distance hinders and limits opportunities for direct contact, team building, coordination and cooperation [48]. Linguistic distance limits the ability for coherent communication to take place [8]. Cultural distance negatively impacts on the level of communication, understanding and appreciation of the efforts of remote teams and colleagues and can have a very serious impact on GSD projects [7, 28]. Coordination, visibility, communication and cooperation are all negatively impacted by geographical, temporal, linguistic and cultural distance [14]. If these elements of distance and their potential for negative impact are not recognized and managed correctly they can create serious barriers and complexity within GSD projects [3, 11, 36, 47] While each of the elements of distance, are recognized as important, cultural distance is particularly significant and is often the least understood of all these elements [12].

2. Culture
Culture can be defined as: "*socially derived, taken for granted assumptions about how to act and think*" [37]. Culture remains below every day consciousness and only becomes obvious to those who share it when it is contrasted with different cultural norms, values and assumptions. The operation of globally distributed software development projects require a level of cooperation and coordination that cannot ignore the impact cultural diversity plays and the barriers and misunderstandings it can and does create [16, 30].

Research has identified the importance of culture as a key factor impacting on globally distributed software development [17, 30, 38, 40] and on the operation of virtual software teams in

particular [3, 36, 48]. The multidimensional effects culture has on GSD projects has also been documented [20, 43].

All culture is acquired through socialization. At the organizational level a number of strategies are implemented to develop and foster organizational culture. Organizational norms, beliefs, values and objectives are imparted though training, management style, communication methods, rewards and organizational structure. Some multinational organizations have a strategy that enforces a standard décor, procedures, stationery and dress code policy across its worldwide operation. While this standardization is at a cosmetic level it can help reinforce an organizational culture. How effective the transmission of the organizational culture is depends on the difference between its values and norms and the national culture of those who it is being imparted to. While there may be outward compliance, national culture is hard to change and this can only effectively take place over an extended time period [24]. There is a need for organizations to not only learn and understand the customs, and courtesies of their remote staff, but to understand their national character, business philosophies and where possible their mindset [27].

Within organizations culture is manifested in two important ways and this has specific relevance to globally distributed software development. One is the effect of organizational culture and the other is the impact of national culture [4]. Organizational culture has been defined as the "*shared values and beliefs, which are seen to characterize particular organizations*" [15]. National culture has been described in terms of shared values, beliefs and philosophies that affect the way society is organized. These values, norms and beliefs are shaped by common history, tradition, climate and prosperity [26]. Culture provides individuals with an identity and affinity with those who share their ethnic and/or cultural background. It is a key element of who someone is and directly impacts how they live, act, work and socialize.

3. Culture its Dimensions and Concepts
With relevance to GSD a knowledge of the national culture and values of remote teams, managers and virtual team members is of significance in helping individuals to interpret and understand the behaviour of remote and culturally diverse colleagues [43]. The ability to classify culture allows it to be contrasted, compared, evaluated and predicted [21].

It is important to state that when considering culture it is a sensitive subject and not the depiction of wooden stereotypes. Cultures are made up of individuals who are not all the same. That said there are common characteristics that distinguish one culture from another. Therefore there are general activities, issues and approaches that need to be recognized" [27].

With this in mind, it is of value to consider some of the published literature on culture which has been highlighted as particularly relevant [3, 12, 30]. While the work of those discussed in this section are important, it is recognized that there are others whose work is of similar relevance. In this context the objective is to present and briefly discuss the research which was utilized in lectures on culture and GSD in the modules outlined in this paper. The rationale for the selection of this literature was that it could be directly related to GSD research. As a result relevant examples and case studies were successfully identified and utilised.

3.1 Geert Hofstede

Geert Hofstede's classification of culture was derived from research carried out in the International Business Machines Corporation (IBM) [32, 34]. His research focused on the values and culture of computer professionals [3], which has particular relevance to GSD. While Hofstede's work is not without its critics [39, 41, 55] It is still widely utilized in information systems research [41] and therefore worthy of consideration.

Hofstede defined culture as *"The collective programming of the mind which distinguishes the members of one group or category of people from another"* [32]. He classified what were originally four value dimensions of culture against which his research indicated countries differed. After a period of time he extended his dimensions to five and plotted data from fifty countries and three regions against those five dimensions [34]. The five dimensions are outlined as follows:

1. Power distance
2. Uncertainty avoidance
3. Individualism versus collectivism
4. Masculinity versus femininity
5. Long-term versus short-term orientation

The power distance dimension relates to how people react to inequality and how they accept the unequal distribution of power within their society and organizations. This acceptance can manifest itself in the way it impacts on relationships between managers, colleagues and subordinates [50]. Depending on how cultures revere hierarchy this is demonstrated in how individuals behave toward those in authority and how they express themselves as a result [3].

Hofstede defined uncertainty avoidance as the mechanism different cultures employ to cope with the uncertainty of life. He outlines that societies have devised three strategies to address the issue of uncertainty; they are technology, law and religion. Different nationalities reaction to uncertainty and the structures and beliefs they have developed to address these issues are dependent on their specific culture. Some cultures endeavour to avoid ambiguity. Others with low uncertainty avoidance prefer less structure, fewer written rules, and are more willing to take risks.

The third cultural dimension Hofstede highlighted is individualism versus collectivism and he describes it in terms of the relationship of the individual to groups within their society. The collectivist's preference is to be part of a closely-knit community. Within the organization, family and society the maintenance of harmony is considered a virtue and confrontation should be avoided. In these circumstances the word 'no' is not often used as saying no is considered confrontational. The individualist's penchant is to be part of a more loosely knit group or community. In this situation the individual see their own needs as paramount and this is reflected in their approach to how they work and their attitude to membership of an organization.

Hofstede's fourth cultural dimension is masculinity versus femininity. Masculine values are described as *"ego goals"* such as career and money. Feminine values are defined as *"social goal"*

centric. Importance is placed on relationships, helping others and the physical environment. This dimension of culture is often referred to as "Quantity of Life versus Quality of Life" by those who utilize Hofstede's work [2].

At the societal level different nationalities demonstrate a predominance of masculine or feminine values. In masculine societies competitive traits, which include success, assertiveness and performance, are valued. This is in contrast to more feminine focused societies which value relationships, quality of life, and caring for others. At the organizational level when individuals from a masculine and feminine value based societies work together the difference in focus and approach can lead to misunderstandings [13]. This can result in behaviour, which in one culture is considered acceptable, but can be offensive and unacceptable to individuals from another [9].

The fifth and final dimension is long-term versus short-term orientation. This dimension was developed independently of the other four dimensions. It was derived from Hofstede's collaborative work with Michael Bond [31]. The kernel of the dimension is the extent to which cultures are orientated toward a long-term outlook compared to those whose focus is more short-term.

3.2 E. T. Hall

In the work of E. T. Hall culture is equated to communication and communication can be separated into three elements - words, material things and behavior [22]. Words are the medium of verbal expression. Material things can be an expression of status, wealth and power. Behavior is an expression of how an individual feels or reacts to a situation, people or event. By the study of the constituent elements of communication in Hall's view an understanding of what he terms a *"silent language"* which is unconsciously expressed can be achieved. In his view study of this *silent language* provides insight into the principles that shape individuals and cultures. Hall equates culture to a computer, which has programs that guide human responses and reactions. Crucially the cultural program will not work if important elements are missing. This happens when individuals unconsciously apply their own rules to another system [23].

Hall defined seven concepts, which he has identified as relevant to the study of national and corporate culture:

1. Speed of messages
2. Context
3. Space
4. Time
5. Information flow
6. Action chains
7. Interfacing

The speed of messages varies. A fast message can be the news headlines on radio, television or a newspaper headline. A short cartoon can also be considered as a fast message. A slow message takes longer to decipher. Slow messages can only be understood by those who take the time and who have the knowledge, to determine their meaning.

Context is the information around a communication, item or event. This information provides the additional elements, which

come together to give it full meaning. In these circumstances this level of information or context can be described as high or low.

Hall considers space as an important element and different cultures require different amounts of personal space. Space can also equate to power and position. In some cultures an individual's power and status can be reflected by the size and location of their office. In other cultures managers are happy to be located with their subordinates.

Different cultures can have different attitudes to time. In his work Hall describes two cultural approaches to time as monochromic and polychromic. In monochromic cultures time is linear in nature and segmented. Polychromic cultures on the other hand are the opposite they carry out simultaneous activities and time commitments are considered flexible. Plans may be and are changed frequently and easily.

How information flows to different locations is also considered an important element. In low context cultures, information is controlled and focused only on those who need to know. In high context cultures, information flows freely around the organisation.

Action chains are the rituals of doing business where step one must be completed before step two is undertaken. Bureaucratic processes and indeed software development and test procedures are often based on the action chain approach. The breaking of the action chain in certain circumstances can have serious repercussions. Low context, monochromic cultures experience great difficulty when the chain is broken as they find it difficult to deal with unexpected change. High context polychromic cultures find change easier to deal with.

The concept of effectively interfacing is a key element in the business environment when dealing with cultural diversity. An effective interfacer is an individual who is a bridge between team members, departments, organisations and cultures.

3.3 Trompenaars and Hampden-Turner

Frans Trompenaars and Charles Hampden equate culture to an onion that comes in layers and has to be peeled, to be understood. In their work they have outlined seven dimensions of culture [54]. Each of the seven dimensions provides a juxtapositional view of different aspects of culture:

1. Universalism versus particularism
2. Individualism versus communitarianism
3. '*Specific*' versus diffuse
4. Affective versus neutral
5. Achievement versus ascription
6. Sequential versus synchronic
7. Internal versus external control

Universalism versus particularism outlines two cultural approaches to what is considered good and correct. Universalism implies in the cultural setting that there is a set of defined rules which are correct and should be implemented in all circumstances. This is contrasted with particularism, which places value and emphasis on relationships and circumstances rather than on rules. Individualism versus communitarianism is similar in approach to Hofstede's individualism versus collectivism dimension [25, 33].

Specific versus diffuse cultures, in a specific culture, business and home are separated and compartmentalized. Individuals from a specific culture concentrate on hard facts, standards and contracts. They can be described as direct, open and extravert. Diffuse

cultures on the other hand are the opposite and there is a large personal side to people's lives. This is reflected in their business relationships, it is not easy for an outsider to gain access. That said once access has been achieved it is both to the professional and personal lives of the individual. As a result to outsiders diffuse cultures can appear introverted, closed and indirect.

Affective versus neutral, these terms are used to describe the acceptability of showing emotion. In affective cultures it is an acceptable practice for people to show their feelings. In a neutral culture it is the opposite and the expressing of feelings is controlled and individuals are not encouraged to publicly display their emotions.

Achievement versus ascription, in an achievement based culture status is gained from what the individual has and is capable of achieving. In an ascribed culture status is derived from who a person is and what position or role they hold.

Sequential versus synchronic cultures relates to time and the ordering of tasks. The sequential approach is to see time as a narrow band and plan accordingly. Synchronic cultures on the other hand see time as a wide ribbon. In this situation multitasking is acceptable and time and deadlines are considered flexible and plans can be easily changed. This is similar to monochromic and polychromic time as outlined by Hall [23].

Internal versus external control, every culture has developed its own way of dealing with nature. Do individuals control nature or does nature control them? Cultures with an internalist viewpoint perceive the environment as mechanical and something that can be controlled. Externalists on the other hand view themselves and their environment as part of nature. They have to go along with what happens and they believe they have very little control over their own destiny.

4. Culture and its Place in GSD Education

Professional software development is normally team based and a socio-technical activity [49]. In the past this has often been ignored or trivialised by educators. The focus has been on the development of technical skills while the broader human and social aspects of software engineering have not been addressed. Given the expanding trend of globalising software development the importance and impact of these broader aspects of software engineering have come to the fore. It is therefore important to equip undergraduate and postgraduate students with the knowledge required to make a meaningful contribution to the software industry, which they are about to enter. In these circumstances, an understanding of the various aspects of GSD which include the social and technical elements are required [45]. It is in this context the need for the provision of educational modules at an undergraduate and postgraduate level in the area of GSD and specifically with regard to culture has been recognized and highlighted [42, 46].

4.1 Culture and Software Development

A question often asked by software professionals, academics and students is "*What has culture got to do with software development?*" As outlined in sections 2 and 3 in the context of GSD, culture plays a key role. The importance of understanding cultural difference and the relevance this can have on the successful completion of GSD projects should not be

underestimated [6]. As a result the author spent considerable time and effort developing GSD modules ensuring adequate coverage of this important topic. This has resulted in the development and delivery of a number of lectures which focused on the importance culture plays and included use of the literature on culture, as outlined in section 3. Extensive use was also made of real examples from the GSD literature which highlighted the impact and importance culture plays. These have included (but were not limited to) examples of Information Flow, Time, Achievement versus Ascription, Sequential versus Synchronic, Power Distance and Uncertainty Avoidance.

The GSD module at undergraduate level was provided to final year students, the majority of whom had spent a minimum of forty weeks on placement in software roles as part of their "*sandwich*" degree course. Many of these students had personal experience of working on globally distributed software projects and/or as virtual team members. Some of the postgraduate students also had relevant experience in this area, while others did not.

For both the undergraduate and postgraduate students seminars were provided to support their respective lectures. They both reviewed relevant publications from the GSD literature, prior to attending their seminars. This material was then discussed. If students had relevant experience they were encouraged to share their insights with their peers. This proved very successful as a number of students were able to outline their specific experiences which related directly to the cultural problems they had encountered in real life GSD situations. This was then discussed and related back the literature on culture which is outlined in section 3.

An additional goal of the seminars were to provide opportunities for students to discuss and learn firsthand about cultural issues which are relevant to software development, directly, from individuals from different cultures. To achieve this goal presentations and discussions were organized with developers from India, Malaysia and China. They proved very successful as it provided opportunities for relevant issues to be discussed in a positive and frank manner. A key objective was to ensure students had a clear understanding of the importance culture plays in the GSD setting. A similar approach was taken with postgraduate students which also provided positive results. At all times the need for respect for different cultures was reinforced. This important goal was achieved by adopting an open, honest and nonjudgmental approach to all the issues which arose while studying this important topic.

4.2 Evaluation

Having developed and delivered the modules, research was undertaken to evaluate the approach employed and to identify possible areas for improvement. Having considered a number of research methods an inductive sophisticated grounded theory based approach [52] was selected as the most appropriate for the study. A key aspect of undertaking this strategy was to endeavour "*to hear the voice of the respondents*", in this case the students.

Sixty seven students undertook the undergraduate GSD module. Ten students undertook the postgraduate GSD module. Of the undergraduates twenty volunteered to be interviewed as part of this study, for the postgraduate element five out of ten students volunteered to take part. In addition focus groups were held with the undergraduates and postgraduates during one of their respective seminars.

The interviews were semi-structured to so that they remained focused on the relevant topic, but care was taken to ensure this did not inhibit the inductive aspect of this study. Each interview took an average of twenty minutes and was recorded with the participants consent. The focus group discussions took an average of fifty minutes each and were recorded with the participants' permission.

The interviews and focus group discussions were transcribed and analysed. Concepts and categories were identified and memos written. There was a similarity in the findings from both the undergraduate and postgraduate elements of this study. These findings can be summarised as follows.

The need to recognise what was required to successfully carry out a GSD project was identified as important. Understanding the factors and variables which facilitate and hinder projects in the GSD setting were also considered very relevant. These included aspects of communication, coordination, cooperation and culture and how each of these factors had to be successfully addressed and where possible leveraged. This was summarised by a student who said "*I thought that a GSD project could be undertaken in the same way as those done here. Clearly I was wrong, there is a lot more to it and I understand that now."*

As a result of the study the structure of both the undergraduate and postgraduate modules were considered adequate. This included the number of lectures, seminars and topics covered. The amount of reading required for the seminars was questioned, as a number of undergraduate felt it was too much. Each week students were required to read a specific journal article and conference paper. When selecting these publications care was taken to ensure they were relevant and concise. During the study when this was discussed with the students these publications were recognised as important and of value. This did not prevent some students feeling they had too much reading to do and they did not appreciate having to do it prior to attending their seminars.

Having reviewed the situation and workload, it was decided if the amount of required reading was reduced and the timing changed it would seriously impact on the value of the seminars and the modules as a whole. Therefore this was not seen as a legitimate problem, but rather reluctance on the part of some students to do the amount of timely reading required.

With regard to culture at both the undergraduate and post graduate level the presentation and discussion of the literature, outlined in section 3 was considered a valuable exercise. The inclusion of examples from the GSD literature and from peers were both highlighted as being particularly helpful in this context. A number of students stated that it was not just theories they were presented with. They had real examples to relate this knowledge to. The opportunity for meeting software engineers from different cultures and discussing this topic with them was also considered of particular value. Many students mentioned that prior to undertaking this module they had not realised that culture had such an important part to play in global software engineering. As a result the complexity of this important factor and its implications were now appreciated and understood.

The undergraduates who had worked on their placement on virtual teams or on GSD projects found this module most beneficial and

highlighted this fact. As a student stated *"I can now understand what was going on and why we were having so many problems with our remote colleagues."* Another student said *"I am going to contact the company where I was on placement and ask if I can do my final year project on how the operation of the GSD team I was part of can be improved."* These students on numerous occasions also expressed the relevance of and their sustained interest in the topics covered by the module.

The results from this study indicate that the GSD modules with their particular emphasis on culture were a success. Another outcome was the requirement for a general introduction to GSD, prior to undertaking placement. This will be addressed as part of a second year module. It is considered important that a detailed study of this subject should continue to take place in the fourth year. In this way the relevant experience of those who have completed their placement in GSD teams or/and on global projects can be shared with their peers. The author's goal is to continue as an educator and researcher and to build on this research and previous work he has undertaken in this area [45, 46]. In this context it is planned to develop virtual student teams with members in Ireland and other international locations to undertake projects at postgraduate level. The objective will be to utilise these teams as a practical opportunity for providing relevant experience and explore different aspects of operating in a GSD environment.

5. Acknowledgement

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