SOLVING GRAND CHALLENGES TOGETHER: A BRAZIL-NORWAY APPROACH TO TEACHING COLLABORATIVE DESIGN AND PROTOTYPING OF ASSISTIVE TECHNOLOGIES AND PRODUCTS FOR INDEPENDENT LIVING

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ABSTRACT

This paper describes the roadmap for a long term strategic internationalization project involving two key higher education institutions in Norway and Brazil. The project involves six different yet related areas of knowledge, namely collaborative design, ergonomics, rehabilitation, human computer interaction and rapid prototyping. One of the global grand challenges includes how to ensure dignified and independent living for the increasingly aging population as the body functions decay naturally with age. The aims are to generate new knowledge and produce highly skilled graduates that are able to work efficiently in multidisciplinary teams to support and orient solutions to real problems related to independent living for the population in general and assistive devices for people with disabilities in particular. The theoretical framework is based on pedagogical ideas on social learning and Hofstede's cultural analysis. The research design of the project involves case studies of real-world problems and practices where students are linked with a rehabilitation centre. To reach the goals new courses at both bachelor and master levels are developed, joint workshops are held, high volume student and teacher exchanges are conducted as well as student and teacher internships. This paper describes the project and discusses how cultural differences are likely to affect the collaboration.

Keywords: Internationalization, cultural differences, assistive technologies, universal design, 3D-printing, biomedical engineering, independent living.

1 INDEPENDENT LIVING

Life expectancies of the global population is increasing, yet budgets for healthcare is not necessarily growing at a similar pace, especially as the ratio of younger and older individuals is shifting. One sustainable solution is to help individuals live independently for longer. Independent living also gives individuals a stronger sense of dignity, as they are able to be in control of their own lives, their own decisions and situation. Assistive technologies and universally designed environments are means for achieving the goal of independent living as they compensate for individuals' gradual loss of functioning due to aging and disabilities.

To achieve increased independence, society needs a better collaboration between engineers, designers and health-workers to develop the right skills to design new assistive technologies, tailor existing technologies and designing universally accessible virtual and physical environments that meet the

needs of users. Professionals with updated and relevant knowledge, skills and general competences need to be educated. Moreover, society is becoming increasingly diverse as the world is becoming more global. In addition to the particular study field, students also need knowledge, skills and general competences to operate within different professionals and across cultures. Individual differences can be seen as vital assets rather than as a problem. This paper describes an initiative to reach this goal through an international strategic partnership.

2   BRAZIL-NORWAY PARTNERSHIP

There are more than hundred years of strong economic relations between Brazil and Norway. Both countries have economic interests in forestry and petroleum industries. Brazil is also one of the large BRICS+J economies (Brazil, Russia, India, China, South Africa + Japan). Consequently, Norway has a strategic focus on maintaining and strengthening its Brazilian ties. Recently, a BRICS education and research strategy was launched with the aim of achieving stronger collaborations between Norway and the BRICS countries with joint education programs, increased student and teacher mobility and common research projects. The Norwegian government is soliciting increased trade and cooperation between Norway and Brazil through Norwegian graduates with Portuguese language and Brazilian cultural understanding as well as Brazilian graduates with Norwegian culture and language understanding. As a follow up, the Norwegian Centre for Internationalization in Education (SIU), together with the Brazilian agency CAPES (Coordination for the Improvement of Higher Education Personnel), announced a call for long term funding of such endeavours.

3   ASSISTIVE TECHNOLOGIES – DESIGN AND ENGINEERING

The initiative started with the establishment of a formal partnership between HiOA (Norwegian acronym for Oslo Akershus University College of Applied Sciences in Norway) and UNESP (Brazilian acronym for São Paulo State University in Bauru, Brazil). The project team covers a wide range of thematic specialties related to independent living. Topics include health science and training [1], ergonomics and rehabilitation, in particular wheelchair design [2]. Moreover, the product design group covers the role of design in a social context such as communication in mental health [3] and in design of burial monuments [4] as well as the technical aspects of design such as in rapid prototyping and materials [5]. The group also have expertise in biomedical engineering and sensors [6].

In addition to the physical world, the consortium comprises experts on the design in digital and virtual domain, especially universal design, where the goal is to design computer systems that can be used by all without adaption. Specific topics include low vision [7], readability of texts on the web [8] and dyslexia [9].

The consortium experts also has documented experience in design and engineering education having made contributions in product design education [10], universal design education and assistive technology education [11] and cultural factors [12].

4   CURRICULAR ACTIVITIES AND DEVELOPMENT

The goal of the strategic partnership is to ensure that future graduates have sufficient cultural understanding to drive Brazil-Norway businesses as well as having a solid background in design and engineering related to assistive technologies and independent living. The prime objective is thus to facilitate high-volume student mobility between Norway and Brazil. Student scholarships make this easier. Both long-term and short-term stays are planned. A long-term stay usually lasts about six months, or one semester, while a short-term stay lasts approximately six weeks. The short-term stays are planned for organized activities such a specific course with a practical angle where one class will travel together. Students from the two institutions are paired and the pairs will be set to solve design and engineering tasks together. This pairing triggers the cultural dimensions and language training opportunities. The long-term stays are organized on an individual basis. Our initiative involves students at all levels, that is, students at bachelor, master and Ph.D. levels.

This project relies on a theoretical framework that combines a social and culturally aware design pedagogy [4, 5] with Hofstede's analysis of cultural differences [13] in which cultures of the world are quantified according to five dimensions. The research question is how problem based learning can contribute to understanding cultural and transdisciplinary issues in collaborative design and prototyping of assistive technologies and products for independent living?

Case study is chosen as the method for theory development because the relevant courses could be studied in a real life context including complex relations and processes [14]. A key objective of the partnership is contributing to knowledge distribution; the development of joint curricular material, in particular courses offered to students at both institutions, taught through a mixture of physical presence and distance education technologies. The following courses (all 10 ECTS) were initially identified as being of mutual importance: Universal Design and Assistive Technologies, Participatory Design for sustainable innovation, Strategic design in entrepreneurship, Cross-cultural communication in product design, Assistive technology and Rapid prototyping for specific contexts.

As a part of the methodical approach, a regular exchange-flow of teachers is planned between the two countries for shorter durations of one to a couple of weeks. With a regular flow of teachers between the institutions, the faculty at both institutions will have better knowledge of the other institution. This again helps teachers to better prepare home students for exchanges such that the mobility experiences become richer and are more aligned with their home studies. Moreover, the low-threshold teacher mobility exchanges are intended to create more excitement towards internationalization among faculty members as excitement about internationalization often is limited to a few individuals with a personal appreciation. In addition, every second year a project conference is hosted by one of the institutions where a larger delegation from the one institution visits the other institution where a broader segment of faculty and administrative personnel get a chance to meet face-to-face and learn about, and from, each other.

A key premise for design and engineering for independent living is relevance to the target users. Formal links to the SORRI-Bauru rehabilitation centre in Bauru, Brazil were therefore established. Students and staff can thus perform both needs analyses and testing directly with patients and rehabilitation personnel and health workers.

5   CULTURAL DIFFERENCES AS A LEARNING ENVIRONMENT

We have used Hofstede's framework for comparing cultures [15] to more easily understand differences and potential challenging areas. Figure 1 plots the indices for Brazil and Norway in terms of Hofstede's classic five dimensions in addition to a more recently added dimension – indulgence. The framework is based on a vast body of data collected in most countries in the world over several decades. The framework does not suggest that certain attributes are better than others. Moreover, the characteristics are representations of a society as a whole and not the characteristics of individuals in the respective societies. It is simply a framework for comparing cultures and identify differences that may need certain attention and awareness. Each of the dimensions will briefly be introduced in turn according to Hofstede's [15] descriptions.
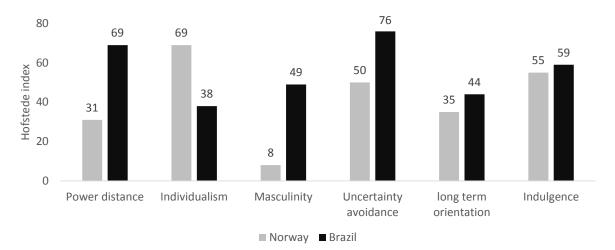

Figure 1. Hofstede's cultural dimensions for Brazil and Norway [44]

The analysis can be seen in light of awareness of the social and cultural context [4, 5] where the initial differences based on statistics are general views, and might tend towards stereotypical ideas on people and nationality, and where in practice individuals might stand out with totally different characteristics, especially in the meeting with each other. In a study of a school that considered adopting a problem

based learning approach (PBL) in a country with a high score on Hofstede's power distance index and uncertainty avoidance index, it was found that they initially had to reduce the obstructive effects of these dimensions of culture on the school's organization [16]. It is therefore necessary to start by analyzing these dimensions.

Power distance addresses the notion that individuals in a society are not equal. The score of 31 for Norway is relatively low and indicates that Norwegians are independent, that hierarchies are considered pragmatic structures, that equal rights are valued and that superiors are accessible. Moreover, power is decentralized. Leaders are informal and rely on their team members who expect to be involved in decisions. Norwegians tend to dislike to be controlled. Communication is direct, participative and consensus orientated. Brazil has a high score of 69, which is characteristic of a society that respects hierarchies and accept inequalities among people. It is important to respect and care for the elderly. Organizations typically have one visible leader who resume all responsibility. It is important to signal social position and status. Thus, Participatory Design for sustainable innovation seems to be a relevant module because it takes into consideration different stakeholders and power relations.

Individualism indicates whether a society is individualistic where people look after themselves or a collectivist society where people belong to in-groups that look after each other in exchange for loyalty. Norway is an individualistic society with a high score of 69 suggesting that Norwegians value personal opinions and direct communication. Privacy is important. Leadership is individual-oriented. Brazil is a relatively collectivist society with its score of 38, which means that the individuals are part of strong groups – especially extended families. The elders are expected to help the younger with their careers. Business is usually preceded by a social familiarization phase. Communication is context-rich and elaborate. Thus, Universal Design and Assistive Technologies is a module where the intent can adopt to these cultural differences.

The masculinity dimension gives an indication of the competitiveness level of a society. Norway has a very low score of 8 signalling a feminine society characterized by care for others, the environment, sympathy for the underdog, solidarity, consensus and valuing quality of life. To stand out from the crowd is not a positive attribute. To enjoy ones work is considered more important than being the best. Actually, trying to be better than others is generally frowned upon. Status is not expressed and leaders lead through dialogue and involvement. Brazil on the other hand has an intermediate inconclusive masculinity score of 49. A higher level of masculinity in term of engineering professionals means better products while for health related professionals may be less care for the patients. A combination of these two groups from both countries may be an eye opener for both professionals living in each individual country. Therefore, Cross-cultural communication in product design is a module that can benefit from such differences in culture.

Uncertainty avoidance is a measure that quantify a society's anxiety towards the unknown, the future and ambiguous and unfamiliar situations, and how a society attempts to avoid these. Norway has a score of 50 suggesting no particular preference along this dimension. Brazil, on the other hand, has a relatively high uncertainty avoidance score of 76. This high score indicates a clear need for rules, bureaucracy and elaborate legal systems to achieve structure, although individuals are not expected to adhere to these rules. Brazilians value relaxing, conversing with colleagues, socialization, long meals and dancing. They are passionate and often express emotions through body language. Rapid prototyping for specific contexts is a module that is both practical and adaptive, relevant to handle uncertainty avoidance.

Long-term orientation expresses how conservative or normative a society is in terms of maintaining traditions and norms and resistance to change. In contrast, pragmatic societies value modern education and look towards the future. Norway has a low score of 35 signalling a normative society. Absolute truths are important in Norwegian society, and normative thinking is common. Norwegian exhibit a strong respect for tradition and expect quick results. Brazil on the other hand exhibit a neutral score of 44 giving no clear preference. Thus, the course Universal Design and Assistive Technologies can be new law-based norms that demands change, which might be a challenge, especially in Norway.

Indulgence is a measure of the degree to which people in a society attempt to control their desires and impulses according to their upbringing. Weak control is considered indulgent, while strong control is considered restrained. Norway has an intermediate and inconclusive score of 55, while Brazil has a higher score of 59 indicating an indulgent society. This means that Brazilians in general are more likely to pursue their impulses and desires in order to enjoy their lives and have fun. Indulgence is

associated with a positive attitude and a tendency towards optimism. Indulgence signals that individuals do as they please as well as spending money as they want. Thus, the similarity between the indulgence scores between the two countries makes it possible to make rehabilitation program that may be adapted by professionals in spite of language and cultural differences. These characteristics can be a challenge, but a context useful for the course Cross-cultural communication in product design.

6   CONCLUSIONS

This paper described a recently started joint long-term Brazil-Norway design and engineering education partnership. The motivation for the initiative, activities and cultural model used were briefly discussed. The modules seemed relevant according to the analysis although the module 'Strategic design in entrepreneurship' may need to be developed with a specific cultural awareness. It seems that cultural and transdisciplinary issues in collaborative design and prototyping of assistive technologies and products for independent living can be identified through problem based learning [16] where more external partners can be invited into the project to support the entrepreneurial aspects of the collaboration. Further this initial study of the project show how a combination of socially and culturally oriented design pedagogics [4,5] and Hofstede's theoretical frameworks [13] can support such learning activities. The project is currently in its first year and it is too early to reflect on the effects and impacts.

REFERENCES

[1]   Gjøvaag, T. F. and Dahl, H. A., Effect of training and detraining on the expression of heat shock proteins in m. triceps brachii of untrained males and females. *European journal of applied physiology*, 2006, 98(3), 310-322.

[2]   Medola, F. O., Elui, V. M. C., da Silva Santana, C. and Fortulan, C. A., Aspects of manual wheelchair configuration affecting mobility: A review. *Journal of physical therapy science*, 2014, 26(2), 313.

[3]   Ingeberg, M. H., Wikstrøm, B. M. and Berg, A., The essential dialogue: a Norwegian study of art communication in mental health care. *Journal of psychosocial nursing and mental health services*, 2012, 50(8), 22-30.

[4]   Stoltenberg, E. and Berg, A., Designing burial monuments to increase emotional awareness in product design. In *Proceedings of E&PDE 2013, the 15th International Conference on Engineering and Product Design Education*, Dublin, September, 2013, pp. 704-709 (The Design Society).

[5]   Nishimura, P. L. G. and Rodrigues, O. V., A PROTOTIPAGEM RÁPIDA APLICADA À JOALHERIA. *Blucher Design Proceedings*, 2014, 1(4), 2365-2374.

[6]   Mirtaheri, P., Grimnes, S., Martinsen, Ø. G. and Tønnessen, T. I., A new biomedical sensor for measuring PCO2. *Physiological measurement*, 2004, 25(2), 421.

[7]   Sandnes, F. E., What do low-vision users really want from smart glasses? Faces, text and perhaps no glasses at all. In *Proceedings of ICHPS 2016,* LNCS Vol. 9758, 2016, pp. 187-194 (Springer).

[8]   Eika, E., Universally Designed Text on the Web: Towards Readability Criteria Based on Anti-Patterns. *Studies in Health Technology and Informatics*, 2016, 229, 461-470.

[9]   Berget, G., Mulvey, F. and Sandnes, F. E., Is visual content in textual search interfaces beneficial to dyslexic users? *International Journal of Human-Computer Studies*, 2016, 92-93, 17-29.

[10] Gulden, T., Sandnes, F. E. and Habib, L., Design Competence in ICT Education. In *Proceedings of E&PDE 2012, the 14th International Conference on Engineering and Product Design Education,* Antwerp, September, 2012, Chapter 12, pp. 419-424 (The Design Society).

[11] Whitney, G., Keith, S., Bühler, C., Hewer, S., Lhotska, L., Miesenberger, K., Sandnes, F. E. Stephanidis, C. and Velasco, C. A., Twenty five years of training and education in ICT Design for All and Assistive Technology. *Technology and Disability*, 2011, 23 (3), 163-170.

[12] Sandnes, F. E., Huang, Y. P., Jian, H. L., Experiences of Teaching Engineering Students in Taiwan from a Western Perspective. *International Journal of Engineering Education*, 2006, 22(5), 1013-1022.

[13] Verdugo R., Nussbaum M., Claro M., Sepulveda M., Escobar B., Rendich R., et al., Preparing Undergraduate Computer Science Students to Face Intercultural and Multidisciplinary Scenarios. IEEE Trans Prof Commun. 2013; 56(1):67-80.

[14] Yin R. K., Case study research: design and methods. Thousand Oaks, Calif.: Sage; 2009. XIV, 219 s. : ill. p.

[15] Hofstede, G., Hofstede, G. J. and Minkov, M., Cultures and organizations: Software of the mind, 1991, London (McGraw-Hill).

[16] Jippes M. and Majoor G. D., Influence of national culture on the adoption of integrated and problem-based curricula in Europe. Med Educ. 2008; 42(3):279-85.