



PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE
ESCUELA DE INGENIERIA

INDISCIPLINARY INTERACTIONS: COMMUNICATING ACROSS DISCIPLINARY AND CULTURAL BOUNDARIES

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Thesis submitted to the Office of Research and Graduate Studies in partial fulfillment of the requirements for the Degree of Master of Science in Engineering

Advisor:

MIGUEL NUSSBAUM

Santiago de Chile, December, 2010

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*This thesis is dedicated to my parents
–for their invaluable lessons on
empathy and perseverance- and to
Javiera –for being a frickin’ cool
sister-.*

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I would like to thank Miguel Nussbaum for the 40 minute phone call that changed my life and for every conversation we have had since then. Thanks for being an amazing professor, an inspiring guide and an even better friend. I also wish to recognize Miryam Singer's support throughout these years. I eagerly await our conversations and discussions; without them many of the ideas presented in this thesis would have never come to my mind.

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RESUMEN

Esta tesis presenta una investigación en torno a la necesidad de buscar modelos que permitan comprender, diagnosticar e intervenir procesos de comunicación intercultural y multidisciplinaria. Tomando como punto de partida el camino anecdótico que condujo a su realización y los encuentros cotidianos del autor ante diversos escenarios disciplinares, se propone un cruce de las teorías sobre construcción social de la mente de Vygotsky y el modelo cultural de Hofstede. A través de una concepción indisciplinada y operativa del conocimiento humano se presenta un modelo que permite llevar las ideas planteadas por los autores del marco bibliográfico a contextos reales, sirviendo este como herramienta de diagnóstico e intervención. Debido a la amplia área de aplicabilidad del modelo se abre mediante esta tesis un fértil campo para investigaciones futuras.

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Palabras Claves: Conocimiento Operativo, Indisciplina, Vygotsky, Hofstede, Cultura, Interdisciplina.

ABSTRACT

This thesis presents an investigation about the necessity to find models that allow to comprehend, diagnose and intervene processes of intercultural and multidisciplinary communication. Using as a starting point the anecdotic path that led to its realization and the daily encounters of the author in multiple disciplinary contexts, a cross between Vygotsky's ideas of the social formation of the mind and Hofstede's cultural model is proposed. Through an interdisciplinary and operative conception of human knowledge a model that enables to take the ideas proposed by the authors from the theoretical framework into real contexts and that serves as a diagnose and intervention tool is presented. This thesis, because of the broad area of applicability of the model presented, opens a fertile field for future investigation.

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Keywords: Operative Knowledge, Indiscipline, Vygotsky, Hofstede, Culture, Interdiscipline.

1. A BRIEF NOTE REGARDING THE STRUCTURE OF THIS DOCUMENT

This document follows an unconventional structure, as it uses two separate forms of written expression to introduce an academic investigation conducted at the Department of Computer Science at the School of Engineering at Pontificia Universidad Católica de Chile. Instead of starting from a regular bibliographical background, it begins by documenting the journey that led to it. It rescues a story that would have otherwise remained untold and undocumented. In a way, it honestly reflects the path of anecdote and chance that led to it.

Chapter three of this document complies with the traditional model of academic investigation; it is properly referenced, written in formal language, rooted within a theoretical framework of previous work by other authors and has been submitted for peer review at a prestigious publication . Chapter two has none of the above; it attempts to contextualize the investigation not through academic rigor but through the powerful means of storytelling. It gradually evolves from a purely anecdotal narrative into an essay composition that introduces key concepts that allow the reader to contextualize the presented research.

2. THE PATH TOWARDS OPERATIVE KNOWLEDGE AND INDISCIPLINE

2.1 People Love Tags

There should be a t-shirt in my dad's closet that says: "You're not an artist, at least I don't see you as one... You've never painted anything!" It is a phrase he periodically throws at me, whenever he has the chance to do so. The first time he said it I was in my senior year of high school, struggling with college options and not knowing what to do with life. Since then, he has continually dropped the bomb whenever the subject of my professional future comes along. "Yeah, sure, you're creative... but that doesn't mean you have to be an artist", he will add as if trying to comfort me after he has just single-handedly crushed my dreams and hopes of not working at an office, wearing a tie and having a schedule. "You're simply not an artist" –and while affectedly holding his hands bent in front of his face he will close his intervention with- "you're not going to be hanging little nonsense thingies on the walls". By now, I've come to terms with this random rant. I know it's coming over and over again, and having heard it a million times I no longer react to it. I've come to understand that my dad finds comfort in clinging to the idea that his only male son will be a banker, a CEO, a businessman... or anything but an artist. I guess that in a way he is right. I'm not an artist, but if I'm not an artist then I wouldn't tag myself as an engineer either, or a computer scientist, or anything at all.

You're probably wondering why on earth this would be considered a thesis document, and you're probably right: it might have been wrongfully tagged, but cope with me for a while, and you'll eventually see my point.

2.2 I am here because the phone rang

It is hard to separate our biographies from what we do, the way we see life, the way we react to everyday events and the way we work. Because of this, the journey on

how I got to study my master's degree in computer science is as important as the final research I present later in this document. When I was in high school, math and science in general were definitely not my thing, not because I didn't like them, or had mayor difficulties with them, but because I had real trouble accepting disciplines where everything felt so fixed and predetermined. Therefore, a career in science – except for the period of my life when I wanted to be an MD- was out of the question. I had enrolled at a local film school where I had been offered a scholarship and had been allowed to attend their classes after school for a year. I wasn't sure this was the best place to study, but at the time it felt like an okay decision. I had already stopped worrying about this issue, and by that time all I had to do was just wait until next year and attend film school as a full time student. That's when the phone rang, and everything changed a little –or a lot. I was shopping for a prom suit with my mom, and having tried on a million and three suits they had all begun to look the same. I was in the dressing room when my cell phone rang. It was an unknown number. "Hello is this Renato?" a voice asked. "You don't know me, I randomly met your father a couple of months ago and he gave me your number. I'm Miguel Nussbaum, a professor at the School of Engineering at Universidad Católica". I don't remember what I replied but it must have been something deep and profound like "Eh, ok". "Your dad told me you're a talented young man and want to be a filmmaker, is that right?" "Ehh... yeah, I guess"- I spastically answered. "Well, I just wanted you to know that the best place to go to film school is our school of engineering, not that we have ever created a film but it's just that engineering is a model that you can use however you want to". About the same instant my mom walked into the dressing room. She had two new suits for me to try on and by now she was getting more and more impatient regarding the whole shopping ordeal. Seeing me there, pants half on and talking over the phone was definitely not what she wanted, "Whom are you talking to? Do you think we have all day?" "It's a college professor from the School of Engineering, he met Dad" –I whispered. "Hang up, you're not going to study there, you don't like it. Now try these on" – and while throwing the suits over my head she walked back into the salesroom. My conversation with Miguel extended over the next 40 minutes; I only remember parts of it but the basic idea was "Art is

multidisciplinary; to be an artist you need management abilities, you need to know how to handle technology and you need keen knowledge in aesthetics. The first two, the school of engineering will give you, the third one you can find by double majoring. We'll teach you to abstract reality, you'll have a terrible time studying math and physics but that's life *kiddo* and by the time it's over you can grab the model we've taught you and use it however you want to. Sure, most guys use it in conventional ways, but if you're smart, and your dad says you are, then you'll be ok".

"COME ON, you're still on the phone! I don't have all day, well, night by now. You better hang up, try those suits on and BUY ONE, I'm not going to do this again some other day"- said my mom ever so gently walking into the dressing room. "So, what are you going to do kid, you still want to go to film school?"- asked the voice at the other end of the phone. Faced with two vital decisions to make, I walked out of the dressing room with a random blue suit. It was made of denim-like fabric and was nothing like the suit I had in mind. My mom said, "Ok, is this THE one?" while tossing the suit from my hands to the sales associate's. I nodded. "Hello, can you hear me"- Miguel insisted. "Yes, yes, I'm sorry reception isn't the best here" -I lied. "Well, we've been talking for 40 minutes now, hope you weren't too busy. Have I changed your mind?" -he now sounded like an insurance salesman. The whole situation felt uncanny, surreal and a weird feeling of transcendence got a hold of me. "You know what, you have... I want to be an engineer now" -I said in a sudden burst of inspiration- "But I can't, I haven't prepared the admission tests because I've been attending film school in the afternoons while everyone else was taking exam preparation classes. I'll never get enough points to get in. But I will promise you this: I will apply no matter what... even if I have no chances". "Oh, well that is a problem then, well I have to go now, but if you get in I'm sure it'll be the best decision. Good luck!" -and after talking with me for 40 minutes he all of the sudden had an urgent need to hang up.

During the two weeks spanning this phone conversation and the standardized admission tests all I did was read cheat books and memorize any random facts I thought could potentially get me some extra points on the test. I eventually got in and, scared to death, walked into my first semester at the School of Engineering. It was as terrible as I imagined it would be. While I was busy attending film school, pretending to be the artist my father didn't want me to be, my new classmates had been studying calculus and preparing for college. On my first day, I discovered that, unlike my classmates, I had no idea what mathematical induction was or what it was used for. I didn't know what trigonometric graphs looked like and understood that the people that studied engineering at a highly ranked university differed considerably from those who studied filmmaking at a small institute at the other end of town. A round of introductions was conducted, everyone ranted on how much they had always wanted to get into this school, how hard it was, how long they had prepared, how excited they were to begin classes and how they had all chosen a field of interest. When asked to introduce myself I said, "I wanted to be a filmmaker, I randomly got here following someone's advice and I have no idea how long I will last here. I might be here for a couple of weeks, a couple of months or the whole 6 years... I can't answer that right now, I'm a little overwhelmed by the situation" – I thought I was going to cry. Only then did it hit me that I had followed a total stranger's advice.

2.3 Staircase to computer science

After my not so promising first day as a mathematician, a sleepless night and an awkward feeling that this might not work as anticipated, day two began earlier than expected. By the time the alarm clock went off I had already read my notes from the day before, showered, had breakfast and was frantically googling terms, writing down formulas and trying to figure out the curve drawn when a plane intersects a cone, a cylinder or a sphere. Day two would bring along programming 101, a class I thought I'd quickly excel in, given the fact I was the only person I knew who had had a computer at home since the age of three. Never had I questioned how these things

worked though, what programming was and how computer code was involved in the process. The professor walked in, connected her computer to the projector and said, “In this course we’re going to talk about modeling reality into computers” –and later added- “let’s check some models, consider for example this...” The slide changed, and my heart skipped a beat. I was ecstatic. For the first time in my 36 hours as a college student, finally, something I was familiar with was being discussed in class. In front of me, on my second day of college, in the place where I least expected it, one of my favorite written pieces of all time was about to be the hot topic of discussion, or so I thought.

I had first encountered Julio Cortázar’s ‘Instructions on how to climb a staircase’ as a kid, when my dad bought my sister and I a collection of Cortázar’s short stories at a book fair by the beach. The hilarious description of a step and the ambiguous confusion between foot and foot always made us laugh and by the time this class was happening I had read it so many times I already knew it by heart. The time it took my classmates to read the slide gave me more than enough time to fantasize about my future as a programmer, a genius that would one day say “It all started as a kid with Julio Cortázar and now, a couple of Fortune 500 companies later, I’d like to thank him for inspiring me through time”. “So, do you guys think this is a good modeling of reality?” –asked the professor. And way before I could even begin to insinuate my Cortázar eulogy the whole class yelled “NOOO”. “Exactly, now, why is that?” –she asked as what I read as an evil grin materialized on her face. “Ambiguity, that’s the problem. This kind of representation is the exact kind of situation that we must avoid as engineers. Ambiguity is our enemy. It flaws our software, bugs our code and crashes our computers”. I have no idea what the rest of the class was about; I stopped listening and would’ve left the room if it weren’t for the fact that the door was right next to where she was standing.

2.4 And the office looked like a jungle inside

A year went by, during which I never heard from Miguel Nussbaum again. I had never even seen him and the closest I came to meeting him was when I walked outside of his office, a door covered in magazine articles, paintings, comic strips, gift wrappers and basically every door sign there has ever been. My favorite was the famous quotation by former Harvard president, Derek Bok, “If you think education is expensive, try ignorance”. I knocked on the door, but nobody answered.

By the end of my freshman year the phone rang again. Thirteen months had gone by since the original phone call. “Hey there, this is Miguel Nussbaum again. I see you followed my advice, how has this year been for you?” –he asked. “Hey, I’ve been wanting to talk to you, thanks for calling” –I was way more nervous than the first time we talked- “It’s been quite a ride”. “Well, I don’t have much time but I’ve seen your grades and you’ve won the right to work for me. Come to my office tomorrow morning at 8am, are you available?”- he said with an inquisitor’s tone. “Sure, thanks I have nothing to do tomorrow” –I was glad the conversation was quickly over as it was evident that nerves were about to push me into a consecutive round of stupid remarks and anxious comments. I didn’t sleep that night; I was finally going to meet the guy that I had most cursed throughout the past 10 months. I got there right on time. This was the first and last time this happened. Since then, I’m always late and Miguel has developed a keen understanding of my unpunctuality. Standing in front of this door, covered in all sorts of random objects, I struggled to find an empty spot to knock on. “Yes” –a voice answered. I stood there, waiting for the door to open but nothing happened. I slightly pushed the door open and saw an office covered in climbing plants that overtook the walls, bookshelves and ceiling. I could tell right away that Miguel was the kind of professor one would hope to find in college: crazy, always happy, having constant trains of thoughts derailing, re-railing, crashing and restarting. It was hard for me to follow all of what he said, but I left that office knowing I had followed the right person’s advice.

2.5 Ten bucks bought me failure

My first visit to Miguel was day one of a four year investigation on Interactive Cinema. The actual work we developed in that project isn't what I want to talk about. It has been documented; it has been published and will eventually be part of a Doctoral thesis in the future. It's the tangential stuff that makes up today's story; those tiny incidental anecdotes that happened throughout my day-to-day encounters with others.

With nothing but an old camera and a \$10 dollar budget, I shot my first interactive film. Saying it was a terrible film is an understatement; it was way worse than that. With two private screenings, one for Miguel and another for my mom, I decided to call it a day and lock the original files in a secret location that shall remain undisclosed. A year into the Interactive Cinema project, it became evident that despite the good intentions and top-of-the-notch engineering education I received, something was missing. The same day of that first screening at Miguel's office, demoralized by my first encounter with art critics, I walked into the School of Physics to pick up my final grades for a course, of which I only remember the name. Right next to the pile of Electricity and Magnetism final exams, was a set of flyers that said "Ceci n'est pas la aesthetique". They promoted the university's Institute of Aesthetics by depicting all sorts of fashion design and hair styling objects. I now get the joke and the Magritte reference, but I'm not sure I got it back then. Anguished by my failed first attempt at being a filmmaker, surrounded by ill-smelling physics labs, a new sudden burst of inspiration hit me. I sent in an application form, enrolled, and two months later was juggling with the course book trying to fit twice the normal credit load into my schedule.

On day one, I had to rush out of a statistics class to get to my first symbolic production class. Rushing through traffic to switch campuses and reach the other end of town before lunch time was over became my daily challenge. I had a whole summer to generate expectations about what this first day would be like. After two

years of math and physics I was more than eager to go back to what I thought were my real abilities. Excited I walked into my first class and reality struck me even faster than I would've ever predicted. As the professor handed out two pages -printed on both sides- with the minimum bibliography to be read during the next three months, it became evident that there was no way I'd be able to go through all of it. Once again, before walking into this place I had done exactly the opposite of what was required to excel. While all of the book worms in that room read authors I couldn't even pronounce, I had spent the past two years solving equations and debugging computer code. As the deadline for the first paper approached, most of my classmates asked questions I didn't understand about readings I hadn't even checked out of the library yet. Once again I was a fish out of water. It turns out, all of those mathematical skills I had developed had somehow eroded any writing skills I had, and my reading speed was lower than ever.

2.6 Cheating, or so I thought

Don't get me wrong, I like reading, kind of. It's not that I don't want to read ever, it's just that, especially back then, there was no time left for it. Books feel time consuming, and they have the best and most precise progress bar ever invented; you always know how much of the book is left. There are no magical jumps like in Windows where all of the sudden the estimated 45 minutes left morph into 10 seconds, then a minute, and then surprise... You're done!

For three years I studied at a place where page length was not only valued but worshipped. Whenever a page limit was inflicted, my classmates raged in hatred towards the censorship imposed while I secretly celebrated. It's not that I don't have the ability to write more than a couple of pages, I do, but whenever I do so I inevitably begin to think "who on earth would want to read this". For some perverse reason not only my classmates but also my professors valued cryptic writing and advocated for it as some form of sacred connection with Mother Philosophy. During

the first six months I felt stupid. Maybe my dad was right; I'm not an artist after all – I thought.

One day, urged by a quickly approaching due date of a six-page minimum essay, sitting in front of a six hundred page book, while at the same time trying to understand artificial intelligence algorithms for a test the following morning, I did something that ended up being more educational than any of the books I had read before. I opened a web browser, went to Google, typed in the author's name and the book's title and began to surf the web. I bumped into an 800 word Wikipedia entry on the book and then found a video on Youtube where the author himself explained his work. 10 minutes later, my keyboard was on fire and the six-page goal was hit within 4 hours. A new efficiency record, one that at the time felt very shameful; I'm cheating my way through college, I thought.

While all of this was happening, things at the School of Engineering were not getting any better. Whenever someone found out about my parallel life at aesthetics, doubtful grins would pop up on their faces. Engineers have serious problems when it comes to other disciplines, especially non-scientific ones. Very much like my dad, they think of them as hobbies, not serious enough to be worthy of their time. Aesthetics in particular wakes up all sorts of wrongful associations like hair styling, cosmetology and Botox injections. As time passed by, I developed the idea that the intersection between these scientific and humanist worlds tended to zero. I used to believe they required completely opposite sets of skills, and that the border between failure and success was differently drawn depending on where you were standing.

2.7 Operative Knowledge

Regarding the Wikipedia incident, a week after the papers were handed in, an in-class discussion was held. "Renato I read your essay, would you mind explaining your hypothesis to us?" –the professor asked. FUCK, she caught me cheating, I thought, and now she is going to publicly humiliate me in front of the class. As I

walked to the board, sweat glands working overcapacity, the worst imagery came into my mind. I proceeded to briefly explain how I had linked pop culture with the six hundred page book I hadn't read. "Very interesting" –she said while handing back my paper with a huge "7" followed by a handwritten "excellent!" on the cover. I took a deep breath and tried to make sense of what had just happened.

I only came to fully understand it 2 years later, at a meeting with my thesis advisor at the Institute of Aesthetics. A group of 5 students and I held meetings with him every Friday. Each week we had to read a book he assigned, and then explain it to the others. On the first day, after lengthy discussions about the other books, by the time it was my turn only five minutes were left. "Well, you'll be the first one next class Renato" –said the professor and then jokingly added while looking at his watch - "unless you can explain it in five minutes". "I think I can" –I instantly replied. I opened my book and began rushing through the post-it notes sticking out of it. "...that's the main idea, then 20 pages of a random rant on science followed by the next proposition, the author says that..." –I remember commenting at full speed. After five minutes of this marathon journey, the total silence that filled the room was interrupted by a "That was totally cool", from one of my classmates. It became the standard procedure. I was always the last one to present, and my executive summaries became a Friday tradition.

It eventually hit me that I wasn't cheating when using Wikipedia entries as my bibliographical references. Throughout the years I had taught myself a skill that was absent in humanistic practice. I called it Operative Knowledge, and it became the backbone of what I proposed in my aesthetics thesis. Defined as little fractions of knowledge of quick access that allow individuals to consume, create and transform ideas, it is characterized by lacking depth, and not being exhaustive. It allows ideas to circulate and be applied to real life scenarios, even if those applying them are not experts. A professor once mockingly defined it as "knowing only what matters", and when commenting the idea to Professor Angela McFarlane she dubbed it "Wiki-Smart". Both definitions capture the essence of my proposition. I'm not saying that

reading is obsolete or that experts are no longer needed but I do believe that new media and permanent connectivity have radically changed the way we relate to knowledge, information and ideas.

2.8 Indiscipline

The path that brought me here led to a double life where the things that mattered in one place were trivial and irrelevant in the other. “Interdisciplinary” is the word that’s supposed to describe the education I was receiving, but I eventually realized that its definition was the basis of the problem. When people talk about interdisciplinary or multidisciplinary work they imagine some sort of United Nations where instead of countries, disciplinary backgrounds come together; a magical place where lawyers, engineers, artists, journalists and whatnot sit down together and fruitfully collaborate. This beautiful poetry is inapplicable in reality, and absolutely misses the mark on where the emphasis should be. Labeling something as interdisciplinary means allowing something to hold two tags at the same time, like “artist and engineer”, but doesn’t question the label itself. The binary divisions we have established distributing human abilities as belonging to one discipline or another are the origin of a system that has led to excessive specialization and not transversal education. When studying two or more separate disciplines you can’t switch between one and the other; they are always there, irrevocably tangled up together and the boundaries between them disappear. We have to question disciplinary divisions because of the fact that they are political shortcuts, and not organic structures of human thought. That’s when indiscipline gets involved. Being interdisciplinary means questioning the problem’s domain and asking: what do all these tags mean? How do these arbitrary words determine our real abilities? Do they bring us together or keep us apart? If my dad doesn’t consider me an artist and I’m not comfortable with being labeled as an engineer, what does that really say about who I am? My dad has a problem with me being tagged as an “artist” as much as I have a problem with being tagged as an “engineer”. People worship taxonomies, classifying, organizing and having everything fit into nice and tidy categories - I

don't. The bottom line is, I don't care for what the tag says and because of that I'd rather it not be there. I'd rather we have an interdisciplinary system.

2.9 Communication, language and cultural blindness

As long as academic structure stubbornly imposes disciplinary divisions, the walls between individuals will continue to grow higher and higher. Communicational gaps between experts and non-experts hinder our chances of finding a common ground of transversal knowledge exchange. Operative Knowledge is ultimately addressing a linguistic and communicational problem; our specialization has led us to be self-absorbed in our own disciplinary limbos. Surrounded exclusively by engineers or lawyers or architects or artists it is easy to see how one would tend to believe the world is monotonic and that our particular biases are higher order universal truths. We have built academic and knowledge communities where thick divisions and boundaries separate us from others. We populate buildings that classify us into fixed divisions and compartments shutting down the world around us. Surrounded by our peers we reinforce our blindfolds unaware of how our specific subcultures end up dominating our observation abilities.

The following part of this document serves a double purpose; it presents an operative version of the theories of two authors, Vygotsky and Hofstede, and, by proposing a way of transferring their ideas into the realm of intercultural and transdisciplinary communications, it pragmatically advocates for an interdisciplinary world where we look beyond our cubicles. An operative knowledge version of Vygotsky and Hofstede allows the reader to take the presented model, cut it out, carry it with him and apply these ideas to everyday real life scenarios. The bottom line is: I've read the books so that you won't have to. Instead of presenting complex ideas that only experts could grasp my intention is the opposite: to empower the reader and be able to provide an operative version of the theoretical framework I've studied.

3. A MODEL FOR UNDERSTANDING INTERDISCIPLINARY AND MULTICULTURAL COMMUNICATION

3.1 Introduction

Information and Communications Technologies (ICT), globalization and knowledge-centric societies, have produced radical changes regarding the abilities and skills required to actively contribute and collaborate within culturally diverse and interdisciplinary working environments. These changes have emphasized the need to transform educational practices so as to train new generations to be aware of the communicational difficulties these new scenarios present. In fact, several initiatives are pushing for curricular reforms -at all levels of the educational system- that replace the traditional emphasis on memorization of fixed disciplinary knowledge for what has been called 21st century skills. These transdisciplinary skills are related to higher-order thinking processes and interpersonal capabilities. Common examples of these skills are communication, creativity, collaboration, critical thinking, and ICT use.

Among the most important initiatives promoting changes regarding the way we prepare future generations for the challenges ahead are: The Partnership for 21st Century Skills (www.p21.org), the ATC21S Project (<http://www.atc21s.org/>), the OECD DeSeCo (<http://www.deseco.admin.ch/>), the OECD PISA (<http://www.pisa.oecd.org>) and the Lisbon Council of the European Union (<http://www.lisboncouncil.net>). These initiatives stress the importance of teaching students to communicate effectively with others in increasingly diverse social and cultural contexts. For example, the OECD Key Competencies Framework argues that “as societies become in some ways more fragmented and also more diverse, it becomes important to manage interpersonal relationships well both for the benefit of individuals and to build new forms of co-operation” (OECD DeSeCo, 2005). These competences are considered crucial for individuals to learn, live and work with others and are addressed with terms such as “social competences”, “social skills”, “intercultural competences” or “soft skills”.

Additionally, the Framework for 21st Century Learning, describes basic abilities that students must have in order to succeed in work and life, when facing today's world. Said framework, broadens the way we understand communication by proposing skills related not only to the effective exchange of ideas, but also the understanding of social, cultural and diversity issues involved when interacting with others. Facing today's multicultural environment, and being able to communicate effectively with a range of audiences goes beyond the way we express ideas and requires us to know how to "respect cultural differences and work effectively with people from a range of social and cultural backgrounds" (Partnership for 21st century skills, 2009). What this configures, is the need for undergraduate programs to prepare students to excel not only in the technical aspects of their disciplines but also to be able to understand how we differ from others and how to embrace said differences so as to be able to collaborate effectively, enrich and complement our ideas and interact respectfully with people from diverse backgrounds and different points of view.

This paper, presents a model for understanding the way we communicate across disciplinary and cultural boundaries. It is based on the ideas of Vygotsky and Hofstede, and presents an undergraduate course that helps students to better understand the way we can communicate effectively with a range of audiences. Section 3.2, explains the theoretical framework focusing on the fact that communication between people of different cultural and disciplinary backgrounds depends not only on our ability to express ideas but also on a deep understanding of the components involved in the process of communication, the social formation of the mind and the ways that our day to day lives are culturally situated. Section 3.3 presents the methodology followed in a semester long course based on the proposed framework. Section 3.4 presents an empirical assessment of the impact of said course on the way students understand the difficulties they face when dealing with interdisciplinary and multicultural issues. Section 3.5 introduces further empirical assessment of the course one year after students had enrolled in it. Section 3.6 discusses a model that unifies the presented theoretical framework and the findings

of the empirical assessment of the course. Finally, Section 3.7 presents conclusions regarding the need to modify curricular planning so as to include a broader approach towards our communication ability, focusing not only on the way we express ideas but also on the understanding of the implications that culture has over said process.

3.2 Theoretical framework

Vygotsky's statement that "it is through others that we become ourselves" (1978) is central to the understanding of cultural and disciplinary differences. He proposes that mental processes and human actions, like communication and concept creation, are socially mediated. The idea is that all psychological functions are culturally, historically, and institutionally situated and context specific (Cole and Wertsch, 1996). Vygotsky enunciates that "traits of human personality, which are latent in every human being due to the organic makeup of heredity, exist in the environment, but the only way they can be found in each individual human being is on the strength of his being a member of a certain social group, and that he represents a certain historical unit living at a certain historical period and in certain historical circumstances" (1994a). Because of this, communication is a process that transcends the realm of idea exchange and is deeply related with an individual's culture and identity.

Intercultural and transdisciplinary abilities, like the ones described by the Partnership for 21st Century Skills, require students to be fully aware of the communicational dimensions involved when individuals of diverse cultural and disciplinary backgrounds interact. To help students achieve this awareness, a theoretical framework is required for navigating a process that would otherwise remain obscure and difficult to understand. Vygotsky's ideas regarding the social formation of the mind (1978) and Hofstede's conception of culture as a "collective programming of the human mind" (1981) offer a starting point for said purpose by broadening our understanding of communication as a socially and culturally situated process.

Table 3-1: Theoretical Framework

Culture		
As noted by Hofstede, culture corresponds to “the collective programming of the human mind that distinguishes the members of one human group from those of another” (1981). Individuals therefore live their lives not as isolated beings, but as members of specific collective communities determined by their context and social interactions.		
Communication	Representation and Modeling	Partial Observation
Culturally situated individuals face the need to interact with their social environment using and acquiring language and speech as a means of communication with others (Vygotsky, 1994b). Said language depends on the particular context of the individual, and as noted by Vygotsky, people do not invent their own language but “find the words in a ready-made state, fixed to ready made things” (Vygotsky, 1994a). Assimilating language and the links between objects and words enables an external speech dependent on social interactions. Therefore, language is initially a tool taken from the environment that configures naming and referencing abilities enabling two-way communication between context and individual.	According to Vygotsky, because of the external speech enabled by communication, we gradually learn how to use language for our own inner thinking process –inner speech (1994a). The connection between speech and thought takes language beyond the realm of external interaction with the environment and becomes a key structural component of an individual’s thought process, logical reasoning and the formation of concepts. Transcending the link between words and context, the use of language evolves into a much richer process of representation and modeling, understood as the process where individuals make sense of the world around them.	Because of the different understandings of the world we live in, which originate from the individual’s representation and modeling process, life is seen through multiple points of view. Therefore, each individual has a partial observation of the richness of human experience and any given understanding of reality is only one within multiple others. Through this differentiation process human beings configure complex and intricate webs of multiple individuals with different knowledge, emotions, paradigms and values. A person’s partial observation of the world may be understood as his/her mental model, the prism through which external and internal events are understood and analyzed.

A Vygotskian reading of Hofstede’s ideas has been proposed by other authors by noting that “‘collective programming’ is not to be understood as an external imposition but an active social composition in which the particular individual plays the protagonist” (Vatrapu and Suthers, 2007) . Based on these propositions, a conceptual framework is presented and explained in Table 3-1. Culture is the pivotal

concept of the framework, providing the general context and backdrop for a process that begins through social interaction and communication, and leads to the construction of an individual's inner speech and (partial) observation of the world around him/her. The framework enables the understanding of social context and cultural background as relevant components of the process of communication. It also suggests the double nature of the link between them, because cultural and social environment influences communication while at the same time, communication is a shaping element of said environment. What all of this configures is a broader understanding of communication and social interaction, where message construction and exchange is the cornerstone for cultural diversity and individual identity.

3.3 An undergraduate course based on the theoretical framework

Based on the general concepts from the theoretical framework introduced in Section 2, a semester long third year undergraduate course was designed and implemented within the context of an Information Technology program. As noted by the ACM/IEEE Computer Society Curriculum Guidelines for Undergraduate Programs in Information Technology (Association for Computing Machinery and IEEE Computer Society, 2008) and the ABET Criteria For Accrediting Computing Programs (ABET Computing Accreditation Commission, 2009), a required program outcome (understood as an ability that the program enables students to achieve by the time of graduation) is the “ability to communicate effectively with a range of audiences”. Because of this, addressing intercultural and interdisciplinary issues is a need within these programs.

3.3.1 Objectives

The course was designed to give students the ability to understand and critically analyze the ways in which our day-to-day lives are built, modeled and influenced by cultural contexts and social contact. By doing this, students would be able to see the broader picture involved in human interactions and understand communication not

only as the punctual exchange of information between people but also as the fruitful encounter of different cultural backgrounds and life experiences. Embracing this phenomenon would better prepare students to develop and understand the key communicational competences that effective interdisciplinary and transcultural communication requires.

3.3.2 Structure

The course was designed using the theoretical framework presented in Table 3-1 that was implemented through the conceptual areas, key concepts and topics of discussion presented in Table 3-2. The main bibliographical resources were Hofstede and Vygotsky. For each conceptual area (corresponding to the main concepts of the theoretical framework) key concepts were determined and then topics of discussion to be presented to the class were established.

3.3.3 Methodology

Students had one, 3-hour lecture session per week where each conceptual area was presented along with the key concepts and their definitions. In-class discussions, specified in Table 3-2, were conducted based on multiple examples from various sources (books, magazines, newspapers, movies, blogs, podcasts, videos, etc). An atmosphere of constant interaction and participation was nurtured by allowing students to freely comment on the examples seen in class and also by encouraging students to present their own examples and testimonies.

Along with the weekly lectures, students had to work in groups throughout the semester, analyzing a “human organization” of their choice that was going through an information technology adoption process. For each conceptual area, groups had to analyze the organization they were working with, according to the concepts seen in class and present their findings in different media languages (video, podcast, mind map, blog, online wiki, etc). This group project served a double purpose; it allowed

students to transfer the contents of the course into a real life scenario and also, because of the medial languages used, it enabled students to further understand how message construction works and gave them concrete tools to communicate effectively with others.

3.3.4 Expected outcomes

The course was intended to lead students towards an appropriation of the concepts from the theoretical framework so as to be able to apply them to multiple real life scenarios. Bloom's Revised Taxonomy (Anderson et al., 2001) defines six consecutive cognitive processes of increasing complexity: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating. The first three relate to lower cognitive processes and the last three relate to higher order thinking. Table 3-3 shows the expected outcomes for each stage regarding the concepts from the theoretical framework.

Through the weekly lecture sessions, where key concepts were presented and discussions were held, the first three cognitive processes were addressed. Students were guided through situations and oriented regarding the applicability and use of the conceptual framework. Through the group project, students had to apply higher order thinking by facing unfamiliar situations. No longer sheltered by the guided process followed in class, they had to transfer the concepts from each conceptual area into a real life scenario that was not specially designed as an instructional situation. By having these two separate components, the course enabled students to go through all six of the cognitive processes defined by Bloom, taking the conceptual framework beyond the theoretical understanding of the concepts and appropriating them so as to be able to use them in unfamiliar real life situations.

Table 3-2: Structure of the course: conceptual areas, key concepts and topics of discussion

Conceptual Area	Key Concepts	Topics of Discussion
Culture	<ul style="list-style-type: none"> • Culture • Community 	<ul style="list-style-type: none"> • Where can you identify traces of a “collective programming of the human mind”? • Analyze a broad set of variables that are culturally determined; which are explicit (like language) and which are implicit (like the relation to death)? • How does culture determine our sense of community? How does our culture distinguish us from those who belong to other cultures?
Communication	<ul style="list-style-type: none"> • Message Construction • Signs and Language • Effective Communication 	<ul style="list-style-type: none"> • How are messages built and how do they work? Consider semiotic approaches. • How do medial languages influence the structure and effectiveness of messages? How do meaning and message change when translating between different codes and languages? • What is the process of communication? What happens when a sender and a receiver interact? • In what ways does language, both verbal and non-verbal, expand and limit our communication abilities? • How do objects, the relations established between them and the context in which this is done mediate our communication ability?
Representation and Modeling	<ul style="list-style-type: none"> • Modeling • Data, Information & Knowledge • Mental Model • Paradigms • Heuristics 	<ul style="list-style-type: none"> • How are representations a way to synthesize reality? Is it true that they are always based on someone’s perception of reality? • How do cultural and social contexts bias perception? • How do we build our mental model? Consider how facts, rules, and paradigms configure our identity. • How do heuristics facilitate the modeling process? • How do models and representations affect the world around us in real life scenarios?
Partial Observation	<ul style="list-style-type: none"> • Diversity • Completeness and Consistency 	<ul style="list-style-type: none"> • Is diversity a basic component of the world we live in? Critically analyze the ways in which gender, age, nationality, culture and other variables configure multiple points of view. • How does completeness and consistency influence the way we understand the world around us? • Is decision-making affected by our points of view and perspectives? Analyze the way others understand the world around them and empathize with their reasoning and partial observation of the world. • How do our limited rationality and the information we have access to fix our understanding of the world we live in? • How does working with experts and transdisciplinary teams enrich our own perspectives and points of view?

Table 3-3: Expected outcomes following Bloom's Revised Taxonomy

Cognitive process	Expected outcome regarding the use of concepts from the theoretical framework when facing interdisciplinary and multicultural scenarios.
Remembering	To be able to recall concepts from each conceptual area.
Understanding	To be able to explain concepts from each conceptual area.
Applying	To be able to use concepts from each conceptual area in familiar situations.
Analyzing	To be able to break information into parts, exploring the relationship between the current situation and past experience. To understand the applicability of the concepts from each conceptual area under unfamiliar situations.
Evaluating	To be able to diagnose the cause of difficulties faced under the current unfamiliar situation, and explain them based on particular concepts from each conceptual area.
Creating	To be able to propose intervention opportunities to overcome the difficulties faced under the current unfamiliar situation, and justify them based on particular concepts from each conceptual area.

3.4 Assessment of the experience

When assessing the course's impact on students, it was necessary to measure to what extent they had appropriated the theoretical framework. A pre and post test was applied where students were presented with 3 online videos and asked open-ended questions (Table 3-4). The videos used described general situations that were polysemic and could be understood differently, according to the student's particular interests and disciplinary background. The questions, which had no correct or incorrect answers, asked students to describe general aspects of the situations presented to them, and did not focus particularly on any of the course's concepts.

Questions were meant to guide students towards a deep analysis of the situations being presented but without forcing the use of any of the course's concepts.

The idea was to empirically measure the use of the concepts presented throughout the course, and how these changed students' capacity to observe, diagnose and intervene in situations involving multiple cultures and disciplines. Evaluating how concepts naturally appeared in the students' answers reflected how these had become structural components of the students' inner speech, aiding in the understanding of the world around him/her.

Table 3-4: Pre and Post-Test used to assess the impact of the course.

Video	Main Conceptual Area Involved	Questions
Orchestra interpreting 4'33'' by John Cage.	Communication	Does the musical piece have any value? What transcendence does it have? Is the composer of the piece an artist? Is there a message in the piece? Do we understand it? Why does the audience applaud at the end?
A scientist is denied access to a nuclear lab to prevent an accident, because he does not have his ID with him .	Representation and Modeling	What problems can you identify in the video? Why do these problems happen? What solution do you propose?
Public service announcement from Japan .	Partial Observation	What is the ad's message? Who is it addressed to? If you had to transmit this message to someone, how would you do it?

The test was applied twice throughout the semester. The first time, the test was applied as soon as students enrolled in the course and before classes began, therefore students knew nothing about the contents of the course (pre-test). The second time, the test was applied at the end of the semester, once all evaluations and classes had ended (post-test).

Expert evaluators, using the key concepts and discussion topics from Table 3-2 as the observation form, read each of the students' answers and determined the presence and use of the concepts. For each of the 4 conceptual areas presented in Table 3-2, each answer was classified into one of the following categories:

- "Concepts from the conceptual area are explicitly present and central to the ideas presented in the student's answer". (3 points)
- "Concepts from the conceptual area are explicitly present but peripheral to the ideas presented in the student's answer". (2 points)
- "Concepts from the conceptual area are insinuated within the student's answer". (1 point)
- "Concepts from the conceptual area are absent". (0 points)

Results of this study, conducted with 62 students, show statistically significant differences between pre and post tests for all the conceptual areas defined in Table 3-2. The numerical values assigned to each category allow analyzing the variation between pre and post tests. Table 3-5 shows the growth factor, between pre and post tests, of the use and presence of concepts from each conceptual area.

Table 3-5: Growth factor of concept use and presence between pre and post test. (Sample Size: 62 Students)

	Growth Factor	<i>p</i>
Culture	1.591	0,00116
Communication	2,566	1,95E-15
Representation and Modeling	3,301	6,25E-14
Partial Observation	3,178	1,43E-08

3.5 Analysis and findings

Results show that for each of the concepts present in the theoretical framework, students were able to appropriate the concepts presented to them and transfer what they learned to different scenarios. Pre and post tests show significant growth in the students' ability to identify cultural differences and interdisciplinary difficulties based on the model used in the course. Culture shows a smaller growth between pre and post tests, in proportion to the other variables. This can be explained because, when first enrolled in the course, students know more about culture than they do about the other variables, suggesting the other variables are more novel to them and therefore they show a greater increase between pre and post test evaluations.

Evaluators commented on the fact that most of the pre test answers were very restrictive and judgmental (for example, in pre-tests most students considered that 4'33'' by John Cage was not a work of art and was not interesting) while post-test answers were more flexible and many students warned the reader that their answers reflected their own opinion and were not absolute truths. This suggests that

throughout the semester, students developed a greater openness to accept the fact that their opinion was partial and that others might think differently.

To further assess the impact of the course, a year later students were contacted and asked to answer the following questions:

1. Do you think the course helped you better understand the difficulties you face when communicating with people from backgrounds different than yours?
2. If you had to add a tagline to this course, what would it be?

Regarding question 1, 78.7% of the 47 students that participated in the survey answered positively, enunciating ways in which the course had helped them understand interdisciplinary and multicultural issues, 12.76% gave arguments both for and against, and 8.51% considered the course had not helped them achieve said objective. Answers show that a year later, the vast majority of students have appropriated the model used throughout the course while a smaller group was not able to do so (Table 3-6 shows direct quotations from the students' answers).

Asking students to create a tagline for the course forced them to condense what they thought was its main idea into a single phrase (Table 3-7). As with the first question, results show a minority of students that consider the course useless.

Table 3-6: Excerpts from opinions given by students a year after enrolling in the course.

Do you think the course helped you better understand the difficulties you face when communicating with people from backgrounds different than yours?	
Positive	"...It showed me that unexpected behaviors and reactions by people are not random but actually have logical explanations..."
	"...It gave me a model to understand things that one intuitively knows, but does not know how to express..."
	"...It shows students that ideas that we think are unique and unbeatable may not be so..."
	"Yes. Throughout college we have been taught an "algorithm" that slowly defines the way in which we solve problems, face different situations and interact with people. This course shows students that, despite the fact that said "algorithm" is good, there are many other ways of facing diverse situations and relating with other people... And in many cases, they are better than ours!"
	"It was useful not only within computer science but on a broader level. The course gives tools to understand and appropriate the way we communicate and learn."
	"As engineers, we tend to over credit ourselves and think we are always right, underestimating other opinions. This course teaches you a fundamental value: a global understanding of the fact that the world has as many points of view as people observing, and that they are all valid. (...) This course opens a window towards bridging the gap between us as individuals, and the rest of the world."
	"Although one can communicate effectively with people without going through this course, it is very useful to have a formal education and a model to understand how it actually works."
	"...It helped me understand I can never say I am 100% right, because many people may see things differently than I do."
	"...It showed me that computer science goes way beyond technical knowledge (i.e. Programming skills)."
	"Yes. It made me realize the biases under which I live my day to day life."
Negative	"I cannot see how this course is useful; despite being very interesting, it does not go beyond being a compendium of knowledge about the human being."
	"No. I believe that the things taught in this course cannot be taught in a course."

Table 3-7: Taglines for the course created by students a year after enrolling in it.

If you had to add a tagline to this course, what would it be?	
Positive	The solution is not always visible from where you are standing.
	An odd course, very weird, therefore... useful.
	Abilities and knowledge that everyone should have, and not everyone has.
	You are what you know
	Let's see the world, but let's really see it.
	A course about concepts that will give you tags to add to things you might already know but will now be able to categorize and organize.
	The only truth is that there is no absolute truth.
	We don't see the world how it is, but rather how we are.
	A different way to see things.
	We are the product of our history.
Negative	A total waste of time.

3.6 Discussion

Results suggest that the way that the course makes Vygotsky's and Hostede's ideas operative, effectively empowered students to better understand multicultural and interdisciplinary scenarios. Because of this, based on the proposed theoretical framework, it is possible to construct a model that serves as a diagnostic and intervention tool for broadening our understanding of how communication, social interaction and inner speech construction are culturally situated processes. Figure 3-1 shows said model, where culture occupies the central position and a three-concept cycle surrounds it. The cycle explains how human beings, by appropriating language from their environment, develop a prism through which they make sense of the world around them. Said cycle can be read in any order because of its repetitive and reinforcing nature. The four concepts are directly obtained from the theoretical framework presented and explained in Table 3-1.

When facing intercultural and transdisciplinary scenarios, the model might be used as a quick diagnostic tool for understanding difficulties and finding intervention opportunities –or an action plan- to solve them. With this purpose in mind, Annex A provides a cut-out diagram that combines Figure 3-1 and Table 3-1 allowing the ubiquitous use of the model without the need to revisit this text.

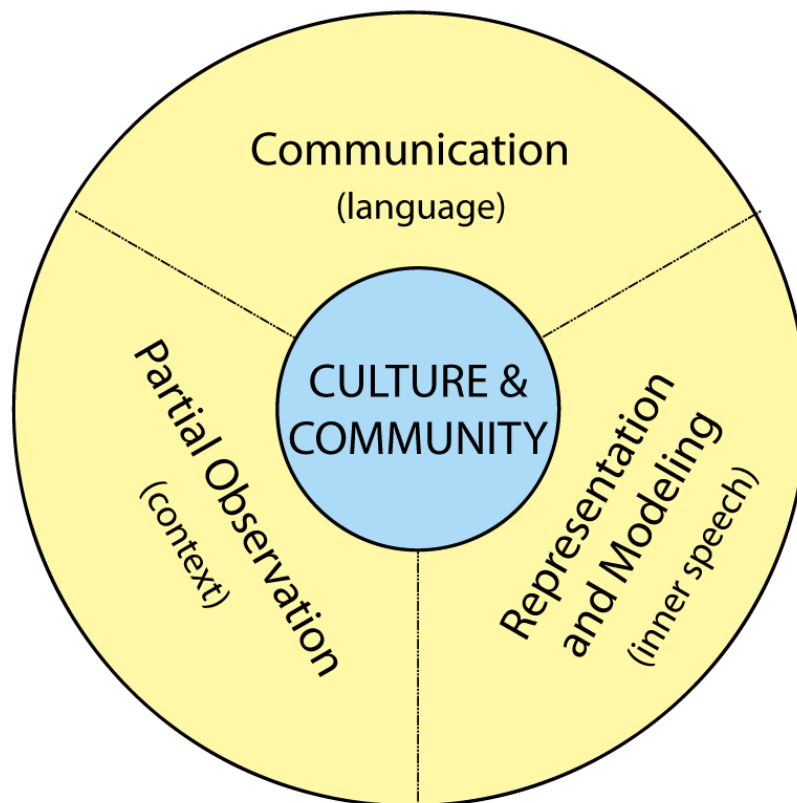


Figure 3-1: Operative model uniting Vygotsky's and Hofstede's ideas.

3.7 Conclusions

The theoretical framework presented in this paper, broadens the way that communication within multicultural and interdisciplinary teams is generally understood. Conceiving an interconnected and reinforced path between communication, the way we represent and model the world around us, and the configuration of particular points of view in each individual, enables a global

understanding of human experience that goes beyond mere technical abilities and considers our cultural identities and community values.

Professionals that broadly develop the ability to communicate effectively with a range of audiences and understand how cultural biases and diversity are involved in the process are essential assets for any company or project facing the challenges imposed by today's transculturalized world. Learning to live and work together requires us to embrace our differences and fully understand the world we live in. This will not happen unless we dedicate time and effort to doing so, therefore, curricular planning and design must address this issue in novel ways and challenge students to see the world... but really see it.

The experience of creating and teaching the course presented in this paper shows that it is possible to prepare students to "communicate effectively with a range of audiences", and that a course may address this ability directly (rather than exclusively being a secondary outcome of other courses). Although it is true that said ability must be present throughout the course of any program, the advantages of having a dedicated class is to be able to show students a broader picture regarding the way we communicate and interact with others, therefore, empowering students with additional understanding of the difficulties they will face under today's working scenarios.

Because of the fact that the experience presented in this paper was conducted within an Information Technology program, future work must be done to show how students from other disciplines receive a course that follows the presented model. Because of the fact that the topics of discussion presented in Table 3-2 can be adapted to multiple contexts, the experience shown in this paper should be replicable across different types of programs in different locations and cultures. The way that the course is implemented in different scenarios will depend largely on the place, the students and its culture, but despite the fact that the syllabus and methodology used in a course like this might be drastically different across the world, the outcomes,

abilities and competences that students acquire should remain the same. One question remains unanswered: as Table 3-6 and 3-7 show, a minority of students was not able to understand the importance of appropriating the concepts presented throughout the course. This group of students is a reflection of the diversity of reactions that the issues being presented provoke. It may be possible that these students do not accept the idea of a “multi-versal” (non universal) interpretation of the world we live in. Because of this, future strategies to motivate, respect and work with this group must be developed.

Extensive opportunities for future work can be found in new applications of the model presented in the discussion section of this paper (for example, assessing how it can be applied beyond educational purposes and used as a diagnostic and intervention tool when facing difficulties related to interdisciplinary and multicultural communication). Field studies where the model is used as a diagnostic and intervention tool across a broad set of scenarios to validate its applicability to real life situations are proposed as future work.

4. NOT EVERYONE AGREES WITH ME, A FOREWORD NOTE

About a month before handing in the final draft of this thesis, I presented a preliminary version of it to other graduate students at the Department of Computer Science. One of the students there commented: “Not because something is written in Spanish does it become a literature thesis, and not because something is written at the Department of Computer Science does it become a thesis about computers”. He was really angry at the fact that my thesis lacked what he called “a computational background”. The easiest way out of this controversy is to say “Yeah, he is right, but that’s precisely my point: my thesis is interdisciplinary in nature”. Although I like that argument and it’s completely consistent with the work presented in this document, I completely disagree with it, as I believe this thesis is strongly rooted within computer science and software engineering. Intercultural and multidisciplinary communication is a fundamental process of requirement analysis when developing computational systems and when leading information technology adoption processes. It is not uncommon to find castles in the air where developers have ignored the user or mistakenly understood their needs. The model presented in the final section of chapter three of this document is a powerful tool for understanding how cultural and disciplinary differences can sabotage even the simplest projects. Wherever technology is involved, uniquely culturally and socially situated users are present. Understanding their requirements and developing solutions that fit their needs goes way beyond technical expertise. Future work must be conducted to validate the model within specific software development projects and also educational practices must be re-engineered so as to make students aware of the fact that “soft skills” are not as soft as they seem.

This thesis was not written over a 6 month period; it started more than 6 years ago when struggling to find a path towards my artistic interests. The journey followed is as important as the final research conducted. This was not an 8-hour-a-day job but a lifestyle; breaking and questioning the established rules has opened a broad range of opportunities that have somehow configured the way I face life today. I would like readers to consider “Indisciplinary Interactions: communicating across disciplinary and cultural boundaries” more as a travel log or journal than an actual thesis. By doing this, they will understand

how deeply embedded these ideas are within me and how urgently I advocate for an interdisciplinary system of operative knowledge.

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ANNEX A : MODEL

