INCLUSIVE INTERFACES

QAZI FAZLI AZEEM

Massachusetts College of Art and Design
MFA Communication Design
Dynamic Media Institute
2014

Title Page Image:

Alchemical Jackal. Qazi Fazli Azeem. 2013.
Inspired from the *Painted Jackal* short story by Rumi.

Inclusive Interfaces

Master of Fine Art — Communication Design 2014
Dynamic Media Institute
Massachusetts College of Art and Design
Qazi Fazli Azeem

By the Author: _____

Qazi Fazli Azeem

Dynamic Media Institute

May 20, 2014

Certified By: _____

Brian Lucid

Professor of Design

Thesis Studio Advisor

Certified By: _____

Joseph Quackenbush

Associate Professor of Design

Thesis Seminar Advisor

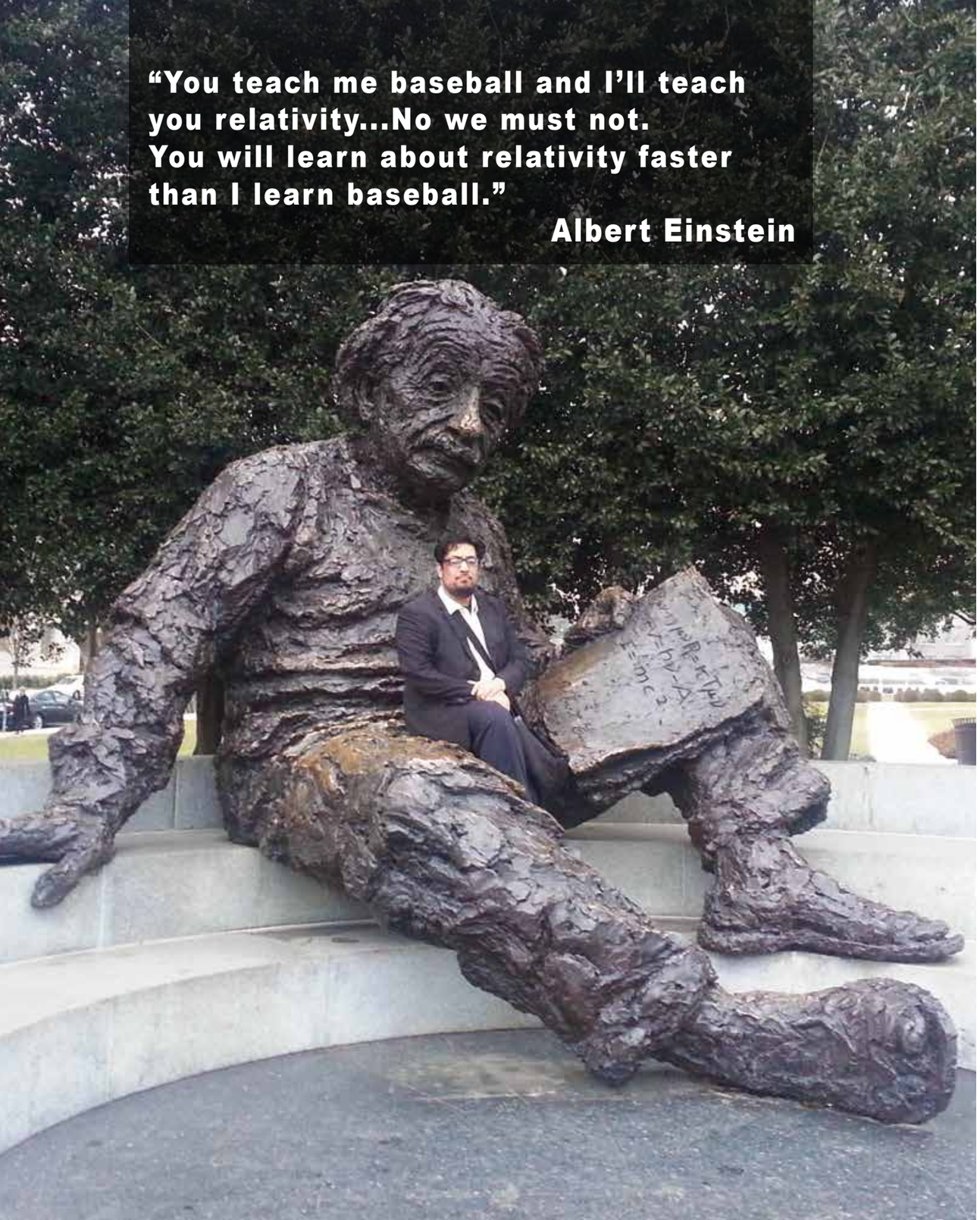
Accepted By: _____

Jan Kubasiewicz

Professor of Design

Coordinator of Graduate Design Program

Submitted to the Dynamic Media Institute in partial fulfilment for the degree of
Master of Fine Art — Communication Design at the Massachusetts College of Art and Design.
May, 2014.



THESIS ABSTRACT

In 2014, 1 in 68 children have autism spectrum disorders (ASD) according to US data from the Centres for Disease Control. Occurring in all groups (race, income, geographic), ASD is diagnosed 1 in 42 in boys, which is nearly 5 times higher than in girls (1 in 189). Almost half (46%) of children identified with ASD have average to above average intellectual ability. That’s a 78% increase compared to a decade ago. Based on an increase in diagnoses, we can assume that the numbers will continue to increase over time.

Researchers have found that child prodigies have greater number of autistic traits, particularly with attention to detail. Half of the families of the child prodigies studied reported autism diagnoses in first or second degree relatives, indicating strong links to genetics.

I was aware of savant syndrome and its potential in higher education due to my experiences as an educator, in addition to my role as the South Asian self-advocate for ASD. I knew about magazine and website articles from the US, describing extraordinary abilities and splinter skills such as hyperlexia, perfect pitch, pattern recognition and photographic memory. I wanted to create tools and experiences for neurotypical students, adapted from diverse learning strengths of autistic children with extraordinary abilities. Would these blended, individualized interfaces stimulate neurotypical students to learn effectively and efficiently, in the same way that they help gifted people on the autism spectrum?

In order to answer my researchable question, I created sensory-neutral interface design case studies for learners with ASD, which helped them access digital educational content (online or offline).

These interfaces can also be used by neurotypical learners, providing more tools to access digital resources. Additionally, I created an adaptive experience for both neurotypical as well as autistic learners, inspired by self-directed interest-based learning, a common trait of learners on the autism spectrum.

My case studies and interaction design projects allow greater choices for both educators and students, where few existed before. My goal is to facilitate inclusion by using *dynamic media* technologies that help optimize learning for a greater number of people.

Left: Qazi Fazli Azeem at the Albert Einstein Monument. Washington D.C., Jan 15, 2014.

Centres for Disease Control and Prevention “Autism Spectrum Disorder (ASD) — Data & Statistics.” Division of Birth Defects, National Centre on Birth Defects and Developmental Disabilities. March 24, 2014. Web. Retrieved April 8, 2014. <http://www.cdc.gov/ncbddd/autism/data.html>

CONTENTS

ACKNOWLEDGEMENTS

Thank you to everyone who has been there for me during my journey here to Boston for my MFA. I was inspired by the great people I met here at in the US through my Fulbright experience. I was mentored and advised by some of the most dedicated and talented professionals in the world. I learnt about design, technology, education, and most importantly, about the common threads that bind us all. *Dynamic media* is not only a design discourse, but a way of thinking and being.

A special Thank You for:

My teachers at DMI, Jan Kubasiewicz, Brian Lucid, Joe Quackenbush, Gunta Kaza, Dana Moser, Fred Wolflink, Lou Susi, Zach Kaiser, John Howrey and Gabi Schaffzin.

Thank you to my DMI classmates Fish McGill, Saul Baizman, Sky (Tien-Yun) Huang, Sofie Elana Hodara, Ceren Paydas, Kimberly Maroon, Stephanie Dudzic and Jeremy Sherman.

The DMI Alumni for their support over the past two years: Lou Susi, Maria Stangel, Yael Alkaly, Cindy Bishop, Daniel Buckley, Heather Shaw, Colin Owens, Elaine Froehlich, Kent Millard, Jeff Bartell, Kat Take, Alexander Wang, Alison Kotin and DMI family members Alexander Reben, Vadik Bakman and Pol Pla. Also, MassArt Alumni Unum Babar, Matthew Kushan, Nadia Afghani, Becky Margraf and Nathalie Miebach.

Thank You to my *Curious Learning* group members from the Harvard Graduate School of Education, Aya Jennifer Sakaguchi & Helen Poldsam, and from MIT-Sloan school, Esha Sahai.

Thank You to my Professors at the MIT Media Lab: Mitchel Resnick, Natalie Rusk, Pattie Maes, Joost Bonsen, Ethan Zuckerman, Hal Abelson, Alex 'Sandy' Pentland, Ramesh Raskar, Media Lab Directors Fellow J. Philipp Schmidt and project innovator John Werner (TEDxBeaconStreet).
My classmates at MIT: Srishti Sethi, Abdulrahman Y. Idlbi, Dan Sawada, Sayamindu Dasgupta, Eric Rosenbaum, Zech lung and Veronika Vyushina.

My *Little Drop* group members Jordan Rogoff and Marcelo Giovanni. *Little Sun* creators Olafur Eliasson, Frederik Ottesen and the team at MIT Arts.

Thanks to my Fulbright batch-mates from the Fulbright Pakistan cohort of 2012: Ahmad Usman, Zahra Saleha Ahmad, Amina Rizwan, Tayyaba Razi, Soabah Wasim and State Alumni Maha Yusuf and Komal Faiz.

The Autism community in the US, Stephen Shore, Kathleen Tehrani, Anita Lesko and the friends at AANE — Nisha Narvekar, Eva Mendes and Dania Jekel.

Thanks to Ray Kurzweil, Don Norman, Marvin Minsky, Juan Enriquez, David Kelley, Jaume Plensa, Zandra Rhodes and Jason Pontin for meeting me after their public talks in Boston and Cambridge.

A special thanks to Lynda Weinman (Lynda.com), Salman Khan (Khanacademy.com) and M. Night Shyamalan for their views about the future of education (Through the *Harvard Cyberposium* and the *Harvard Askwith Forums*). Hearing you live and having you answer my questions afterwards gave me insight into becoming a better educator.

Due to my Fulbright status, I was supported by countless people with the US State Department, in particular my IIE adviser Stephanie Sasz and the USEFP team in Pakistan lead by Rita Bruun Akhtar and Saleem Razaque.

A special thanks to Melissa Diamond, Khaula Rizwan, Asma Ansari and Soabah Wasim, for helping me proofread my thesis.

Whatever I am today, is because of the support from my sister Hina, my grandmother Waheeda Ikram, my family, my late parents Fazli Karim Khalil and Arifa Ikram Karim, who encouraged my ambition to make the world a better place for all of us.

Fazli Azeem. May 20, 2014









INTRODUCTION

Early-Learning Challenges and Interventions

My ideas and perspectives emerged from my early learning challenges. My lack of participation in common group activities (such as watching sports) was a result of being "different" (being on the autism spectrum) while growing up in Pakistan, a developing country. I did not like loud noises, which resulted in my staying away from family and friends watching cricket on the television, closing my ears as they cheered occasionally. I felt uncomfortable drinking tea, as that meant sitting down, making eye contact with strangers and partaking in social conversation for hours. Pakistan and South Asia rewards conformity— groupthink and similarity in political ideas. McDonald's advertisements in the US portray an individual enjoying his happy meal, saying "I'm lovin' it", a stark difference to Pakistan's McDonald's advertisement showing a large family with many young children (as well as grandparents) enjoying a group meal together.

In the later part of 2006, I became the first person with Asperger's syndrome (a form of autism spectrum disorder) identified in Pakistan's print and broadcast media. It was only then that I started understanding and unravelling many of my life's challenges, particularly in the different ways I communicated and learned.

My earliest memories are of toys, particularly action figures that I used to delight in taking apart, to see how they were built. In some cases, I could not put them back together since their rubber, plastic and metal joints were not designed to be broken. This enabled me to think about ways to re-join and mix them with parts from other action figures and toys, and in the process of doing so, to make new toys. I used the most common available materials at the age of 4 — tape, paper, glue, rubber bands and soft modelling putty to put them together in new ways.

Reflecting on this behavior, I acknowledge that my large set of freestyle Lego blocks may have influenced this way of thinking, since I saw everything as an element of something bigger, which could be taken apart, reassembled and made into something different. Wherever I could not see a modular system in my toy's joints, I used modelling clay to fill the holes for stability. Japanese Satoshi Tajiri, also on the autism spectrum, remixed sketches of animals when he was a child, growing up to become the game designer for Nintendo's Pokémon game. This remixing, or "bricolage," as referenced by educator Seymour Papert, is how children use creativity to learn, by making artefacts that can be shared. I created new toys for myself by remixing what I was given, a deep idea that would go on to influence me as an educator and a designer.

I thought the same way about remixing behaviors that I exhibited publicly, understanding that certain behaviors would give the impression of credibility and may lead to greater social inclusion (e.g. Talking about subjects of my expertise and wearing formal business clothes).

To gain credibility, I emulated mannerisms, cultural practices and the behavior of educated elders, those whom I perceived as having social respect and clout. I began to reflect on the power of communication as a solution to my personal issues with learning, potentially leading to social inclusion. This was a positive experience for my life as I thought deeply about how I communicated with others.

In my youth, I did not have any friends because of my inability to hold conversations outside the sphere of my interests, a common feature for those on the autism spectrum. This gave me ample time to read comic books and watch science fiction on television. I grew up watching Star Trek, which portrayed diverse and imperfect people working together for a greater purpose. Reading science fiction novels by Jules Verne and Isaac Asimov allowed me to dream about a world in which I could improve my imperfections through technology. I used my creativity, making 'tools' out of clay, toys and plastic, imagining what technologies I could create to make myself better than others.

Remixing toys allowed me to try the same with books and text. I was an early reader and could connect words with images, through heavy rote learning and episodic memory. This developed into gifted reading ability (hyperlexia), although I did not understand the social use of language until in my teens, exhibiting echolalia (repetitive speech) in my formative years.

Mapping words to images, I was soon reading comics and then comic strips inside newspapers. An incremental approach helped me take the same logic to learning speech, conversation and nearly everything that I have taught myself over the years.

Access to Technology

Having grown up in Pakistan I was fortunate to have had access to computers, both in school and at home. Computer games honed my ability with the keyboard and mouse, increasing my typing speed and hand-eye coordination with the mouse, although both of these felt unnatural and took time getting used to.

Viewing software-based learning CDs (from Lynda.com) on the computer by accident (as I bought them instead of computer games ones day) made me realize the potential of self-experiential learning, where I was able to learn faster than I did at my school.

In the summer of 1999, an internship at IBM Pakistan gave me access to early adopters of technology. I helped hundreds of corporate executives learn to use their IBM Internet accounts by troubleshooting technical problems. Tired of repeating myself on the phone, I made a list of the 8 common problems users were calling about, and made them available on the call-in menu. My solution was to provide options to the user, who could then use their own judgment and help themselves faster than I could advise them. From this I determined that empowering learners is a strong motivational tool for longer engagement and independence.

By 2002, I had completed two years of undergraduate computer science at the University of Karachi. I later dropped out due to learning challenges in the advanced mathematics courses. The formal learning inside a university environment gave me just enough structure to continue learning on my own, when I was not able to learn further in that environment.

I used skill-based training videos from Lynda.com, transforming the way I initially taught myself. I picked up skills on Adobe design software, learning at my own speed and on my own time. By 2008, my learning speed and interest in computer graphics led me to a career, teaching design skills at Karachi's Indus Valley School of Art and Architecture, Pakistan's leading, private art and design College.

My teaching method was inspired by techniques that I had used on myself, years earlier. I kept my lessons modular, practical, visual, incremental and logical. After a decade of freelance design work I had observed learning from different angles. This motivated me to become a fulltime educator in 2009, giving students choices that I had not had myself.

My Transition from Student to Educator

A major personal goal in my life had been to understand myself better, by finding others like me, individuals on the autism spectrum. This motivated me to come forward as a South Asian self-advocate for ASD, a self-appointed non-profit title I have held since 2006. I started advising parents and special educators online about my personal interventions and learning techniques. I travelled to many countries in the region, giving presentations and training special educators.

I saw a common theme emerge, related to how children on the autism spectrum learn. Modular therapies such as applied behavior analysis (ABA), structured teaching (TEACCH) and other educational methods are all based on structured ways of learning, taking small skills and connections and generalizing. People with ASD do not understand humour or the social context of language, living life through logical 'formulas' that they can trust.

This may be why those who are on the spectrum cannot function when their 'routine' or 'formula for what to expect next' is broken, hence the tantrums, breakdowns and anxiety overload.

As the Internet became cheaper to access, the demand for computer-based learning made me think of a career as a computer educator. I joined the Newport's Institute of Communications and Economics at Karachi, graduating in 2006 as one of the first multimedia undergrads in Pakistan.

My first job was as a design software trainer at the Arena Multimedia training centres in Karachi, training thousands of designers until the summer of 2009.

Dynamic Media as 'Evolution'

In 2013, TED speaker Juan Enriquez and author of the TED book *Homo Evolutis* wrote about the human species having the ability to guide and choose their evolutionary path. Walking inside the MIT media lab during February 2014, I saw a cardboard insect labelled with a quote from the Media Lab Director Joi Ito about the Internet, that 'it's a living, evolving organism.' Marshal McLuhan's reference to us being part of the medium in his book *The Medium is the Massage* is a perspective that connects with the role of technology as media, influencing not only our minds and opinions, but directing our own evolutionary growth.

Advances in technology are now intersecting with Biology, an example being memory manipulation by Professor Ed Boyden's *Opto-Genetics* research at the MIT Media Lab. These jumps in technology present massive implications on the future of learning.

Technology has allowed us to overcome natural selection by using adaptive tools for inclusion. I see *dynamic media*'s role in creating inclusive educational experiences. If education is the one factor that allows success and survival in the modern world, technology will allow us to simulate and then attempt to control natural selection, guiding our own evolution. We can improve upon nature by choosing to guide our destiny.

Top: Teaching character animation to high-school students at the CAS School in Karachi, Pakistan. 2010
MIddle: Researching *dynamic media* at the Massachusetts College of Art and Design in Boston. 2013.
Bottom: Supervising a research group for Google Glass at the MIT Media Lab in Cambridge. 2013.

Dynamic Media for Inclusive Education

In the last 400 years, there have been great changes in the world through democracy, science, technology and medicine. Most areas of formal education are still premised around the rote learning of school work, where there is often only one way to answer a question and the subject is not an integral part of our culture.

Dissent is the word dictatorial government's use for those who have different and often better ways of doing things, which may be in opposition to what a ruling political party or ideology propagates. In Pakistan's school system I experienced that propagation of non-inclusive education and punishment of creative, independent thought with lower grades. On many occasions, I was seen as a troublemaker for questioning educational practices in organizations that I taught in. Is special education (as opposed to inclusive education) a historical attempt to separate those who conform from those who don't? Children need to be 'exposed' to diverse materials and social situations, having the choice of turning interest-based learning into skill-based careers.

The failure of television to live up to its potential as the greatest teaching machine ever created may result from one-way interactions, where we cannot engage with the teacher or co-learners. This societal dynamic was broken by the Internet, through YouTube, blogs, wikis and discussion forums such as *Reddit*. The computer and smartphone have quickly replaced the dumb TV set. McLuhan's analogy from his book *The Medium is the Massage*, infers the old media influencing the content and values of the newer medium. This can be seen in the proliferation of television content such as cooking shows, weather shows…into content for our smartphone screens.

The emergence of casual, free online learning opportunities (i.e. the massive open online courses—MOOCs and hobbyist websites such as Instructables.com) are examples of *dynamic media* that are leading the educational revolution. Smartphone and tablet screens are becoming the new normal, with apps becoming primary access points for personalized, just-in-time learning.

The best *dynamic media* will be the tools and apparatus that enable us to learn, make mistakes, interact with the content and re-contextualize, re-mix and share what we have learned.

Andrew A. Zucker, senior education research scientist at the Concord Consortium writes in his book *Transforming Schools with Technology: How Smart Use of Digital Tools Helps Achieve Six Key Education Goals* about the use of computers and digital tools to enhance teaching and learning in American schools. He writes about educational goals for technology such as making schools engaging and relevant, training high-quality educators, reaching all students and improving the ways in which we measure learning. Zucker demonstrated that schools are being transformed and that digital tools digital tools are much as necessity for students and teachers as for school administrators.

University education needs to be an inclusive educational experience that would accommodate a greater number of students with alternative and non-traditional ways of learning. For me, the idea of inclusive education *(Mitchell 2012)* equals people with special needs going to their community educational space, in the same class setting with non-disabled peers of the same age. Inclusive education enhances the life of a person with intellectual disability and teaches those without a disability how to accept, understand and support others.

My answer to the challenge of inclusive education is a greater choice of interfaces, which allow many ways of accessing digital content. The educational content would be free *Open Educational Resources* (OERs) based on learner interest, acquired either by an online search or through recommendations from an educator. Established OER online platforms such as KhanAcademy.com are being used to increasingly augment personalized learning all over the world. CAST, a non-profit research and development organization is working to expand learning opportunities for all individuals through *universal design for learning (UDL)*, a design process that promotes inclusion by removing barriers for personalized learning.

Summary of Projects

My *Numerology visualization* project (see page 55) allowed me to reorient myself, reimagining my world view in relation to others, converting an analog process into a digital equivalent. My *Perfect Customer* project (see page 58) changed and evolved rapidly, as I tried many interaction-design technologies, eventually becoming a hands-free interactive project using the Microsoft *Kinect* sensor. *Little Drop* was my first group project (see page 63), where I worked on the form and function of a conceptual water purification device, a product interface different from my previous design work.

Inspired by my work as an educator, I started designing for screen-based devices, commonly available to college students in the US and in Pakistan. My *Inclusive Interface* series of prototypes (see page 67-75) were augmentations and visions of what existing MOOC-based content delivery interfaces could become. I designed an adaptive video player with accessibility accommodations for sight (font size), hearing sensitivity (volume) as well as concentration (thumbnail-based short video content). I included an adaptive testing system that learners could choose from, with timer feedback based on colors, vibration or shapes, instead of just a numerical countdown. The last component of the *Inclusive Interface* is a gestural control for browsing through open educational resources and videos, using the *Leapmotion* hands-free controller, for people who do not want tactile feedback (e.g. sensory overload for some learners with ASD).

Aware of the role of spatial memory and perception among gifted learners, I created a prototype, *Spatial Learning*. This was a virtual learning environment with educational content being accessed in 3D (See page 76). I continued designing for screen-based interfaces through my early app designs for mobile learning on the smart phone, using the device as a map, virtual classroom and as a replacement for the teacher. My *Curious Learning* group project (see page 81) was a culmination of earlier educational interfaces, where I designed an online environment that would take learning outside the classroom.

Right: Early prototype for *Inclusive Player*, 2013. See page 67.

Overleaf: Painted Jackal, 2012


“If they can’t learn the way we teach,
we teach the way they learn”
– O. Ivar Lovaas

DEFINITION *of Terms*

The nature of my inter-disciplinary research into special needs, interaction-design and education required me to work with technical knowledge. To further explain and clarify the context and my own understanding of the jargon that I used in my writings, I am defining some words, based on widely accepted online sources.

Autism Spectrum Disorders (ASDs)
The Centres for Disease Control and Prevention (CDC) in the US, defines autism spectrum disorders as a group of developmental disabilities that can cause significant social, communication and behavioral challenges. People with ASDs handle information in their brain differently than other people. ASDs are "spectrum disorders." That means ASDs affect each person in different ways, and can range from very mild to severe. People with ASDs share some similar symptoms, such as problems with social interaction. But there are differences in when the symptoms start, how severe they are, and the exact nature of the symptoms.

Diagnosis of Autism
Diagnosing ASDs can be difficult since there is no medical test, like a blood test, to diagnose the disorders. Doctors look at the child's behavior and development to make a diagnosis. ASDs can sometimes be detected at 18 months or younger. By age 2, a diagnosis by an experienced professional can be considered very reliable. However, many children do not receive a final diagnosis until much older. This delay means that children with an ASD might not get the early intervention that they need.

Treatment of Autism
There is currently no cure for ASDs. However, research shows that early intervention treatment services can greatly improve a child's development. Early intervention services help children from birth to 3 years old (36 months) learn important skills. Services can include therapy to help the child talk, walk, and interact with others. The Individuals with Disabilities Education Act (IDEA) says that children under the age of 3 years (36 months) who are at risk of having developmental delays may be eligible for services. Treatment for particular symptoms, such as speech therapy for language delays, often does not need to wait for a formal ASD diagnosis.

Savant Syndrome
This (gifted ability) is a rare condition in which persons with serious developmental disabilities, including autism, have some extraordinary abilities. As many as one in ten persons with Autism have such remarkable abilities such as hyperlexia, perfect pitch, pattern recognition and calendar calculation, commonly referred to as splinter skills. Savant syndrome can occur in other developmental disabilities or through brain injury, but is more frequently associated with people on the autism spectrum.

Neurotypical
Not displaying autistic or other neurologically atypical patterns of thought or behavior, i.e. non-autistic.

Hyperlexia
This is a gifted reading ability in very young children, overlaps with some cases of autism spectrum.

Open Educational Resources (OERs)
These are teaching and learning materials that are freely available online for everyone to use, whether one is an instructor, student or self-learner. Examples of OER include: full courses, course modules, syllabi, lectures, homework assignments, quizzes, lab and classroom activities, pedagogical materials, games, simulations, and many more resources contained in digital media collections from around the world. The critique about lack of assessment for OER's has been addressed through current educational platforms such as KhanAcademy.org

MOOC
This word is short for Massive Open Online Course, an educational resource resembling a class that has assessment mechanisms and courseware that is all online, usually free to use without admissions criteria and involves hundreds of students or more.

Learning Styles (LS)

These can be defined as the way human beings prefer to concentrate on, store and remember new or difficult information. Learning Style Analysis gives a diagnosis about someone's information intake preferences and provides guidelines or recommendations. Learning style elements can be divided into biological (innate) and learned, conditioned elements, which can change over time. LSA reveals flexibilities, preferences and non-preferences in many different areas, which can significantly contribute to a student's success or failure in learning. Knowledge about certain combinations of preferred LS elements can predict school success or failure and identify underachievement in traditional school systems. Learning Styles can be seen as explaining information 'INPUT' capabilities of human beings. This ability cannot be described as 'intelligence' but as 'idiosyncratic personal style'. When these important aspects are understood and acted upon, teaching strategies become more useful and effective and learning becomes more enjoyable for students who struggle in traditional classrooms.

Multiple Intelligences (MI)

This is a theoretical frame work for defining, understanding, assessing and developing people's different intelligence factors. MI categories intelligence into eight (maybe more) capacities, 'bio-psychological potential' as Howard Gardner describes it and has so far named. These include linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intra-personal and naturalist intelligence. MI covers the ability to reason, calculate and handle logical thinking. Students with similar intelligence factors in the MI framework can have vastly different learning styles, based on their personal biological makeup and their individual conditioning.

Media

This has multiple meanings:

1. Plural form of medium.

2. The main means of mass communication (especially television, radio, newspapers, and the Internet) regarded collectively. In the context of my research, I refer to 2.

Interface

The Oxford English Dictionary gives the following descriptions for the word interface:

1. A point where two systems, subjects, organizations, etc., meet and interact:

2. A surface forming a common boundary between two portions of matter or space, e.g. between two unmixable liquids

3. A device or program enabling a user to communicate with a computer.

4. A device or program for connecting two items of hardware or software so that they can be operated jointly or communicate with each other.

In the context of my research, I refer to both 3 and 4.

Dynamic Media

"Dynamic" has many meanings, some of which are

1. A process or system characterized by constant change, activity, or progress.

2. Relating to forces producing motion. Often contrasted with static.

3. Expressing an action, activity, event, or process.

   In the context of my research, I refer to 1.

Robot

According to the Oxford Online Dictionary, Robot can mean:

1. A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.

2. A machine resembling a human being and able to replicate certain human movements and functions automatically.

In the context of my research, I refer to both 1 and 2, i.e. a physical form replicating certain human functions.

Individualized Educational Plan (IEP)

This is a customized educational plan made by teachers, parents and school administrators for each child. This document is a legal 'contract' that sets out curricular objectives that are adapted and modified to meet the individual student's learning needs.

Common Multiple Intelligences

Visual (spatial): Preference for using pictures, images, and spatial understanding.

Aural (auditory-musical): Preference for using sound and music.

Verbal (linguistic): Preference for using words, both in speech and writing.

Physical (kinesthetic): Preference for using body, hands and sense of touch.

Logical (mathematical): Preference for logic, reasoning and systems.

Social (interpersonal): Preference for learning in groups or with other people.

Solitary (intrapersonal): Preferring to work alone and use self-study.

AUTISM *Spectrum Disorders*

Research on the autism spectrum has seen its share of controversies and public debate. The most widely accepted way to diagnose a person with ASD is through the DSM-5, the Diagnostic and Statistical Manual of Mental Disorders (created by the American Psychiatric Association). This is a standard classification of mental disorders used by mental health professionals in the United States. Currently in its fifth iteration (released during May 2013), the DSM-5 contains a list of diagnostic criteria for every psychiatric disorder recognized by the U.S. healthcare system, becoming the international alternative to the International Statistical Classification of Diseases (ICD) for Autism educators and professionals around the world. This chapter gives an introductory summary of Autism, its history, diagnosis, symptoms and current educational research.

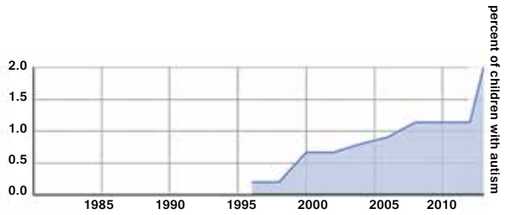
History of the Autism Spectrum: Changes in the (DSM-5)

Swedish paediatrician Hans Asperger used the word 'autistic psychopathy' as early in 1934. American psychiatrist Leo Kanner wrote a highly influential paper in 1943 'Autistic disturbances of affective contact' which brought the disorder in full view of the American public. This was the first published recognition of Autism as a unique syndrome, paying attention to the social and linguistic deficits as well as the child's insistence on sameness. Ironically, this was also the first connection with savant skills and gifted ability. While wrongly confused with childhood schizophrenia, there was no consideration for Autism being a result of genetic factors until 1971.

Hans Asperger lived in Austria and was arrested twice at the University of Vienna for helping educate children with special needs, which went against the policies of the Nazi regime at the time. His writings praise the 'children with autistic psychopathy' that he was studying, as being gifted and intelligent. In 1972, Eric Schopler of Chicago founded TEACCH in North Carolina — Teaching and Education of Autistic and other Communication Handicapped Children, a structured method now used all over the world.

In the 1980s, cognitive theories emerged, such as executive dysfunction and "Theory of Mind", which further went on to explain Autism from the perspective of science. Margaret Bauman and Thomas Kemper did a ground-breaking study in 1985 that for the first time proved that specific neurological abnormalities were associated with Autism. Cells in the hippocampus, subiculum and amygdala were found to be tightly packed and smaller in size.

In 2013, Asperger's Syndrome was removed from the DSM as a separate category and merged with autism spectrum disorders. The generic Pervasive Developmental disorder — not otherwise specified (PDD-NOS), was also removed.



Above: The above graph shows the percentage of children with ASD as a constant increase due to the widening of the autism spectrum.

Left: Photos of my autism awareness work in South Asian countries and around the world. Since 2006, I am Pakistan's first and South Asia's only international self-advocate for the autism spectrum.

DSM-5 Diagnostic Criteria

There are currently no medical tests for Autism and the only way to achieve an accurate diagnosis is by studying the social and communicative behavior of the learner. These are the current behavior evaluation processes for paediatricians and special needs educators to diagnose people on the autism spectrum, as detailed by the American Psychiatric Association. Educators cannot officially provide a diagnosis, this list is given for awareness of the DSM criteria for an autism diagnosis.

A. Limitations with social communication and interaction across many areas, such as:

1. Limited social and emotional reciprocity, from challenges starting conversations and problems with maintaining to-and-fro communication. Limited sharing of interests, emotions, or failure initiating or responding to social interactions.

2. Challenges with nonverbal communication such as body reading and expressing body language, abnormal eye contact during conversations, problems with understanding and using of gestures. This may include a lack of facial expressions, inability to read them as well as recognizing nonverbal communication.

3. Problems creating, sustaining and understanding reciprocity with relationships. This may include problems re-contextualizing and adapting to social situations, problems sharing imaginative play and problems making friends. There may also be a lack of interest in others.

BELOW: This chart is a summary of severity levels in the DSM-5, as defined by the American Psychiatric Association.

Severity level	Social communication	Restricted, repetitive behaviors
Level 3 “Requiring very substantial support”	Serious problems with verbal and nonverbal communication, limitations starting conversations and responding to others. Communication is usually only for basic needs, e.g. asking for food.	Stubborn behavior, problems dealing with changes to routine and repetitive behaviors. Difficulty in concentrating on different things and taking action immediately.
Level 2 “Requiring substantial support”	Problems with verbal and nonverbal social communication, social impairment even though support provided. Does not start conversations, limited response to communication with others. Make simple sentences, having limited interests and odd nonverbal communication.	Stubborn behavior, problems dealing with changes to routine and repetitive behaviors, which happen often and are obvious to the casual observer, interfering with daily life. Difficulty in concentrating on different things and taking action immediately.
Level 1 “Requiring support”	No supports but communication problems are noticeable with limited response to communication with others. Appears to have less interest in social interactions. May be able to speak in full sentences communicate, but problems in to-and-fro conversations. Attempts to make friends are odd and typically unsuccessful.	Stubborn behavior interferes with some functions in life. Difficulty switching between activities, problems with organization and planning cause issues with independent living.

B. Restricted, repetitive patterns of behavior, interests, or activities, as manifested by at least two of the following, currently or by history:

1. Stereotyped or repetitive motor movements, use of objects, or speech (e.g., simple motor stereotypes, lining up toys or flipping objects, echolalia, idiosyncratic phrases).

2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns or verbal nonverbal behavior (e.g., extreme distress at small changes, difficulties with transitions, rigid thinking patterns, greeting rituals, need to take same route or eat food every day).

3. Highly restricted, fixated interests that are abnormal in intensity or focus (e.g., strong attachment to or preoccupation with unusual objects, excessively circumscribed or preservative interest).

4. Hyper or hypo reactivity to sensory input or unusual interests in sensory aspects of the environment (e.g., apparent indifference to pain or temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement).

C. Symptoms must be present in the early developmental period (but may not become fully manifest until social demands exceed limited capacities, or may be masked by learned strategies in later life).

D. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning.

E. These disturbances are not better explained by intellectual disability (intellectual developmental disorder) or global developmental delay. Intellectual disability and autism spectrum disorder frequently co-occur; to make co-morbid diagnoses of autism spectrum disorder and intellectual disability, social communication should be below that expected for general developmental level.

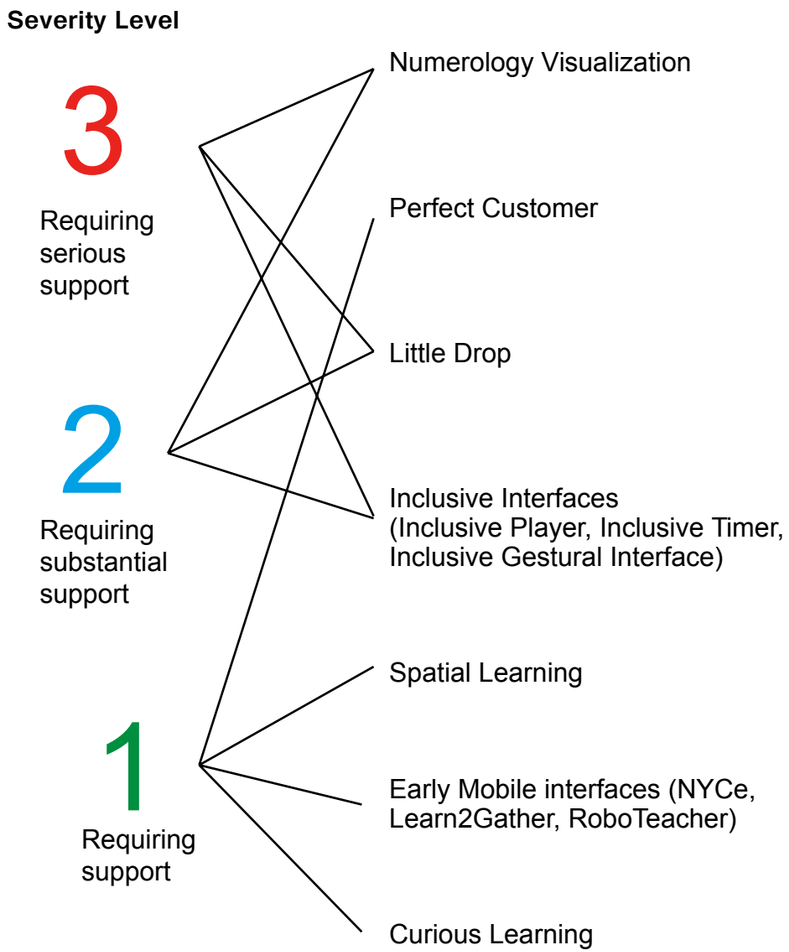
Note: Individuals with a well-established DSM-4 diagnosis of autistic disorder, Asperger’s disorder, or pervasive developmental disorder not otherwise specified should be given the diagnosis of autism spectrum disorder. Individuals who have marked deficits in social communication, but whose symptoms do not otherwise meet criteria for autism spectrum disorder, should be evaluated for social (pragmatic) communication disorder.

Educators should specify if these conditions are also present:

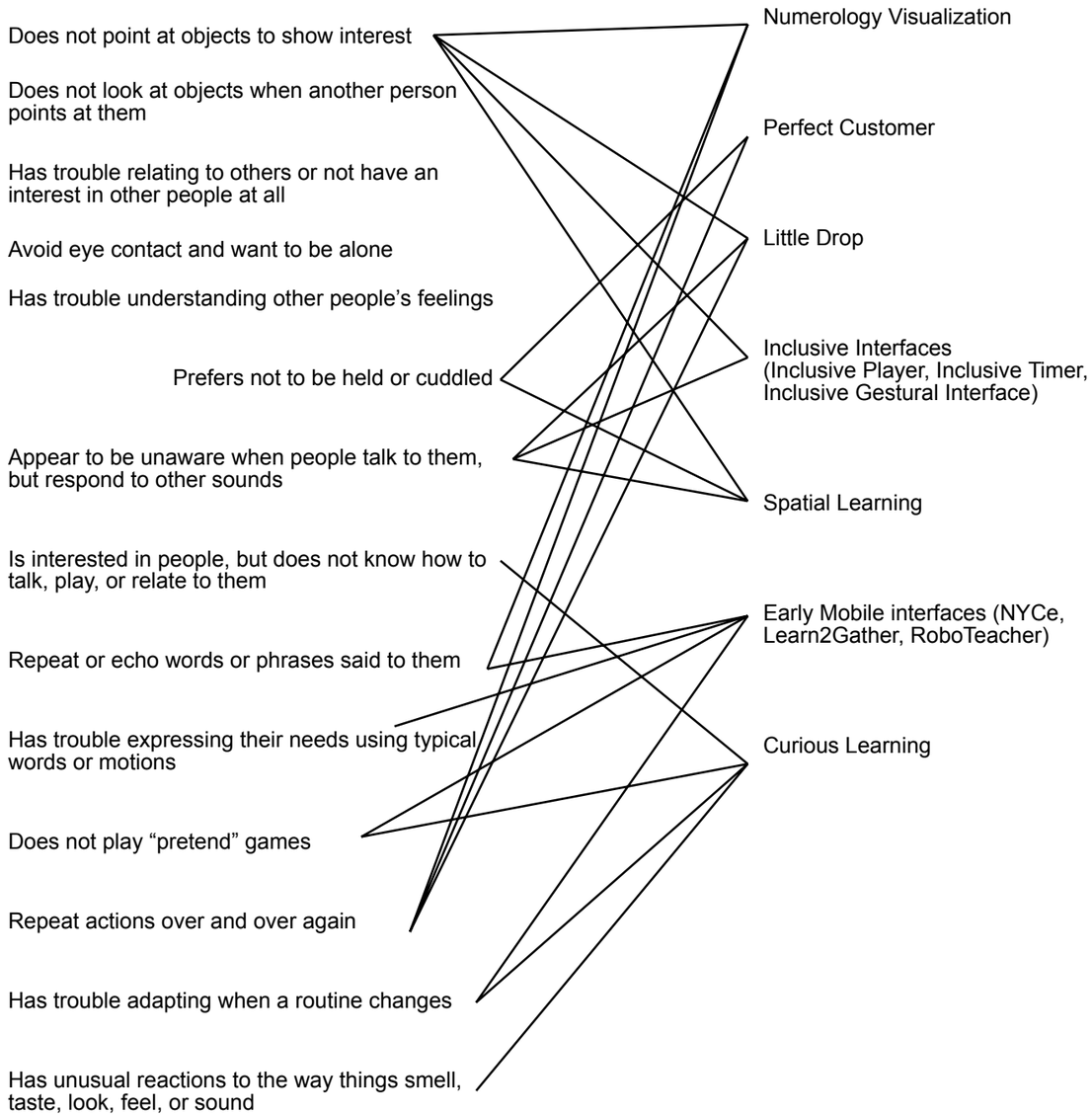
- With or without intellectual impairment
- With or without language impairment
- Medical, genetic or environmental factor present

As of May 2013, psychologists and psychiatrists are using the diagnostic criteria for autism spectrum disorder (ASD) as defined by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Based on severity, many of these map with my interaction design prototypes. These diagrams contain the DSM-5 Diagnostic Criteria mapping severity of symptoms to my educational interface projects.

My Interface Projects Mapped to Severity of Autism Symptoms



My Interface Projects Mapped to Autism Symptoms

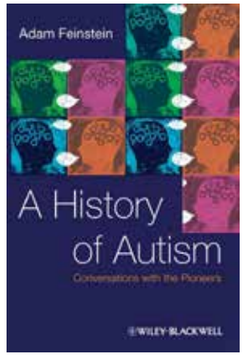


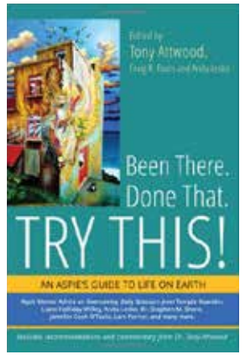
People with ASD often have problems with social, emotional, and communication skills. They might repeat certain behaviors and might not want change in their daily activities. Many people with ASD also have different ways of learning, paying attention, or reacting to things. Signs of ASD begin during early childhood and typically last throughout a person's life.

Symptoms of ASD: Early Intervention for Parents and Teachers

Symptoms:

- Not pointing at objects to show interest (for example, not pointing at an airplane flying over)
- Not looking at objects when another person points at them
- Having trouble relating to others or not have an interest in other people at all
- Avoiding eye contact and wanting to be alone
- Having trouble understanding other people's feelings or talking about their own feelings
- Preferring not to be held or cuddled, or might cuddle only when they want to
- Appearing to be unaware when people talk to them, but responding to other sounds
- Be very interested in people, but not know how to talk, play, or relate to them
- Repeating or echoing words or phrases said to them, or repeating words or phrases in place of normal language
- Having trouble expressing their needs using typical words or motions
- Not playing "pretend" games (for example, not pretend to "feed" a doll)
- Repeating actions over and over again
- Having trouble adapting when a routine changes
- Having unusual reactions to the way things smell, taste, look, feel, or sound
- Losing skills they once had (for example, stop saying words they were using)





Above: My advice, perspective on life and advice for people on the autism spectrum has been published in many books around the world, including the above two.

Right: An illustrated poster shows common symptoms for detecting autism in children. Early intervention and support leads to positive outcomes.

Savant Syndrome, Hyperlexia and Gifted Learners

Savant syndrome is a rare, but extraordinary, condition in which persons with serious developmental disabilities, including autistic disorder, have some 'island of genius' which stands in marked, incongruous contrast to overall handicap. As many as one in 10 persons with autistic disorder have such remarkable abilities in varying degrees, although savant syndrome occurs in other developmental disabilities or in other types of central nervous system injury or disease as well. Whatever the particular savant skill, it is always linked to massive memory.

Gifted people with ASD often have savant syndrome, a late 19th century word originating from European asylums where feebleminded individuals were discovered to have extraordinary skills in memory and mathematics, though they could barely speak. Savant experts like Dr. Darold Treffert and neuroscientists discovered that savants are more like the rest of us. Their extraordinary skills tap into areas of the mind (common to everyone) that function like supercomputers, compiling massive amounts of data from the senses to create a working model of the world.

Without doubt, the best known autistic savant is a fictional one, Raymond Babbitt, as portrayed by Dustin Hoffman in the 1988 movie *Rain Man*. However, the original inspiration for the savant portrayed in Rain man was the late savant Kim Peek, who memorized over 6000 books and had encyclopaedic knowledge of geography, music, literature, history, sports and nine other areas of expertise (*Peek and Hanson 2008*). He could name all the US area codes and major city zip codes. He had also memorized the maps in the front of telephone books and could tell you precisely how to get from one US city to another, and then how to get around in that city street by street. He also had calendar calculating abilities and, later in his life, advanced musical talent had surfaced.

Savant syndrome, with its 'islands of genius', has a long history. The first account of savant syndrome in a scientific paper appeared in the German psychology journal, *Gnothi Sauton*, in 1783, describing the case of Jedediah Buxton, a lightning calculator with extraordinary memory (Mortiz 1783). Rush (1789), the father of American psychiatry, also provided one of the earliest reports when he described the lightning calculating ability of Thomas Fuller 'who could comprehend scarcely anything, either theoretical or practical, more complex than counting'. However, when Fuller was asked how many seconds a man had lived who was 70 years, 17 days and 12 hours old, he gave the correct answer of 2,210,500,800 in 90s, even correcting for the 17 leap years included (Scripture 1891).

Detailed reports of these and many other savants dating from Down's original description of the disorder are contained in the 2006 book *Extraordinary People: Understanding Savant Syndrome* (Dr. D. Treffert). Moreover, information about many of them, including some video clips, can be accessed on the savant syndrome website maintained by the Wisconsin Medical Society Foundation at savantsyndrome.com

After several centuries of reports and observations, we know that:

(a) The condition is rare but one in 10 autistic persons show some savant skills. In Rimland's (1978) survey of 5400 children with autism, 531 were reported by parents to have special abilities and a 10 per cent incidence of savant syndrome has become the generally accepted figure in autistic disorder. Whatever the exact figures, developmental disabilities are more common than autistic disorder, so a reasonable estimate might be that approximately 50 per cent of persons with savant syndrome have autistic disorder and the other 50 per cent have other forms of developmental disability, intellectual disability or other CNS injury or disease. Thus, not all autistic persons have savant syndrome and not all persons with savant syndrome have autistic disorder.

(b) Savant skills typically occur in an intriguingly narrow range of special abilities. Considering all the abilities in the human repertoire, it is interesting that savant skills generally narrow to five general categories: music, usually performance, most often piano, with perfect pitch, although composing in the absence of performing has been reported as has been playing multiple instruments (as many as 22); art, usually drawing, painting or sculpting; calendar calculating (curiously an obscure skill in most persons); mathematics, including lightning calculating or the ability to compute prime numbers, for example, in the absence of other simple arithmetic abilities; and mechanical or spatial skills, including

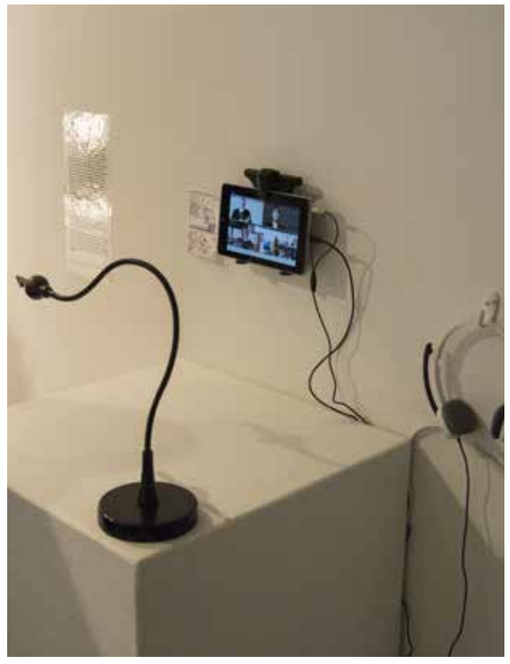
the capacity to measure distances precisely without benefit of instruments, the ability to construct complex models or structures with painstaking accuracy or the mastery of map making and direction finding.

Hyperlexia, which is distinguished by precocity rather than age-independent level of skill, has also been frequently reported in autism (*Grigorenko et al. 2002*).

Education of Savants

Dr. Trevor Clark (Autism Association of New South Wales, Sydney, Australia — 2001) developed a savant skill curriculum using a combination of successful strategies currently employed in the education of gifted children. These include enrichment, acceleration, mentorships well as autism education in an attempt to channel often non-functional savant and skills of a group of students with autism. This special curriculum proved highly successful in the functional application of savant skills and an overall reduction in the level of autistic behaviors in many subjects. Improvements in behavior, social skills and academic self-efficacy were reported, along with gain in the communication skills of some subjects. *Donnelly and Altman (1994)* noted that increasing numbers of 'gifted students with autism' are now being included in gifted and talented classrooms with non-disabled gifted peers. Accompanying elements are an adult mentor in the field of their talent, individual counselling and small-group social skills training. Some specialized schools are emerging as well. For example, Soundscape Centre in Surrey, England began operating in 2003 as the only specialized educational facility in the world uniquely dedicated to the needs and potential of persons with sight loss and special musical abilities, including musical savants. Orion Academy (www.orionacademy.org) in Moraga, California, USA specializes in providing a positive educational experience for high school students with Asperger's syndrome.

Hope University (www.hopeu.com) in Anaheim, California is a fine arts facility for adults with developmental disabilities. Its mission is to 'train the talents and diminish the disability' through the use of fine arts therapy including visual arts, music, dance, drama and storytelling.



Above: My interactive video display project for gifted learners, *Perspective*. March-April 2014. Displayed at the 2014 MFA Thesis Show and the 2014 DMI Fresh Media Shows (Boston Cyberarts and Nave Somerville.)

TEACHING *through* TECHNOLOGY

Virtual Learning Environments

Virtual Reality technologies have a real potential for allowing people with Autism to take ownership over their spaces and design them for their own needs. Studies with the online virtual environment Second-Life have shown that communities of people with Autism can be formed online. Inspired by research on visual-spatial abilities and memory of people on the autism spectrum, I prototyped a screen-based learning experience using MOOC video lessons and text. The results can be seen in my projects section later (see pages 67-75).

Robots Teaching Children with Autism

Over the last 20 years, robots have been introduced as 'social agents' in a variety of contexts, including adult group homes, day care centres and classrooms. I refer to the machines that not only replicate some human tasks but physically resemble their human counterparts, in some shape or form, like the android C3PO from the movie Star Wars. Lower costs for increasingly sophisticated technology and greater robotics education through the Lego Mindstorms kits have led to an increase in interest in robots. An increase in schools offering Lego robotics as well as robot battle events has increased awareness. At the same time, examples such as Paro, Japan's therapeutic robot seal have been proven as a therapeutic service for the elderly. New tools being developed at the University of Southern California for people with ASD show particular promise, particularly with solutions that include the use of sensors and robots.

Directly applicable use cases for Robots include:

- Cueing and joint attention (teacher replacement)
- Social skill learning (non-judgmental)
- Language and communication (conversation)
- Motor skills learning (eye gaze and movement with the robot in a space)
- Robots as natural student learning motivators (for those with Autism)
- Learning objectives and description Robot behavior (in context of digital learning content and accelerated learners)
- Imitation
- Turn taking
- Asking for help
- Self-initiation
- Problem solving
- Asking questions
- Sharing
- Introducing oneself
- Bringing the robot into a learning environment (classroom etc.)

I was interested in prototyping a use case where the robot could replace the teacher or become an affordable alternative, in the absence of a trained expert. I thought about a robot being a teaching companion for the student, sounding like the iPhone SiRi app, but active in starting conversations and leading student to mapped curriculum-based content. The *RoboTeacher* app (see page 79) design prototype was a screen-based interface demonstrating this idea.

Online and Distance-based Learning

Learners on the autism spectrum traditionally function better in quiet environments, with self-pacing and self-motivated learning. This can be achieved using distance learning tools and technologies such as MOOCs, video conferencing, open educational resources and personal video players. Computer-based learning is superior to traditional class room learning, in most cases. Most of my Inclusive Interface project prototypes were created to support learning from digital resources, providing interface choices to access content in different ways.

Universal Design for Learning

In order to explore the strong connections between technology and tools for students on the autism spectrum, I referred to November 2013 book edited by Katharina Boser, Mathew Goodwin and Sarah Wayland: *Technology Tools for Students with Autism*.

The book confirmed my suspicions about the traditional learning environment being ineffective for students on the spectrum, particularly those who are gifted and learn better, deeper and faster on their own.

Such a traditional learning environment can be described as a way of representing information (text, lectures etc.), as way of expressing what learners know (listening, reading etc.) and a way of engaging with learning. One topic may or may not be interesting to all.

The traditional classroom is for the "average learner with median social, communication and self-regulation behaviors, not optimal for most learners on the autism spectrum." (Katharina Boser; Matthew Goodwin; Sarah Wayland. *Technology Tools for Students with Autism: Innovations That Enhance Independence and Learning.* Brookes Publishing. pp 24. 16 October 2013. Print. April 8, 2014.)

Alternative to the traditional learning environment, the *universal design principles for learning* (UDL) (CAST 2012) are flexible approaches for individual learner needs. As an educator, I saw these UDL *principles* being an effective list to guide the design of tools for Multiple ways of representing information (Visual, text, sound, tactile, interactive) These would cater to perception, language, expression and symbols. For comprehension, UDL *principles* state that there should be different ways of customizing display of information, and alternatives to auditory information.

Alternatives to visual information would include varying methods for response and navigation (user interface, as addressed by my interface projects) and optimized access to tools and assistive technologies. UDL states that there should be multiple ways of acting and expressing after interacting with the information, such as physical action and communication. UDL *principles* that would help executive functions include clarifying vocabulary, symbols, syntax and structure. Supporting decoding of text, mathematical notation and symbols, promoting understanding across languages, illustrating through multiple media.

Getting learners used to different levels of performance (eg easy, medium, hard) in their subject area would deepen learning.

There should be many ways of engaging with the learners, particularly through multiple topics and selective interests. This would lead to recruiting interest, self-regulation of background knowledge, highlighting patterns, critical features and relationships. The UDL *principles* allow accommodations for learners to generalize, appropriate goal setting and an enhanced capacity for monitoring progress

The fundamental goal of *universal design principles* for learning (UDL) is to develop an expert learner, who can understand the way they learn, and manage internal and external resources to manage the demand of their own learning. As learners develop expertise in a subject area, they become better at focusing on critical features, their understanding becoming holistic and fluid. They employ rules in a discretionary manner which changes based on context. They are able to manipulate abstract elements to achieve their learning goals.

Classroom-based Technology Tools

Routines are very important for people with ASD, as they help manage social and academic pressures. Reinforcing routines and facilitating transitions requires a structured environment, most often being the classroom itself. The TEACCH approach for children with ASD provides visual structure to translate expectations around the learning environment, with traditional tools such as visual schedules. My interests and research with technology-based interfaces made me consider how I would help a person with ASD navigate their learning environment. As a response, I thought about these design interventions:

- Routine and self-management: A personal smartphone or tablet can have a pre-loaded story that reminds the student about their task, and what to do if they are feeling frustrated, tired or overwhelmed-an example can be digitized animations of "Social stories" by Carol Gray on the smartphone, viewed when needed by students:
    - o A 3D virtual world can be used to simulate a quiet class environment, an example being my *Spatial Learning* project (see page 78).
    - o Visual timers and stopwatches can be used for periodic breaks, in case students want to compete against each other in an exercise, e.g. reading a page, an example being my *Inclusive Timer* project (see page 72).
- Delivering instruction
    - o A mobile MOOC app can be used to replace the classroom teaching structure, to enable the student to learn at their own pace, in their own environment. An example being my Learn2Gether app.
    - o Instead of a blank paper, a diagram of content structure can be used e.g. main idea, supporting idea1, supporting idea 2, conclusion etc. This will help speeding up productivity and reduce confusion and distraction.

When an engaging interface is provided for online-learning, individual learning performance can be optimized, minimizing the time to learn, leading to longer retention. Nishikant Sonwalkar of MIT uses a Pedagogy Effectiveness Index (PEI) (on scale of 0 to 1) to measure success for online education platforms, based on diversity in Media, Interactions and catering to different learning styles. A higher PEI score requires diverse content as well as content access choices (e.g.. interfaces and interactions).

CONTEXTUAL *Research*

Learning Strengths of Gifted People on the Autism Spectrum

Jacob Barnett, Child Prodigy and Researcher
Jacob was a 2 year-old nonverbal toddler when he was diagnosed with moderate to severe autism. His parents were told about the symptoms of Autism, that he may never talk, go to school or become independent, requiring help with even simple things like tying his shoelaces. In 2014, 14-year old Jacob is close to getting a Quantum Physics PhD from the world-renowned physics research lab, the Perimeter Institute of Canada. With a tested 170 IQ, Jacob is working on a new theory of relativity, which his professors say may win him the Nobel Prize for physics.

At the age of 10, Jacob enrolled at the Indiana University — Purdue University Indianapolis (IUPUI), teaching college students in calculus and publishing research in science journals. He still has Asperger's Syndrome (An autistic spectrum disorder) and runs a charity, *Jacob's Place*, for children with Autism, using his life story to dispel myths about the disorder.

His mother, Kristine Barnett says that Jacob has dealt with his Autism symptoms — "He overcomes it every day. There are things he knows about himself that he regulates every day," she told the Indianapolis Star newspaper last year.

The early childhood development of Jacob Barnett has been painstakingly documented by his mother in the book S*park: A Mother's Story of Nurturing Genius.* This allowed me to see his learning style and similarities with myself as well as other people with ASD.

Kristine wrote that Jacob was attracted to colored alphabet flash cards at age 3, when he was nonverbal. She bought more of them and allowed him to take them with him everywhere, from school to his bed. His educators tried to take the cards away but failed to do so, while his mother bought him more of them, encouraging him.

Jacob seemed to ignore the pain from his ear infection only when looking at the geometric plaid pattern on the duvet cover on his bed, his face
inches away from the lines.

This hyper-focus behavior, shifting attention to patterns, and blocking pain and sensory input is similar to what I did when I was younger, during my own ear infections. Both blocking of sound and ear infections are common traits for those on the autism spectrum, due to sound sensitivity. I propose here that the neuro-plastic brain of a child on the spectrum tries to minimize this latent sound and ear sensitivity pain through attention diversion by hyper-focus on an environmental object, the greater levels of focus being a direct result of pattern recognition abilities.

Kristine Barnett wrote that Jacob liked his alphabets so much that he played with anything that looked like them, including the colorful alphabet refrigerator magnets. Jacob kept his eyes focused on the magnets far away as he completed a puzzle. He did it in 14 seconds with his non-dominant hand, a puzzle that took other 2 year olds an average of two minutes to complete. This was an example of splinter skills, found commonly among those on the autism spectrum. There are delays in communication and a lack of eye contact, but there may be exceptional and even gifted ability in areas such as pattern recognition.

Kristine knew about the *squeeze-machine* designed by Temple Grandin that allowed reduction of anxiety and an increase in concentration by an interactive proprioceptive squeezing sensation. She made a similar pouch out of a sewed up hammock for her son Jacob, which allowed him to concentrate better at the card recognition games that she played with him.

This shows that proprioception, i.e. body awareness and pressure can help in concentration. In Jacob's case, the pouch blocked out the environment and had one opening to look outside, blocking other visual inputs. With sufficient concentration and focus, the smartphone screen allows learners to concentrate on content, oblivious to the people around them.

Kristine writes that she had read up on savants, their memory abilities, remembering maps, obscure information like number plates and phone book information.

Jacob could do these things, but more than these, he actually understood how to think and analyse the information that he was reading.

His pattern recognition abilities are an indication of incremental, logical thinking found among gifted children, who use memory like Lego blocks, building up complex concepts. The interesting learning pattern that seemed to emerge in Jacobs' daily interactions was a system of incentives from his mother Kristine. These were not the traditional "Do this test and I will give you a candy bar"… but more towards "Do this class." Jacob would be rewarded later by counting coins, looking at car number plates or working with large 5,000-piece puzzles at home. These rewards were of his interest, and primarily educational in nature. Kristine was motivating Jacob to learn a difficult subject or lesson by giving him a subject of his interest to learn later.

Jacob learned about other savants by seeing their interviews on YouTube, showing that he was familiar with online learning platforms, in 3rd grade, when he was 8 years old. His pro-active mother took him to audit an astrophysics class at Indiana University—Purdue University Indianapolis (IUPUI), taught by Professor Edward Rhoads.

This allowed him access to professors who he could have conversations with, eventually leading to further mentoring, classes and advice that led to an accelerated path as a physics researcher. If not for his mother, Jacob would still have been following an age appropriate (as opposed to ability appropriate) Individualized Education Program (IEP), set forward by a special educator at a public school.

There are many Jacob Barnetts out there in the world, child prodigies born in developing countries outside the United States. They do not have access to the inclusive (but imperfect) educational environment in the US, and may not have an educated mother such as Kristine Barnett to advocate for their special needs. I identify with some of Jacob's abilities as I faced many of the same challenges that he did, when I was growing up. I designed tools and interface prototypes, for gifted learners such as Jacob, so that educators and neurotypical students could understand the experience of learning faster while trying to minimize sensory overload.

Above: Jacob L Barnett is a mathematician and astrophysicist who, while still a teenager, has become an orator of physics classes at Indiana University.

Temple Grandin: Self Advocate and Academic

Temple created the "hug box", a device to calm autistic children through proprioception. She was the subject of an award-winning biographical film *Temple Grandin*, starring Claire Danes, which won an Emmy award in 2010. Temple Grandin was listed in the Time 100 list of the 100 most influential people in the world in the "Heroes" category.

Temple is the most public figure among all self-advocates for Autism around the world. Her 2013 book *The Autistic Brain: Thinking from Across the Spectrum* addresses the diversity of the autism spectrum, giving examples of different learning styles and strengths, as opposed to weaknesses, of people on the spectrum.

Temple addresses the learning styles of people on the autism spectrum from the perspective of their sensory challenges i.e. categorized as:

1) Sensory seeking, leading to inattentive or over focused behavior. Examples of these may include rocking, spinning, twirling, hand-flapping or noise-making. For a neurotypical person, these may translate to craving certain foods, feeling certain textures, hearing certain sounds as a comparator.

2) Sensory modulation (over or under responsiveness) with movement sensitivity and low muscle tone. Here, senses are overwhelmed, e.g. problems tolerating sounds, bright lights, the texture of a chair or a noisy environment. A sensory neutral interface can help learners on the spectrum, particularly if they have the choice of interaction with a learning interface. E.g. hands-free control such as eye or hand tracking or voice input. With under responsiveness, there can be non-responsiveness to a name or under reacting to pain. In such a situation, a responsive interface could be used to shows immediate result of the interaction. Examples can include haptic feedback. Children with ASD who have atypical movement sensitivity are usually over-responsive to proprioceptive and vestibular input i.e. parts of body working together or the sense of balance. Children with low energy and weak motor responses have poor fine and gross motor skills, common with Dyspraxia.

3) Sensory modulation (over or under responsiveness) with extreme taste or smell sensitivity. This pertains to smell and taste.

Above: Temple Grandin is an American doctor of animal science, a professor at Colorado State University, a best-selling author, an autistic activist, a consultant to the livestock industry on animal behavior, and an engineer.

Visual Processing Problems
Temple points out that tablets have huge advantage over computers, since you don't have to take your eyes off the screen, leading to a cause-and-effect relationship that can be made easier through haptic feedback (where suitable). She also points out to educational implications of people on the spectrum not being good processing faces and emotions. This has implications on video training with results and a disembodied voiceover or transcript to complement the professor or instructor speaking on the screen.

She goes on to describe Irlen Syndrome, where people on the autism spectrum cannot tolerate the white background of paper, overwhelming the senses due to brightness. A simple use of sunglasses, tinted glasses and colored paper (and colored phone or tablet backgrounds) can help the learning process. In such a situation, I would recommend learners on the spectrum to use LCD screens, which do not flicker, as well as variable (larger) font sizes for easier reading.

Auditory Processing Problems
Due to a larger Amygdala (part of the brain that controls fight vs. flight response and anxiety) in people with ASD, sensitivity to sound causes all kinds of sensory problems. Categorized as auditory processing disorders (problems with hearing too much or too little), Temple has identified four of these common problems:

1) Language input: Either the spoken words are too fast or the words don't connect to the correct meaning. In such a situation, a visual analogy or pointer, along with subtitles, may help learning.

2) Language Output: Speaking out a response through stuttering or not being able to vocalize a spoken answer. A simple text to speech solution can help, as well as button-based answers common on digital systems.

3) Attention shifting slowness: An interface that allows a next button, gives control to the learner to move at their own pace, to repeat the educational content when distracted and to control volume, exists in most digital learning platforms.

4) Hypersensitivity to sound: The hyper-focus and concentration issues disrupt chain of thought. Sudden phone calls may distract and disturb learning. A sound-free environment or insulated headphones, along with a narrow visual interface, can stop or limit environmental distractions.

In such a situation, I would personally recommend that learners wear earplugs, record unpleasant sounds and play them back with a lower volume to de-sensitize their ears. Her findings and research have been verified by researchers who read her publications and books, as well as educators and scientists.

Touch and Tactile Sensitivity Problems
A strong skin sensation that makes you uncomfortable would deter learning as a result of the distraction or pain. According to Temple, some people on the autism spectrum are sensitive to types of textures, e.g. soft, warm, grainy, wet, oily surfaces. Skin or hair sensitivity due to clothes is a personal issue, and an educational interface or environment that tackles these issues needs to adapt itself, to the needs of the learners touch. A glass tablet with haptic feedback may be a good idea, unless skin sensitivity is high, and hands free or eye tracking or even voice control with a visual feedback interface would provide more comfort.

In such a situation, I would recommend learners with ASD use a heavy mouse or an object-based interface, or a touch screen with haptic feedback.

Olfactory (Smell) Sensitivity Problems
Educational technology and interfaces do not usually refer to smell as a distracter, but for some on the spectrum, smell is form of sensory overload, according to Temple. However, research has shown that avid readers prefer the touch and smell of a book, whereas the person on the autism spectrum may be choose no smell or paper grain. The digital delivery model of education would be superior for a person on the spectrum, in such a situation. An interface that lacks any noticeable smell e.g. of plastic, oil, rubber or wood, as well as a texture free smooth glass interface, would be optimal. Added smells, perfumes or a mild scent may help making an interface more pleasant to the user.

In such a situation, I would recommend a learner with ASD to use aromatherapy oils, peppermint oil or using an interface with no smell.

Two Types of Visual Thinkers: Spatial vs Object
Temple Grandin refers to the Autistic picture-based visual thinker as a person whose thoughts rely on images, and the pattern-based thinker as a person that thinks in terms of space. She had conversations with an expert in the area, Dr. Maria Kozhevnikov, who researched this area in the late 1990s at the University of California. Temple was given a test to determine her own visual thinking type. She took the *Vividness of Visual Imagery Quotient* (VVIQ) test, which asked her to imagine colors and shapes, noting how vivid they were in her mind. Her interaction with Maria's test allowed her to see that a person on the autism spectrum, like neurotypical, would either be visually strong, or spatially strong. Temple concluded, at least for her own tests, that high object imagery plus autism would equate a scientific mind. This has an interesting result on educational materials, particularly content relating to emotion, e.g. when opinions about relationships are being taught to a person on the autism spectrum.

Like Temple, my memories are spatial. I share my design and engineering career path with her, as well as a love of animals, details and visual thinking. Her perspectives are not unique, but they are rare, particularly as a primary source of research. Temple's success as a designer is a result of her concentration and focus, which I would go as far as to call 'hyper-focus', paying close attention to the smallest details in a short period of time, definitely a gifted ability.

Universal Design in Higher Education

During my fall 2013 Industrial Design: Form class, I looked at Human-centric design work by industrial designer Don Norman, who is credited with saying, "When we design something that can be used by those with disabilities, we often make it better for everyone." I had researched and read about the *universal design* framework, an inclusive industrial design process that could help me frame my ideas and create prototypes.

Ronald L. Mace, former program director of The Centre for Universal Design at North Carolina State University coined the term *universal design* around 1997. *Universal design* (UD) evolved from *accessible design*, a design process that addresses the needs of people with disabilities. UD goes further by recognizing that everyone passes through childhood, periods of temporary illness, injury and old age. By designing for human diversity, we can create things that will be easier for all people to use. UD takes into account physical, perceptual and cognitive abilities, as well as different body sizes and shapes.

In 2012, Centre for Inclusive Design and Environmental Access (IDeA Centre) researchers Edward Steinfeld and Jordana Maisel updated their definition of *universal design* in the text book *Universal Design: Creating Inclusive Environments* as "A process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation."

In addition, the IDeA Centre developed eight *Goals of universal design* to accompany the updated definition. Each goal corresponds to a measurable outcome and a knowledge base from research:

- Body fit — accommodating a wide range of body sizes and abilities.
- Comfort — keeping demands within desirable limits of body function and perception.
- Awareness — insuring that critical information for use is easily perceived.
- Understanding — making methods of operation and use intuitive, clear, and unambiguous.
- Wellness — contributing to health promotion, avoidance of disease, and prevention of injury.
- Social integration — treating all groups with dignity and respect.
- Personalization — incorporating opportunities for choice and the expression of individual preferences.
- Appropriateness — respecting and reinforcing cultural values and the social and environmental context of any design project.

Three aspects of *universal design* for higher education are:

A. Instruction / Delivery methods

B. Information Technology

C. Physical Spaces

A) **Instruction / Delivery methods**

Using UD principles for design, we have to use multiple instructional delivery methods which are accessible to all or most users. We select flexible curriculum i.e. MOOC content and Open Educational Resources. Using technology gives flexibility and choices. Web-based text content must be accessible for text to speech readers. Universal, simple web templates can be used to deliver content, using structured, logical and commonly used UI elements. We make content relevant, catering to characteristics such as age, gender, ethnicity, race, socioeconomic status and interests. Using real world case studies helps map learning to professional outcomes. Diverse student and staff backgrounds help the educational process. Providing course materials ahead of time allows self-preparation and accommodation. Provide multiple ways to gain knowledge, something that is of particular interest in my projects. I have thought about the same content being presented in different ways, for example a lecture as a presentation file with slides, as an mp3 recording or even as a summary of the discussion. Using large visual, tactile aids or even small physical models of objects allows deeper engagement and accessibility, particularly for those with special needs

or a strong learning style. Accommodations are closely connected with assessments, extra time, personal mentoring and time to test out different interfaces (particularly new technologies) is essential for student and teacher comfort. Augmenting communication through a chat system, using communication apps on portable devices as well as specialized software can help students adjust and give timely feedback in the learning environment. Use of video training and online software allows students to learn at their own time and pace, particularly those that need extra time to prepare.

B) Information Technology

Early 1980's efforts to make IT accessible led to creation of *universal design* guidelines for information technology, addressing issues pertaining to sensory, physical, cognitive language abilities as well as seizures (due to their visual trigger). The user interactions with IT became divided based on their function and when the user had to work with them through the human computer interface (HCI).

Output/Design – UD principles should maximize the number of people who can

- Hear the sound clearly
- Not miss important information if they can't hear
- Can see visual output and can read text
- See visual output clearly
- Not miss important information if they can't see
- Understand the output (visual, sound etc.)

Input/Controls — includes all forms of HCI — human computer interface including the mouse and keyboard, but not limited to them.
UD principles have to maximize

- Reaching controls easily
- Finding the controls if we can't see them
- Reading labels on the keys
- Determine status of controls/keys if we can't see them
- Physically operate controls and other input mechanisms
- Understand how to operate the controls
- Connect special alternate input devices

Manipulations: These include actions that involve routine maintenance and handling, including connecting/disconnecting wires.

- Physically insert and remove object required to operate a device
- Physically handle or open the device
- Remove/replace detachable parts
- Understand how to manipulate parts to use the product

There are additional accommodations for documentation and safety, which I will not reference, assuming that the commercially available interface technology I am using is easy to use (plug and play) as well as safe for the end user. I used commercially available interaction design hardware (*Leapmotion*, *Kinect*, RFID Reader etc.) that has been tested independently for quality and safety.

C) Physical Spaces

Accessible entrances, lecture style open classrooms, adjustable height furnishings, equipment for light, sound and projection control, sound insulation, heating, visible facades and tech-enabled environments are some factors that allow learner success in the physical space. The implementation of Learning Studios, i.e. transformable tables and movable chair, easily configurable from large to small student seating groups, allows students to spread out their materials and collaborate on their own terms and comfort levels. It may be impossible to physically accommodate every kind of learner, but by using *universal design* principles, the maximum number of learners can be accommodated to their individual needs, facilitating their learning process. Structured teaching classroom setups in inclusive schools for people on the autism spectrum already demonstrate this wide adaptability, customization and environmental control for lighting, sound insulation as well as blocking visual stimuli
through portable barriers.

Interested in surveying physical learning spaces around the Boston area, particularly those that encourage collaboration, innovation and creativity, I observed these environments:

A) Artisans Asylum

Artisan's Asylum is a non-profit studio located in Somerville, Massachusetts. They have a large space with materials and power tools to support artists and makers. The whole space is open, there are few doors except tvhose for noise filtering and paint/welding areas. Collaboration and meeting other experts in open spaces is what allows makers and hackers to join and build companies, with many successful Kickstarter projects coming out from the Artisan Asylum (e.g. 3Doodler, Magnet-Comic, Project Hexapod and OneTesla).

Physical Space of the Artisan's Asylum

- It is a messy place, full of equipment and creative projects. However, there is an unusual honor code, modular system, collaborative spirit and sheer will to succeed that drives the people who work and create things here.
- The equipment is expensive, dangerous and very versatile, regular trainings are held there as well as workshops to train new users and share knowledge.
- The entrepreneurial spirit is very strong there. I met people from all backgrounds, who spend their days or nights there. Almost everyone knows each other by name.
- Some of the projects there have no commercial goal other than artistic endeavour and a "cool factor." I saw the team that is making a 12 ton steel monster robot spider that can be ridden by a person. I also saw the workspace of the team behind the *3doodler* plastic printing pen, a successfully backed kickstarter.com project.
- More than the art, the Asylum's real success is connecting people with similar interests, who team up to work on projects together.

To encourage risk, entrepreneurial thinking and critical thinking, I would build on what I saw at the Artisan's Asylum. Ideas such as online collaboration, mentoring, access to experimental interfaces and novel ways to interact with online content would help make a good learning environment. My Inclusive Interface and Form prototypes implemented these ideas.

B) Intel Computer Clubhouse
A non-profit after-school skill-based tech program for under-served young adults.

Physical Space of the Computer Clubhouse

- A comfortable environment with creative works of past student participants displayed on reachable shelves, the constructionism project-based philosophy of Seymour Papert is embodied in this after school program for Boston's underserved minority youth.

- There are no tests, no grades and no reports. Students 'play' with materials and give presentations on topics that are relevant to their lives and to their areas of interest. There is a very strong social and civic undercurrent at the program, with emphasis on equal education through accessibility.

- Career-based skills are taught to the children, such as video editing, presentation skills, sound editing, script writing and desktop publishing. These skills get them internships and lead to jobs and careers, based on their portfolios.

- Students are young teenagers but are treated with respect as responsible adults. The behavior of the clubhouse faculty and participants, and the prevailing culture of trust stems from a highly visual way of presenting curriculum, by displaying finished projects on a wall, instead of a written list. Ideas that I took away from the space of the Intel computer clubhouse relate to an informal, collaborative non-pressure environment, very different from a time-based focused online learning environment such as for a MOOC.

C) MIT Media Lab
Spaces for learning include the macro (building/organization) as well as the micro (seating space for a student with laptop or a mobile learner with a smartphone/tablet). The MIT Media Lab was designed by architects Maki & Associates and sponsored by SEGA, to encourage collaboration and sharing of projects on the premise of a kindergarten. The lab has large glass walls, video demos and prototypes as well as interactive art scattered everywhere. Large open areas are designed to encourage a comfortable and non-judgemental environment.

Physical Space of the MIT Media Lab

- The trusting and transparent culture of the MIT Media Lab (with information kiosks distributed all over the building) and the large see-through glass walls encourage collaboration in a non-judgemental environment. The culture of the space at the Media Lab is supportive, the success of the organization being the people that it drew from all over the world. I learned that greater success and creativity can happen when people from unrelated fields collaborate on ambitious projects, having fun by creating together.

- The whole building looks like a large kindergarten space that encourages students to play and learn through collaboration, sharing and remixing ideas and prototypes. Design of educational environments would need to feel safe and comfortable, even if that means using skeumorphic visuals.

- The furniture is mobile, the walls are made of soundproof glass and all kinds of experiments happen throughout the day and night. Being inspired from this physical layout, I wanted my user interfaces to be adaptable, changing their appearance based on the type of user. They would see sample videos of content that other users may be seeing right now, or ask a question from another user not in the current/related MOOC or subject of learning, with an "ask another online user" button to encourage cooperation.

- The classrooms are designed like board rooms, in a circular knights-of-the-round-table manner, with a small number of graduate students led by two or more professors in classes that encourage collaboration. Small groups allow deeper and intimate communication.

These observations helped develop my concepts about *spatial learning*, physical structure, accessibility and the role of content curation in context of an open learning environment.

Evolution of Education through Technology

From University to MOOCs

During my fall 2012 design seminar class with Professor Joseph Quackenbush, I researched the origin of the world's earliest university system, *Takashila*. I was surprised to find out that it originated in the area that is now Pakistan, my country. The "evolution of education" through recorded history has been consistent, adapting and changing through technology. The Internet and new media has enabled Open Educational Resources (OERs) and MOOCs: Massive Open Online Courses to become the next iteration towards low-cost scalable education. My research led me to blended, adaptive Moocs as the strongest contender for supplemental learning. *Dynamic media* technologies are influencing the educational experiences and goals of education, from a formal mass production model to a user-led interest-based future. This research allowed me to dig deeper into my own historical role as a teacher and foresee the impact MOOCs can have on a larger under-served population without college degrees, particularly those with learning disabilities and different learning styles.

Established around 700BC, *Takshashila* (also called *Taxila*) was the oldest recorded formal university in history. Created by Hindu and Buddhist kings, *Takashila* taught over 10,500 students from all over the world, most of them from ancient empires of Babylon, Greece, Arabia and China. Students joined at age sixteen, paying for their own expenses, or working for the teacher. The university specialized in medicine.

The oldest university that still exists, for the English speaking world, is Oxford University in the UK. Proof of teaching has been found to have started as early as 1096 AD, making it the second oldest surviving university, after the University of Bologna.

Education has always changed through jumps in technology. The printing press enabled cheap mass production and personal ownership of textbooks. Computers made education even cheaper and reduced the geographical and national limitations.

The biggest jump and personalization came with cheap personal smartphones and the miniaturization of technology through apps.

The University of Phoenix is an online university with more than 112 international campus locations and over a 100 degree programs. Reports have found out only 5% of online students actually graduate, with tuition costs being as much as five times the cost of community colleges. Some have gone as far as to accuse the University of Phoenix of being a criminal enterprise that taking advantage of veterans, minorities and people with disabilities. Because of it widespread brand awareness, the example of the University of Phoenix is given to demonstrate the large profit that can be made in helping non-traditional students achieve their educational goals, providing them a better, safer and individually relevant learning experience. MOOCs with paid certificates are a cheaper alternative to online ventures such as the University of Phoenix.

Many institutions tried to commercialize MOOCs as well as online education, going as far back as the early 90s, but lost time and money due to lack of interest and credibility. Hybrid educational models, university credit and a developing collaborative free-mium (pay for certificate) model succeeded in recent years, where these early initiatives failed.

Launched in 2001, MIT's OpenCourseWare gives away MIT's course and teaching materials for their undergraduate and graduate courses, free to any learner in the world. Teachers can use the materials for curriculum development, and life-long learners can make their own syllabus. With a new iPhone app and future cooperation with edX and MIT's open learning initiatives, the OCW program is the leading open-educational-resource platform for high quality higher education content.

There have been major innovations in the Online Education space, leading to different hybrid experiences and mashups that are very different from classroom education. The focus is shifting towards online communities, peer reviewing as well as micro skills and certifications for career growth.

The earliest Massive Open Online Courses appeared around 2008, free, online and collaborative. Stanford's 2011 launch of MOOCs by Sebastian Thrun led to over 160,000 students signing up. High publicity led to creation of for-profit companies like Udacity and Coursera, as well as MIT and Harvard's edX, a non-profit response to steps taken for the commercialization of online education. MOOCs continue to evolve into hybrids such as cMOOCs and xMOOCs, with great strides being made using free video conferencing and online forum tools from Google and other technology vendors.

Newly formed middle organizations such as *Learning Counts* provide mapping of MOOC course outlines to for-credit University courses. The implications are important, as a significant part of an undergraduate degree can now be replaced by online course credit, reducing cost and allowing flexible studying hours. Complete online-only undergraduate degrees from Georgia Tech are now possible, through MOOCs and evaluation software. However, research has shown that MOOCs are not being taken by those that need them the most, minorities, under-served communities and those with special needs and learning disabilities.

In the words of Northeastern University president Joseph Aoun, "We're witnessing the end of higher education as we know it." A growing number of for-profit MOOC and hybrid OER ventures (edX, Coursera, Udacity) are re-evaluating their successes due to low completion rates, lack of access for the under-served and a strongly college-based teaching model that seems to work primarily for self-driven, motivated students. The premise of a new medium trying to look like the older one is valid, as a strongly visual sense of skeumorphism arising from classroom education is hampering innovation in digital learning.

I realized that the interfaces I wanted to design could be applied beyond MOOCs, and did not have to resemble their counterparts in traditional classroom or course structures. The changing nature of *dynamic media* technologies allowed me to create my designs according to UD principles. This would allow a greater number of learners to take advantage of self-directed learning as a result of the online learning revolution.

Dialogue with Leading Online Educators

Sanjay Sarma, Director of Digital Learning, edX
Cambridge Massachusetts-based Harvard-MIT consortium, edX provides free access to world-class educational videos. In September 2013, I participated in an event hosted by the MIT Enterprise Forum of Cambridge, aptly titled "Software Circle & EdTech Group presents: The Future of MOOCs: Prospects and Pitfalls – the MIT Perspective." This event allowed me to meet Sanjay Sarma, Director of the MIT Office of Digital Learning, who oversees MITx and MIT OpenCourseWare. Nishikant Sonwalkar, Editor-in-Chief of the MOOCs FORUM Journal moderated the event. I was aware of research at MIT on adaptive educational interfaces (similar to my researchable thesis question) done by Nish Sonwalkar, and wanted his perspectives on the future of interfaces for online education.

I was particularly interested in their active search of young, gifted students from the around the world, for whom edX was the primary and perhaps only access to quality higher education. Nishikant Sonwalkar said that a student had taken a MOOC from Mongolia, passed it, and then applied and had gotten admission to MIT. He said "Maybe MOOCs are the place where we can find the stars in academics, and bring them to the light, even from the darkest corner of the world … that may be just 1 or 2 percent of it… is that a justification for MOOCs, as a force of democratization of education across the world?." Sanjay Sarma replied that there is something special about unadulterated meritocracy, particularly here in the US and at the MIT and said "MOOCs are a unique instrument to bring merit out, the spirit of merit as the ultimate judge…." He went further by giving the example of a 15-year old Mongolian Battushig Myanganbayar who got a perfect score in Anant Agarwal's Electronics MITx MOOC, and said that "finding such people can change cultures." Nishikant asked Kathy Pugh if edX now has a specialized program to find such geniuses, to which she replied that edX has an active social manager who looks out for young, gifted learners, and that they are definitely looking out for them. Only five percent of edX users live in the US, the vast majority are international, most of them from India.

There have been multiple cases of gifted children from Pakistan who captured the attention of educators in the US, due to their young age and learning abilities beyond their years. One such case was a 12 year old girl, Khadijah Niazi from Lahore, Pakistan – who sat next to Udacity founder Sebastian Thrun and Microsoft founder Bill Gates, at the Jan 2013 Davos Conference, an year ago. Pakistan Telecommunication Authority (PTA) blocked YouTube during September 2012 in Pakistan after the website did not remove the trailer of "Innocence of Muslims", which Islamist political parties protested. The unanticipated repercussions of this ban led to slower MOOC video access by tech-savvy students using VPN and proxy servers to circumvent the ban. However, this shut off access for young Pakistani schoolchildren to free educational content on YouTube, at schools and universities across the country, leaving YouTube and MOOC access to a rich educated minority. Most MOOC videos are traditionally hosted on the free YouTube video sharing website.

Pakistan's YouTube ban led to edX sharing downloadable videos on their website for all of their MOOCs. My *Curious Learning* project was developed for promoting free MOOC content to non-traditional online learners, this interaction allowed me to see the future vision of edX, particularly for international users, who make up over 70% of their audience. This interview informed me to the extent that the first iteration of *Curious Learning* was designed around the edX user interface and online forums.

Above: Sanjay Sarma represents edX at the 2013 MIT Enterprise Forum fireside chat at MIT CSAIL. Sep 6, 2013.

Salman Khan, CEO, KhanAcademy
Salman Khan, Founder of Khanacademy.com is revolutionizing online-education by delivering world-class educational videos for learners around the world, free of cost. I had a conversation with him on May, 9 2013 where he came to deliver a lecture about KhanAcademy.com at the Harvard Graduate School of Education.

Khan's digital teaching tools track student performance by spread-sheets and provide real-time visual feedback to identify exceptional learners as well as those who need teacher intervention. He said that his video tutorials allow mastery at the student's pace, as well as freedom to learn at any time.

"In a traditional academic model we group kids together usually by age … and then we move them all together at a set pace."

Traditional classes move everyone to a harder subject, even when some students cannot keep up. "Imagine if we applied that process to other parts of our life, say building a house. You are artificially constraining how long someone had to work on something. And then when you inspected it and identified weaknesses, you just ignored them and moved on to the next thing, often with something that is going to build on the weaknesses that you just identified."

"Early results are promising." Khan said his system is being used in a number of schools and charter networks in California with a few examples showing that an average student often goes on to become the best or second-best student in the class."

Khan's work has implications for developing countries, as aside from English, they have over 7,000 videos in languages such as Mandarin, Farsi, Hindi, Urdu and Bengali. Since all of the videos are hosted on YouTube, the websites blockage motivated many Pakistani non-profits to download videos to DVDs, USB drives and local websites, to provide access to underprivileged learners.

Khan writes in his book *The One World School House: Education Re-imagined* that the current gap in the educational system is becoming wider, more learners are falling through it each year. Lifelong learning is needed as well as an inclusive model that does not exclude the majority of learners who cannot afford education. He writes "Who knows where genius will crop up? There may be a young girl in an African village with the potential to find a cancer cure. A fisherman's son in New Guinea might have incredible insight into the health of the oceans. Why would we allow their talents to be wasted? How can we justify not offering those children a world-class education, given that the technology and resources to do so are available – if only we can muster the vision and the boldness to make it happen?" I agree with Salman about the potential of the Internet and technology to make international education sustainable and low-cost, particularly for people with special needs and those that are marginalized.

Salman points out the irony that no two educations are the same, as curriculum can be standardized but learning cannot. "Standardized tests only demonstrate approximate grasp of a subject, that each student understands his or her own way. Personal responsibility goes hand in hand with recognition of the uniqueness of each learner." These ideals resonated with the principles of *universal design* for higher education, which I had studied and written about earlier.

Left: Qazi Fazli Azeem with Salman Khan, at the 2013 Harvard Graduate School of Education-Askwith Forum. May 3, 2013.

KhanAcademy.com relies on Open Badges to motivate learners through the user experience on their website; their users learn points and badges while going through videos. Professor Mitch Resnick, head of the Lifelong Kindergarten group at the MIT Media Lab, is sceptical about badges and their connection to motivate young learners through gamification. He is concerned that learners may be motivated by the badges themselves, and not because of the process or the outcomes of the learning. In the case that the gamification process would stop, so might the learning.

The issue is pertinent since some MOOCs have attempted to motivate learners by awarding them unaccredited certificates on completion, serving the same purpose an intangible 'badge' for learner motivation. Gamification has roots with evolutionary learning and has been used with massive open online games, to increase the addictiveness of the experience. The premise of badge-as-reward should be moved ahead to badge-as-evidence-of-learning. Social media check points and achievements exist today, from the number of *Twitter* followers to the number of likes on *Facebook*. *Yahoo Answers* and other answer sourcing websites reward users who give correct answers with points. What these points may link to is some kind of game-based credibility system, with a possible monthly competition or just the online identification of experience. *Mozilla.org* launched their open badges platform in 2013 to allow cross-platform and open source badges to support gamification in many areas, including education. The adoption of badges into enterprise and corporate platforms such as salesforce.com is an indication that badges, like MOOCs are still evolving and changing.

Lynda Weinman, Co-Founder, Lynda.com

Searching for a different perspective on online education, to balance out KhanAcademy's non-profit approach, I met the CEO of Lynda.com, Lynda Weinman, at the 2013 Harvard Cyberposium.

The Education Technology Panel on November 2, 2013 at the Harvard Business School featured Steven Syverud of Coursera and Lynda Weinman from Lynda.com, with Deborah Quazzo of GSV Advisors as the moderator. Portions of their panel discussion are reproduced below.

Deborah (moderator): Over a billion dollars have been invested in the education technology market in each of the past 3 years. We're seeing massive network effects with high water market 40 million users. Why now? Why do we suddenly have all this innovation in the education space?

Deborah (moderator): We still have massive issues like achievement gaps, skills gaps, inequity, cost, etc. Technology is controversial in the classroom, so is technology disruptive or destructive?

Coursera: The quality and specific environment of a university can never be replicated online. But not everyone is able to go to an institution like an Ivy League. We want to bring elements of acclaimed universities to people who can't attend them. We're not disrupting universities in a negative way. In fact, the MOOCs are more collaborative with universities than they're given credit for.

Lynda: Teachers found it was complementary and liberating to offer Lynda.com to students. We need to better evaluate what's better done in person and what's better done online. A lecture is better delivered online than in person, but you can't do a Q&A, project-based learning, or discussion groups online. This is the changing role of the educator. There are threats to the status quo, but there are improvements in efficiency and efficacy.

Deborah (moderator): in K-12 system, technology is empowering, not threatening.
We can personalize delivery, as students operate on very different levels. Now we're worried about how to get to the 99% instead of the 1% early adopters. How did you arrive at your business model and what does the future look like?

Lynda: We didn't consider any other model because we were so early-stage that the freemium model wasn't even in the vernacular. Have not changed subscription price since 2001. First rule is to offer something of extraordinary value for very low price (the scale of the Internet allows this since we now have 3 million users). Paid model allows us to pay our contributors and employees. Some contributors live off the royalties. We have pride in creating a business model that is a win for every person, from students to contributors to employees. We recently took money for the first time (bootstrapped for 18 years) in the largest funding round in history of education companies.

Coursera: The mission of our organization is that we make a high quality education available to everyone, so the courses will always be free. Here are the challenges: 1) Putting high quality content online right now-only a small segment of users end up using it. 80% of users already have a college degree. Believe it's not enough to make the users available, but also putting in it a place and framework where people can engage with it. 2) There are going to be parts of the site that you pay for. You can currently pay $60 to get a verified certificate, making us compete with a free product that we're offering ourselves. There are tons of opportunities though; other organizations may want to license the content to teach to their students or employees. but we have to articulate how we want to license the content without fundamentally changing it.

Audience question: How has working with teachers unions impacted you?

Deborah: We don't really deal with teachers unions in the US. There's been a real aggressive move to make sure unions are aligned with the district when they apply for Race to the Top grants around technology. Unions appreciate that the technology is there to give them leverage.

The above panel discussion and my conversation with Lynda Weinman about the future of online education on the Internet, pointed at massive gaps that needed to be addressed, both due to cost as well as students with unique learning styles that were not being served. I was a Lynda.com student before my career as a graphic designer, and most of what I know (software skills) are a direct result of Lynda's online courses. Most of my students at the Arena Multimedia vocational training centres in Pakistan relied on supplementing their education through video training modules from websites such as Lynda.com, since conventional educational had failed them getting jobs after graduation. This contextual research informed, inspired and influenced my design solutions for interfaces to access open educational resources.

Above: Lynda Weinman speaks at an online education at the 2013 Harvard Business School Cyberposium. November 2, 2013

Right: A photo of Qazi Fazli Azeem with Lynda Weinman at the Cyberposium..

Early INTERFACE EXPLORATION

Numerology Visualization (2012)

Description
The first project I did after starting at the Dynamic Media Institute was a response to the phrase "*You are Here*", in my design studio class with Professor Jan Kubasiewicz. I was using Google Maps on my phone, with my hands, to navigate my way around the city. This was my earliest interaction with technology when I arrived in Boston, being fresh off the plane and new in the USA.

I was interested in the relationship between the use of my hand, the smart phone and what the hand meant to me, as a designer, artist and numerologist. My hobby as a Pythagorean numerologist and being aware of palmistry, allowed me to see the hand lines mapped to possibilities and opportunities. I wanted to simulate a digital numerology reading experience, different from the analog hand-calculated process, due to my dyscalculia (i.e. learning challenges with mathematics). This was a purely personal response where I wanted to map Pythagorean numerology to a *dynamic media* technology, allowing me to overcome my learning challenges through automation.

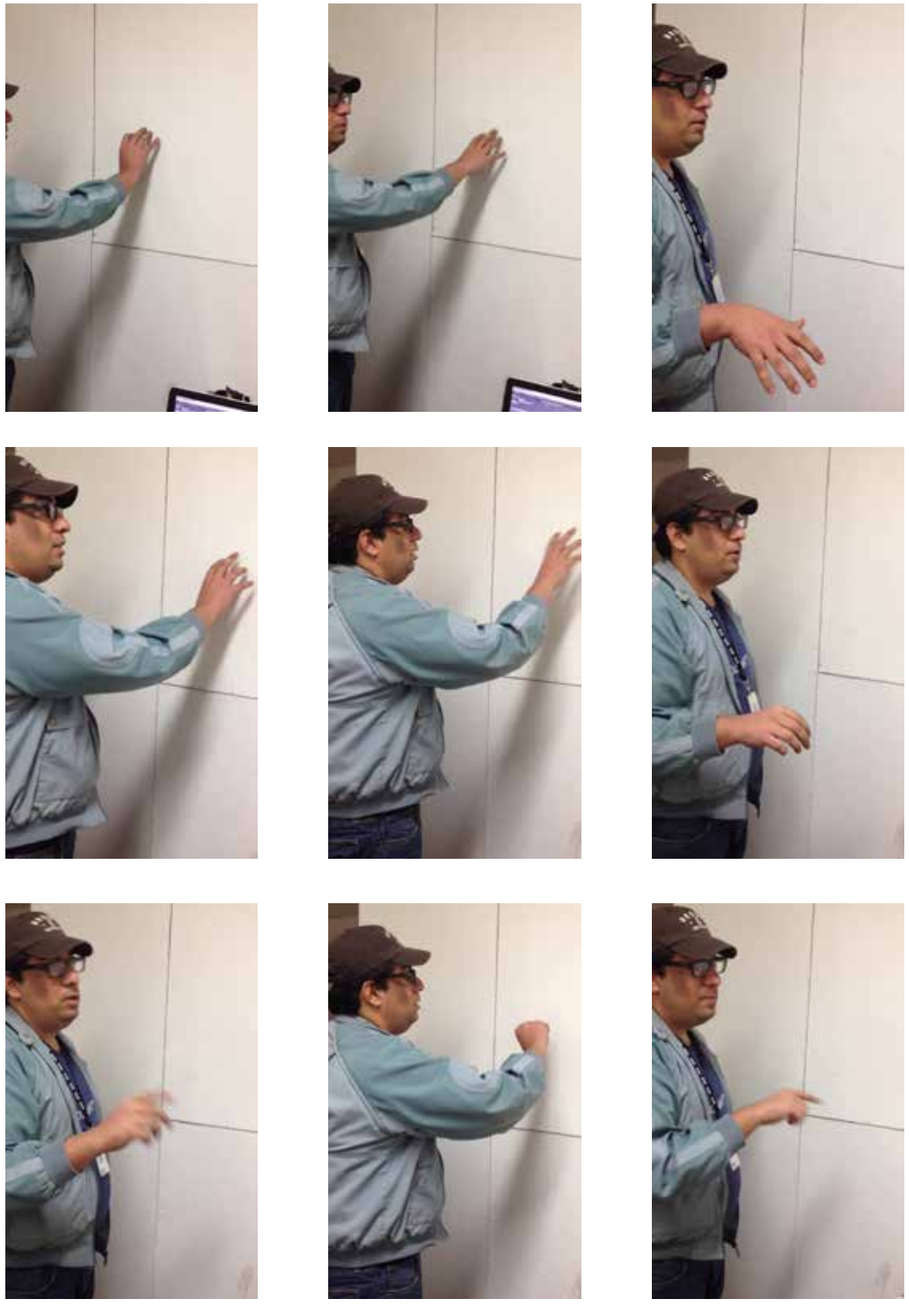
Above:
A photo of me with students from Brandeis University and Processing language creator Ben Fry, at the Boston Public Library W. A. Dwiggins Lecture. April 3, 2013.
Left and Previous Page:
A young visitor at the MassArt Presidents gallery walks away after seeing the *Numerology Visualization* project video during the 2013 DMI Fresh Media art show..

Design Process
My initial idea was to create a physical map of my room at MassArt's artist residence, and the path leading to my classroom inside MassArt. The role of technology, the potential of *dynamic media* as well as the accessibility of the map as a public artifact or way-finder, influenced my approach to mapping a design solution. I was aware of synaesthesia, a difference in perceiving information, based on an ability of gifted people on the autism spectrum.

I envisioned creating a prototype for a wireless input system that would input the date of birth of the user using RFID (Radio frequency identification) tags, instead of a mouse or keyboard. The result of a date of birth, after being input, would be visualized on the computer screen, showing one of hundreds of permutations, unique combinations of graphics and music, representing outcomes from the user's life. The system would be created using the *Processing* language and would be a kinesthetic and synaesthetic multi-sensory (touch, music, dynamic live mapping of music) experience. Since this was my first project and I had not started learning *Processing*, I made an animated video prototype using *AfterEffects*, to simulate what it would look like.

What I Learned
I wanted to create this system for my own use. The design prompt was open-ended and hence we were left to our own biases, motivations and interests. I realized that I saw myself as an imperfect user and a student of technology.

My first intersection with *dynamic media* resulted in a video animation prototype, which I would go on to make into a physical prototype, later in the year. My initial inspiration guided the direction of my thesis and research about inclusion through digital methods. This project allowed me to think about my own perception of the world in relation to others and gave insight to the new people around me.



Left: Qazi Fazli Azeem demostrates his personal hand-gesture based numerology calculation method. Nov, 2012.
Above: The RFID cards are used to enter a users date of birth into the *Numerology Visualization* project, which then visualizes predictions on the monitor. Nov, 2012.

Perfect Customer (2012)

Description
This project was a response to the 1967 short film, *Perfect Human* by Danish film maker Jørgen Leth. The film depicts a detached perfect man and woman, labelled 'the perfect human', 'functioning' in a white boundless room, as though they were subjects in a zoo. The film itself was the prompt given by Professor Jan Kubasiewicz in my design studio class.

My initial direction was to focus on the linear narrative, making it dynamic, with multiple outcomes depending on user choice. I was interested in the transition from a 2D to a 3D view, if that could be done through technology. I wanted to experiment with an immersive virtual environment, since the environment itself was an active player in the film. For a short time, I wanted to see the implications of the film being translated scene-by-scene into interactive 3D models.

Design Process
I broke the film into scenes. I saw abject consumerism, with the man smoking a pipe, the woman applying makeup, both of them wearing formal clothes throughout the film.

The stereotypical movements and actions showed a power dynamic in the behavior of the actors, being subservient to the filmmaker. This disconnect in power, to me, was a reference to corporatocracy, as referenced in the book *The Price of Civilization* by the economist Jeffery Sachs. An economic and political system controlled by corporations or corporate interests, their formal suits being uniforms for their work. It was apparent to me; the *perfect human* in 2012 was in reality the *perfect customer*. Daily activities could be mapped to commercial ones, such as watching TV, listening to music, surfing the Internet, watching advertisements.

This project became my first physical interface, drawing from the initial inspiration of some learners on the autism spectrum being sensitive to touch and haptic feedback, preferring not to physically touch the mouse or keyboard. Parts of the body that interact with the environment would be intersected with artefacts of digital identity, such as a credit card, smart phone, email address or a social media account. I thought about the *perfect custome*r, if he would browse the web, would he use Google or Bing? If he saw online TV would he use Netflix or HuluPlus? Would he use iTunes or the Google Play store? Would he read a book on his Amazon kindle or his Apple iPad?

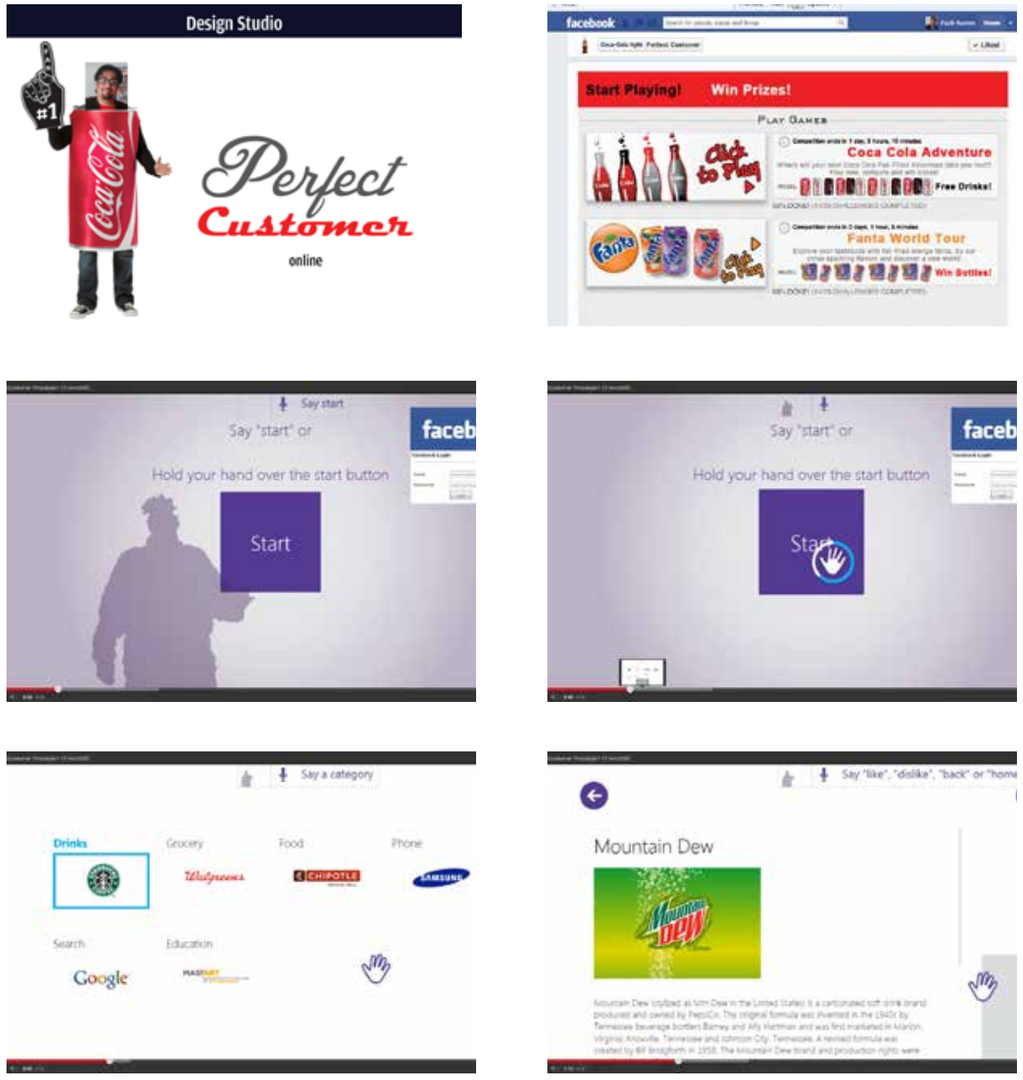
This project was created to give users a different social experience interacting with information about their favorite brands and products. I used a Microsoft *Kinect* to create a hands-free user experience that would be used while standing.

I wanted to simulate prolonged engagement through gamification as well as a different way of interacting with information. In the context of the theme and the name of the project, I chose information from well-known brands such as Pepsi, KFC and Gatorade. My design incorporated interactive games that could be played through social-media integration, as well as a built-in quiz that gave points for correct answers. These would add up to small rewards for loyal users. I saw some users connect the presence of the *Kinect* with expectations of a game, due to its connection with the X-Box platform.

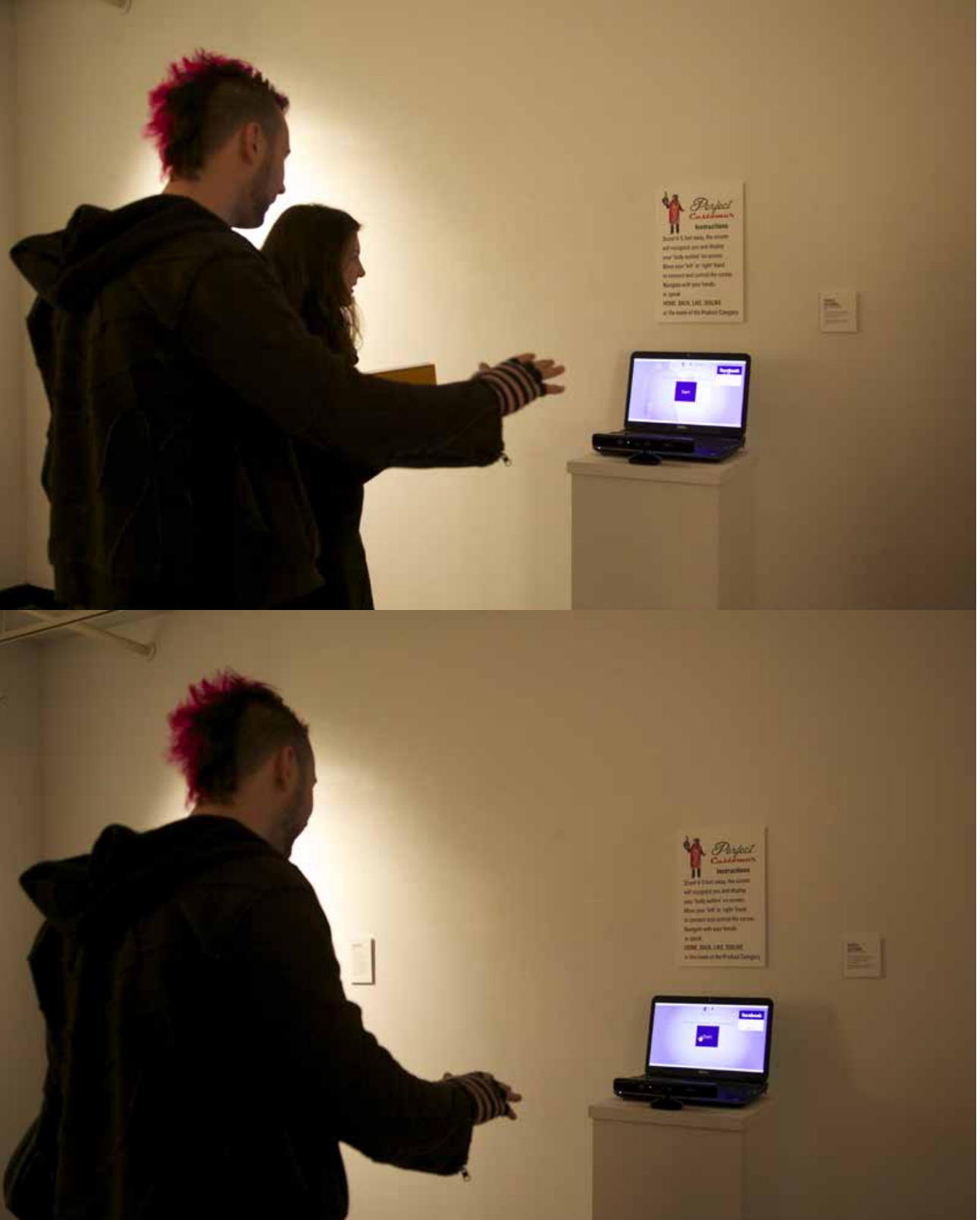
I tested this system during the Fresh Media 2013 show at the President's Gallery at MassArt, and then moved on to design tactile touch-based experiences, to compare with this hands-free interface experience.

What I Learned
My design inspiration was the direct result of the non-haptic wireless hand gesture-based interaction process that I had started earlier with the *Numerology Visualization* project. This project was intended for everyone who came to the Fresh Media art show. I saw a diverse group of users interact with it, from as young as age eight to as old as seventy.

I learned that I could re-purpose modular interaction technologies and provide new interface options to engage learners. Ideas of constructionism (the user choosing and hence 'making' their own interface) and connectivism (social media integration) emerged from the experience of designing and testing this project.



Above: My *Perfect Customer* Kinect-based hands-free user interface project changed many times, with the last iteration an information-browsing service controlled by voice commands or hand tracking. December 2012.



Various: My *Perfect Customer* Kinect-based hands-free user interface project was displayed and tested at the 2013 DMI Fresh Media art ahow, at MassArt's President's gallery.

Above: Qazi Fazli Azeem, Jordan Rogoff and Marcelo Giovanni, members of team solarsip at the 2013 MIT-Museum Energy night with a poster of the Little Drop UV water filtration straw, a sister product designed for artist Olafur Eliasson's Little Sun.

Little Drop (2013)

Description
I participated at the MIT Hacking Arts Hackathon to understand how people learn and work under high stress conditions. This was to simulate the learning process of gifted people, having diverse interests and working with new ideas in a short period of time. At the event, I met skilled students and professionals from the greater Boston area. Architects, engineers, entrepreneurs, designers and artists made up the initial *Little Drop* team for the weekend hackathon at the MIT Media Lab. We knew that we had less than a day to work together, negotiating and compromising between our diverse ideas. This was my first hackathon event and group project where I worked on a bigger problem (water purification) that was out of my comfort zone. This was an ideal situation to simulate rapid learning from a diverse group of college students. I was the only artist in my group, along with graduate students from the Harvard Graduate School of Design, MIT Sloan School, MIT Media Lab and engineering professionals from the greater Boston area.

The challenge given to us was to re-design and re-iterate the Little Sun, a portable solar powered lamp designed by the Dutch artist Olafer Eliasson, winner of the 2014 MIT McDermott award

The solar lamp was made from bright yellow plastic, five inches across and shaped like a sunflower with a solar panel on the back, powering a bright yellow LED light. Five hours of charging in the sun would equal 10 hours of soft light, or four hours of bright nightlight. The prompt was to rethink the product, adding features and making it appeal to poor users in developing countries without electricity. The device was originally intended to replace night burning of kerosene oil, which was both expensive and hazardous.

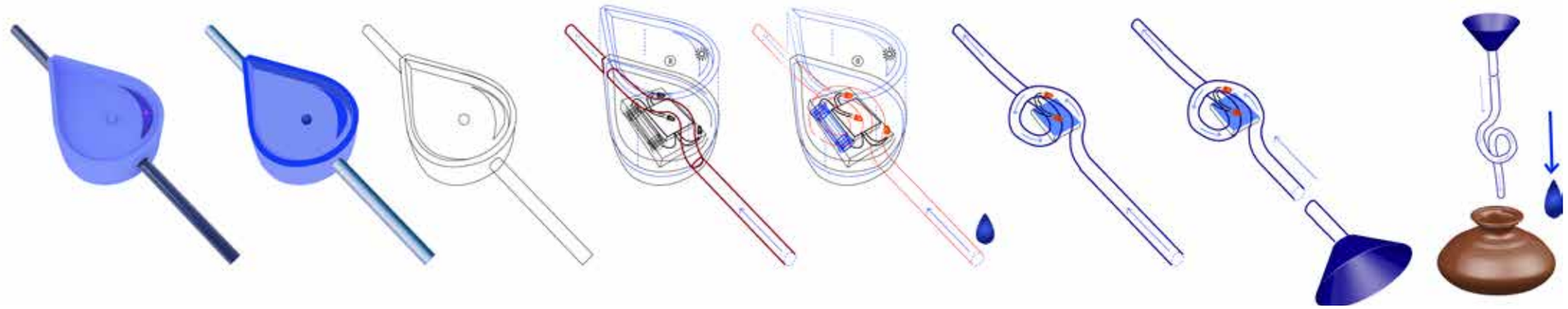
Left: A 3D rendering of the Little Drop, a UV germicidal water filteration straw, designed with a team of graduate students at the 2013 MIT Hacking Arts Hakathon, for Dutch-Icelandic artist Olafur Eliasson.

Design Process
Being inspired by the form and function of the Little Sun solar lamp, I designed a sister product, the UV germicidal water drinking straw, Little Drop. For the prototype process, my role was to design different form factors, shapes and hand-held shells surrounding the battery and the UV LED.

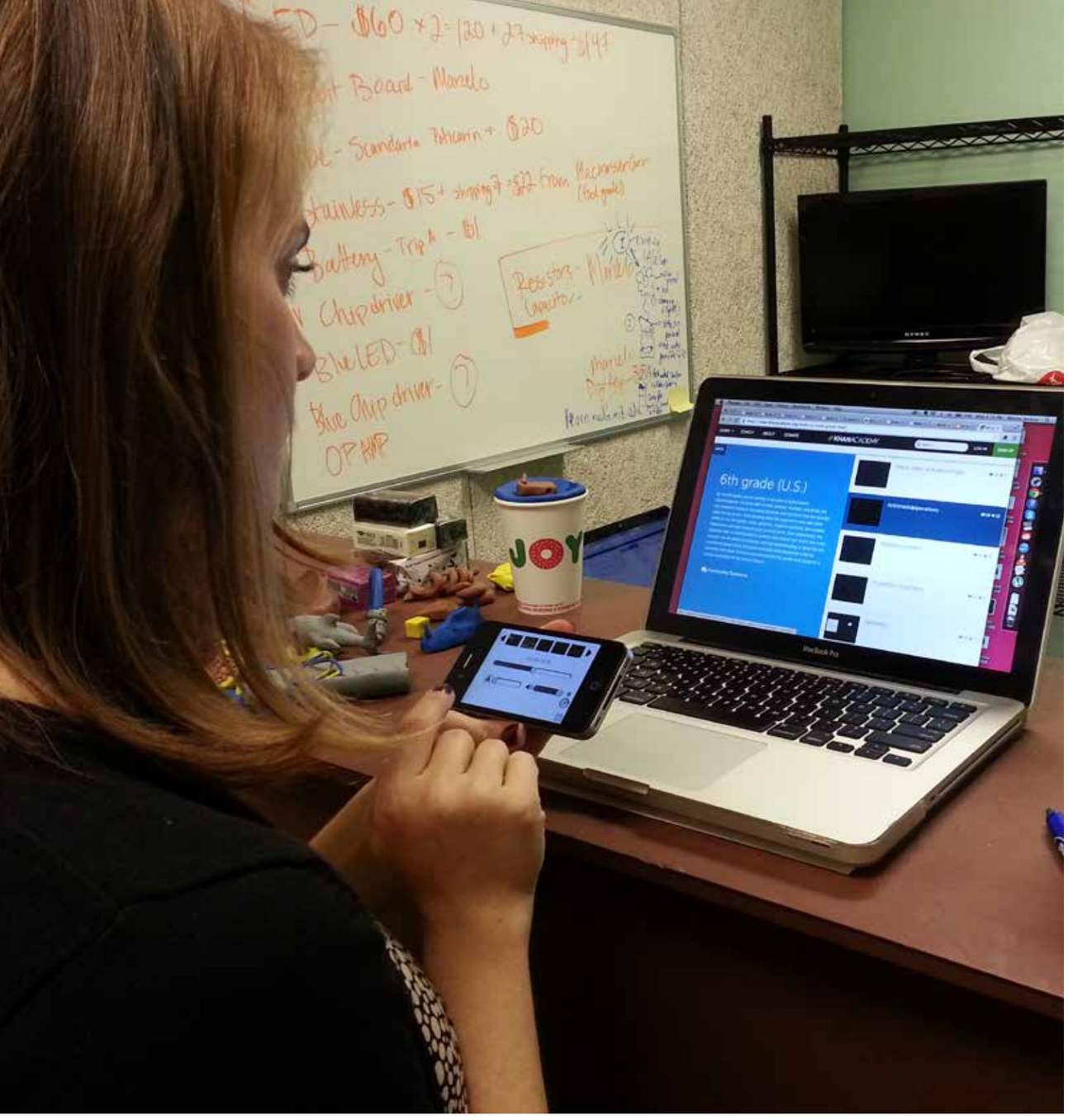
I used whatever materials were available for my prototypes, such as wood and clay. The analogy was the same as learning to make something new based on what I already knew. The shape was eventually 3D printed and shown to potential users. I exhibited the prototype shape and got user feedback at the MIT Museum Energy Night as well as the White House & FEMA 2014 Safety Datapalooza in Washington DC. User feedback was positive; most people said that if it was portable and was able to clean drinking water, the shape would not matter. The analogy is that if an interface is portable, and does not get in the way of a system being used, users would be interested in using it to achieve their goals.

What I Learned
I collaborated with people that I did not know anything about, going through rapid design iterations until everyone was satisfied. I had studied *Industrial Design: Form* at MassArt with Professor James Read, and applied it to a real-world problem. The *Little Drop* prototype was treated like an interface, a tool so simple that users may interact with it without actually learning how to use it. I wanted to create something that a potential user could just pick up and use immediately. The connection of this project with my researchable question was to measure if an interface could hide complexity and be minimally self-explanatory through the affordances available. This project gave me a greater appreciation of industrial design and how it relates to *universal design*, by attempting to design inclusively for all kinds of users.

Above: Designer Jordan Rogoff with Qazi Fazli Azeem, representing the MIT solar-sip team at the 2014 Safety Datapalooza in Washington D.C.



Various: The different Little Drop prototypes designed for the MIT Hacking Arts Hackathon, and later for Little Sun creator and MIT McDermott award winner, Dutch-Icelandic artist Olafur Eliasson (seen in the photo above).



Above: Graphic designer Jordan Rogoff tests the *Inclusive Player* prototype to browse khanacademy.com videos at the MIT Media Lab. December 2013.

Educational INTERFACE *Projects*

Inclusive Interfaces

Inclusive Player (2014)

Description
Online learning presents a great opportunity to help educate people with learning disabilities and those on the Autism spectrum. The most significant media artifact that I had to design with was video training. Hosted on free video sharing websites like YouTube, much of the video content tied to free Massive Open Online Courses (MOOCs) and Open Educational Resources (OERs) is freely available on the Internet. So much so that there is too much content online, and no easy way to browse it, other than individual viewing in a web browser. Modification of text transcript size as well as browsing through play-lists and chapter names is only available in commercial platforms such as wLynda.com, or in KhanAcademy.com's limited titles. Most OER and MOOC interfaces have small buttons, minuscule screen representation of icons, designed not to distract from the video content, while occupying smaller screen real-estate.

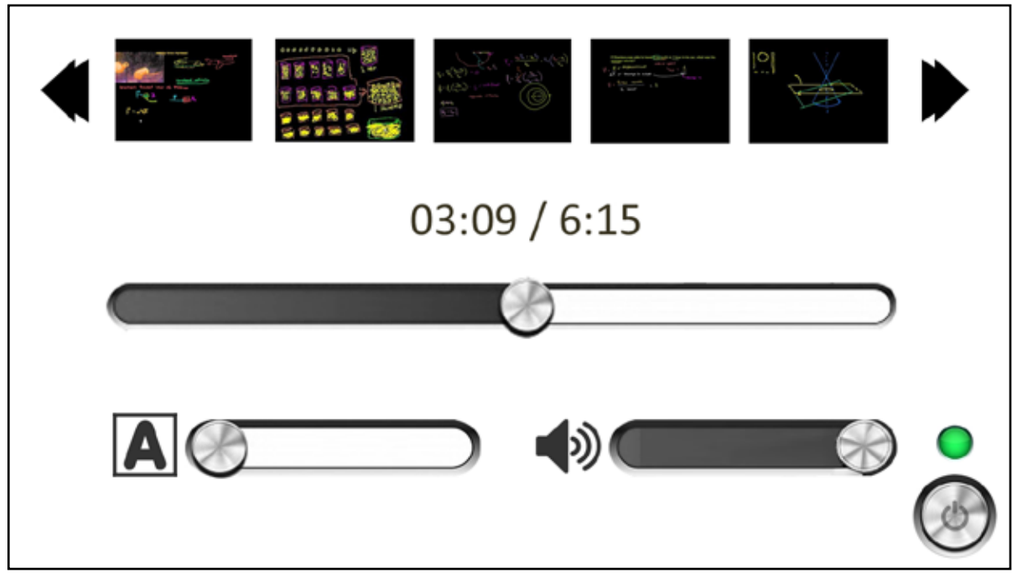
I wanted to make a seamless interface for a mobile app with haptic feedback (vibrations) and large buttons. This could be used to control the interface of online learning courses, as well as accommodations for accessibility options such as font size, volume, current progress and skipping to the next or previous lesson. The user would see video content on a laptop, TV or tablet, but would use their smartphone to browse through it. If the user wanted to use their phone to see the video content, an interface such as the *Inclusive Player* would provide accessible access.

Design Process
The direction of my initial design sketches conceptualized using the smartphone interface for controlling video content like a remote control, not using the smartphone as the video player itself. Due to cost and practicality, I later switched to a sliding hybrid interface, a semi-transparent layer of controls above the video content. I thought about having no text, only larger icons representing text size, speaker volume and a play head. Buttons would allow moving forwards and backwards with the content. Based on feedback I received, I decided to have video name icons and title names as part of the top level of the interface, appear as a drop-down filmstrip from above. This would allow visual feedback about the length of the lesson plan, minimizing potential anxiety about boredom or time restriction. Merging the current playback time within the play bar was an interface choice, to save on screen space. I have never seen video players with adjustable transcript font size, and wanted to build in that feature particularly for verbal learners who preferred reading as opposed to listening to the videos.

What I Learned
Testing out the prototype with college students at MassArt and MIT, a comment that stood out was the experience of these modular interchangeable interfaces being like interchangeable Lego blocks. Many students liked playing the video content and did not like putting on tight or loose headphones to hear the related sound. My transcript-enabled interface (with the power to turn the volume off) appealed to indoor users. The form factor of a virtual learning environment needed more than just a content deployment solution, it needed a way to test what the students learnt. Researchable questions that emerged directly as a result of testing this interface were:

1. How would I allow this interface to jump to a quiz or testing module, and accommodate for different types of sensory learners, without excluding anyone? Would this process engage learners with different learning styles?
2. How would I replace this video environment for a user who does not want to touch a screen, preferring to use hands and finger gestures for controlling content?

I addressed these questions in my next project.



Above and Left: Concept sketches and user testing of the Inclusive video player interface design.

Inclusive Interfaces

Inclusive Timer (2014)

Description
I was concerned about visual feedback during the general quiz sections of online educational courses such as MOOCs. Most students do not perform well under pressure, particularly when giving tests or quizzes. This problem would only increase if students were tested through a mobile interface, due to restrictions in screen size and environmental distractions (noise).

I wanted to provide alternatives for different types of visual feedback that communicated the remaining time in an online quiz. Online learning materials are short, modular, and broken into chunks of data for mobile delivery and are usually connected with time sensitivity, particularly when attempting to check for mastery through a connected quiz.

Design Process
I designed a color-based timer, morphing from one color to the next over time, as the end of the quiz draws near. I did not want to exclude learners with color blindness, and designed for them, giving an alternative interface to choose from. The traditional number counting down feedback would be there, secondary to the learner's preferred choices of feedback. Learners like me have dyscalculia which results in problem estimating numbers and quantifying how much time would be left to answer a question. Haptic or visual feedback, (through a vibrating device) would allow live feedback by increasing vibrations as the end-time approaches in a quiz. I included these features in my design iterations.

Lastly, I designed a pie chart shape-based countdown which would allow the shape to fill up with color, mapped to the time remaining to solve or answer a short question. Large red circles below with the characters A, B, C, D would allow finger-based multiple choice selections. I did think about each button relating to a separate color, instead of a letter, particularly important for those with a reading disability, e.g. dyslexia, who may find similar colored text illegible or hard to read.

What I Learned
In some cases, the size of the smartphone limits visual feedback, especially in the context of participating in a timed exercise or quiz. The more buttons and options we try to fit on the screen, the farther away we move from an inclusive experience and towards information overload. I knew that a tablet-based interface would be more inclusive due to a larger screen size, and wanted to provide the same feedback for a user with a smaller-sized smartphone.

There were accessibility limitations for this design iteration, as some learners with Autism do not like being touched and are tactile sensitive (as defined in the DSM-5). These learners would not appreciate haptic feedback, and would need a different visual prompt, such as color and shape based (pie-chart) feedback. Tactile sensitive learners with ASD would prefer an interface that they would not have to touch. Thinking about how such a learner would interact with the user interface, I went on to re-iterate my design and created the *Inclusive Gestural Interface*.

Above: A concept sketch and screen-shot of the *Inclusive tmer* user interface.

Above: The *Inclusive Timer* Interface in color feedback mode.
Below: The *Inclusive Timer* Interface in number countdown feedback mode.

Above: The *Inclusive Timer* Interface in vibration/haptic feedback mode.
Below: The *Inclusive Timer* Interface in visual countdown feedback mode.

Inclusive Interfaces

Inclusive Gestural Interface (2014)

Description
As I worked with the idea of a hands-free user interface, I remembered the limitations of the Microsoft *Kinect* sensor for my earlier project, *Perfect Customer*. The *Kinect* works an average of 6 feet away from the user, with the new *Kinect* for Windows working at a distance of 3.5 feet. This would be impractical for a personalized user interface of a learner who may only have access to a smartphone, tablet or a laptop.

Working around this distance limitation, I acquired the *Leapmotion* device, a new short-range gestural hand sensor. Most of my interface projects were designed for learners in an indoor environment, using their hands to manipulate the interface. I wanted to design an experience that would replace the mouse and keyboard, devices which have now been around for more than 70 years.

Using the *Leapmotion*, the user's fingers, hands as well as wrist gestures would allow a greater range of expression, closer to the screen. A simple but powerful uses of the *Leapmotion* device would be flicking pages in a book just by moving a finger in the air. In the case of learners with ASD who would have tactile touch sensitivity, touching the cold glass screen of a smartphone or tablet device and making precise gestures with their fingers, could be avoided by using a hands free interface built with this technology.

I wanted to design an experience where there would be minimal training required to interact with the system, other than a visual cue. I was interested if the interaction would resemble physical play, hiding the complex technology to provide a 'sensory-neutral' interface for learners with ASD.

Design Process
Using the basic three finger gestures, swipe, tap and circle, I thought about mapping these through the *Leapmotion* device to equivalent functions for browsing educational content, such as 'moving to the next video', 'play/pause current video' and 'menu options', respectively. I wanted to have the volume controls built into the interface during play-back, with a vertical gesture controlling it. Secondary goals for the interface were to make the technology near-invisible, not to have any physical artifacts distract from the content or educational material.

My researchable question was to see if I could design a hands-free seamless 'sensory-neutral' interface that would appeal to learners who may not be using technology as their primary tool for learning (as opposed to books and classroom lectures). Longer, complicated and deeper content could be consumed at the learner's pace. *Universal design* principles recommend a greater choice of options to interface with learning materials to me, the *Inclusive Gestural Interface* would allow greater inclusion for a diverse group of learners by replacing a mouse with in-air finger and hand gestures. The system would, of course, not work with learners who do not learn visually or those with muscular dystrophy or hand-eye coordination issues.

While touch-screen phones were not a new technology, the iPhone made them accepted, comfortable and convenient. I wanted my *Inclusive Gestural Interface* to replace most forms of mouse input. Using *Processing* code from the *Leapmotion* library, I modified an example project to detect a gesture and parse/browse through learning videos, while the *Leapmotion* was connected to a personal laptop. Full and direct integration with a smartphone is currently being developed by the company, and may be an option in the future, i.e. to have a swipe gesture-based interface without a computer.

What I Learned
People with ASD have a higher probability of having dyspraxia, the 'clumsiness disorder'. While I was designing for these learners, my original inspiration came from my own early childhood difficulties pressing the buttons on a keyboard. I wanted to have a system that did not get in the way of the learner, who may be clumsy with challenges in hand-eye coordination. Since the user would need to be sitting close to their laptop or screen, using these hand gestures to control content on a smartphone or tablet would be the next iteration, when the code and technology develops further, soon. The *Leapmotion* device allowed a practical prototype to be created within a short period of time, using the *Processing* examples from the online SDK. Researchable questions that emerged as a result of making this project were:

1) Could I combine this gestural tool with the *Inclusive Player* and *Inclusive Timer* project interfaces to create a hybrid interface? I was interested in a hands-free gestural control of the interface, as opposed to the traditional swipe gesture on a touch-screen.

2) The limitations of this developing technology would reduce over time, enabling the swipe and hands-free gestures to control augmented media devices such as Google Glass or future versions of smartphones. I would be interested in developing interfaces for browsing educational content on these augmented reality devices, particularly in a 3D space.

These gestures are not unique, the distance from the device and the short-range affordance of the *Leapmotion* trumps the long-range *Kinect*, particularly for a seated posture common to digital learners. Short range and finger-based gestures have only recently been enabled using the new *Kinect* One for the Microsoft Xbox One, costing close to $150. Miniaturization of the *Kinect* into smartphone applications through Google's project Tango is the beginning of personal gesture recognition technology, which will come into common use.

My prototype was an exercise to simulate a portable interaction system, something that I want to continue working on after concluding my graduate degree. Used together, my *Inclusive Interfaces* were designed to provide greater choices to learners, particularly for interacting with open educational resources such as MOOCs and video training.

Above: The *Inclusive Gestural Interface* being tested with MOOC online videos.
Below: The *Leapmotion* interaction device which powers the *Inclusive Gestural Interface* hands-free experience.

Spatial Learning (2014)

Description
Temple Grandin wrote in her book, *The Autistic Brain*, about 2 types of intelligence that Maria Kozhevnikov discovered at the University of California during the 90s. There are two visual pathways in the brain, the dorsal (upper) one *Processing* information about the visual appearance of objects, such as colors and detail. The second is the ventral (lower) path, *Processing* how objects relate to each other, spatially. Temple Grandin defines visual intelligence for people on the autism spectrum as being pattern-based thinkers or having spatial intelligence. Kristine Barnett, the mother of autistic child prodigy Jacob Barnett, writes in her book The Spark about her son Jacob when he was a toddler. Jacob seemed to ignore the pain from his ear infection only when looking at the geometric plaid pattern on the duvet cover on his bed, his face inches away from the lines. This hyper-focus behavior has been documented by researchers as the beginnings of spatial intelligence, connected to pattern recognition in the brain.

I wanted to simulate a 3D virtual learning environment with interactive educational content, to stimulate spatial intelligence in learners. *dynamic media* enabled jumps in virtual learning environments (VLEs) and new tools such as low cost virtual reality headsets (e.g. the Oculus Rift), allow 3D simulation and immersion with digital content.

Design Process
To simulate what an online learning course (MOOC) or open educational resources (OERs) would look like in a 3D environment, I used the beta version of *ZIBITR* to simulate an experience. Taking open-access videos from Learning Creative Learning, a cMOOC that I had taken at the MIT Media Lab, I simulated and placed the content in a virtual space, much like a room in an art gallery. The virtual space had walls, space for videos (that could be played on clicking), space for text (that could be read on clicking) and even a door to move forwards or backwards through the chapters and content. The spatial mapping of linear content into a 3D space allowed me to organize the content as a curator.

I had to make decisions as to where each object could be placed, where each photo slide would be shown, how large the headings would be and how to divide content into four sections, each one a wall.

I wanted learners to visualize a 3D environment where the user could move around in space.
A similar conceptual model could be mapped to a 3D learning environment, similar to the experience of a 3D game.

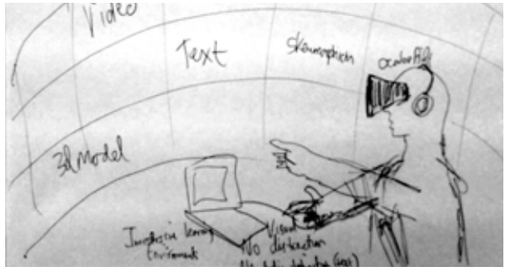
What I Learned
The structure of laying out video content on a flat 2D wall may defeat the purpose of the 3D room, unless there is a clear starting point and ending point to the progression of the content. A hall-like or tunnel like interface (with multiple exit doors) allows us to keep the linear structure of the curriculum in place. This experience could be mapped from a structured online course (MOOC) or a lesson plan from lynda.com or khanacademy.com, only when the direction of the content is apparent. A gallery like room allows deeper engagement with interactive exercises, 3D models, virtual simulations and curiosity-based learning, which are not possible in a 2D format.

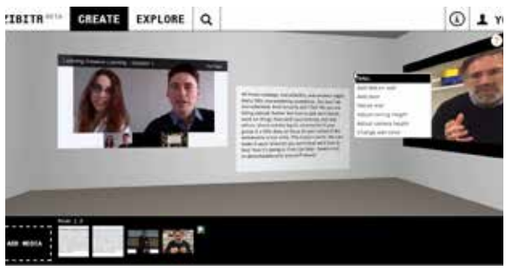
A 3D environment that allows a different way of learning may work better if the experience has interactive content, not just videos that are seen or text that is read. Taking advantage of the sandbox virtual experience, in-game dynamics such as basic physics simulations and 3D models would allow a fun way to learn by exploration. Research has existed for over 20 years in support of Virtual reality 3D environments to teach adults and children with special needs.

The room structure itself is limiting. Online examples of new media 3D environments have experimented with no walls at all, reducing or removing the limitations of space, with content in layers like floors of a building. Higher content denoting progression forward, lower content implying basic or beginner material. I was aware of educational content being placed in floor-like grids. My experiments and prototype were more skeuomorphic (The design concept of making items represented resemble their real-world counterparts), resembling the four-walled structure of a traditional classroom. I wanted to not only display chapters in a curated MOOC lesson, but supplemental learning materials and interactive 3D models in the same virtual room.

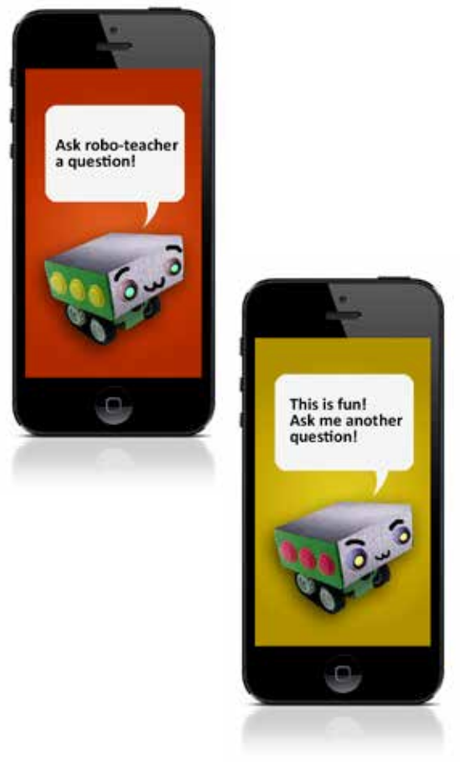
I did not test 3D avatars or a multiple-user experience, due to existing research with online systems such as *Second Life* and MMORPGS (Massive Multi-player Online role-playing games), a separate field, already authenticated and verified by earlier work at DMI. I learned that the virtual room format was not the best solution for a single-user MOOC lesson plan (based on my observations), but a good solution for multi-user social engagement through avatars (based on earlier observations).

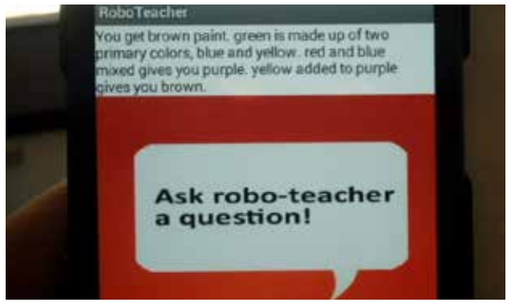
Due to time restrictions, I did not move beyond preliminary prototyping towards deeper exploration of virtual learning environments (VLE). I intend to continue this avenue of *spatial learning*, using the Oculus VR headset to prototype 3D learning environments after completing my graduate degree. My intent, in the long term, is to combine all my inclusive design projects into a greater inclusive learning experience. This is an area of research that needs further experimentation as the technology is tangential to my thesis.





Top: An early concept for *Spatial Learning*, I wanted to simulate learning materials such as video and text in a 3D spatial virtual environment. Sep 2013.
Middle: A prototype 3D learning environment using the prototype zibitr web kit and MIT Media Lab LCL MOOC videos. Feb 2014. <www.zibitr.com/exhibition/80>
Bottom: I intended the *Spatial Learning* experience to use new VR tools such as the Oculus Rift 3D headset. Feb 2014.





Top: *RoboTeacher* app gets ready to answer a question for a user based on speech input. April 2014.
Bottom: *RoboTeacher* app screens. April 2014.

Top: A photo with Professor Joost Bonsen and with the MIT developer of AppInventor, Leo Burd, researcher at the MIT Centre for Mobile Learning. Media Ventures Class, MIT Media Lab. April 2014.
Middle: A designer working with the AppInventor team at the MIT Media Lab demonstrates rapid prototyping with Andoid phones during the 2013 Festival of Learning. Feb 2013.
Bottom: *RoboTeacher* app answers a question for a user, on mixing different colors of paint. Feb 2014.

Early Mobile Interface:

RoboTeacher (2014)

Description
A recurring theme in technology is the role of robots, as teachers and companions in the learning environment. From empathy modelling, emotional attachment, companionship, and mentoring to replacing the teacher, robots have had unprecedented success in the remedial classroom. My travels around Boston and MIT, meeting Artificial Intelligence and Robot enthusiasts such as Ray Kurzweil, Juan Enriquez and Marvin Minsky gave me the opportunity to reflect on their public opinions about the greater role and potential of robots in society.

Thinking about the implications of robots on learning, I ran into robot designer Alex Reben at the second annual TedxBeaconstreet conference at Google Cambridge. Alex designed his personal robots to learn by asking questions from users. His robots were extensively tested by children and young adults during the TedxBeaconstreet event. I wondered if some traditional teaching tasks, such as lecture delivery, could be replaced by robots, in the absence of teachers.

Design Process
Alex Reben's personal robot, *BlabDroid* was being demonstrated for young children, as they came up with potential uses for it. A recurring theme was using robots as a replacement for the teacher. I designed the *RoboTeacher* app, inspired by the look of Alex's *BlabDroid* by using the Android *Appinventor* software to create a quick prototype interface. I wanted to simulate the idea of the robot as a teacher, using user data over a period of time (for all its users around the world), becoming better at answering questions. The app had a friendly animated cartoon face, since I wanted the design to be approachable. I designed the interface to respond to a direct question, with answers given through screen text as well as read out by text to speech. Initial testing with a group of college students in Boston was positive, but worked better when indoors without distractions. The app was designed to be used in a quiet, personal environment.

What I learned
My researchable question was to evaluate if a mobile app could provide a non-judgmental socially neutral environment for a learner with ASD. This would allow me to focus on mobile apps as solutions to the social anxiety and communication difficulties of people with ASD. They may prefer asking a question from the app, compared to asking them in a class full of other students. Older students were concerned with the *RoboTeacher* app being of limited functionality, while younger students saw it as a toy. Lack of eye contact and limited social skills of people on the autism spectrum could lead to augmented communication in an inclusive classroom.

Having a robot or a robot app augment or support a classroom is very different from the educational experience being centred around or being led by *RoboTeacher*. Trying out the concept with college level students, most of them went beyond the limitations of the prototype to ask tougher questions, attempting to interact with the screen for additional functionality. This meant that I needed to develop the interface further in subsequent projects, moving away from a minimalist voice-activated interface.

I intend to continue this avenue of research after completing my graduate degree. My intent, in the long term, is to combine all my inclusive design projects into a greater inclusive learning experience, with robot communication and learning being tangential to my thesis research.

Left: *Curious Learning* app, an inclusive, adaptive geo-located curiosity based mobile and social learning experience. April 2014.

Above: A user tests an earlier design of the *Curious Learning* app, an inclusive, adaptive geo-located curiosity based mobile and social learning experience. Jan 2014.

Capstone Mobile Interface Project:

Curious Learning (2014)

Description
My interaction with the edX team (see page 48) as well as MOOC interface prototypes put me right in the centre of the changes that Massive Open Online Courses (MOOCs) are going through. I was enrolled for Learning Creative Learning (LCL), the first MOOC offered to the world through the MIT Media Lab during spring 2013. I saw over 10,000 students join the online Google plus community for LCL, but realized that only a few hundred members actually posted homework assignments and personal projects online. I read about low completion rates in most MOOC platforms, a small percentage of students staying till the end, compared to the large numbers who signed up for them.

Learning from previous projects, I knew about high quality content out on the Internet, but saw challenges with learners with ASD accessing it, being overwhelmed by the interface. A secondary prompt was a class that I took at the MIT Media Lab, MediaLabX: New Learning Platforms. Challenged with creating the online MOOC platform for the MIT Media Lab itself, my team was supervised by MIT Media Lab professors Mitch Resnick, Pattie Maes, Ethan Zuckerman, Hal Abelson and by Media Lab Director's Fellow J. Philipp Schmidt.

The initial team composed of graduate students in the class, educators A. J Sakaguchi, Helen Poldsam and Molina Warty from the Harvard Graduate School of Education, engineer Dan Sawada from the MIT Media Lab, and me as the user interface and UX designer from MassArt. Later after the semester ended in fall 2013, me, A. J and Helen kept working with the project, pushing it further, while the other team members left. We were joined by MIT Sloan graduate student Eesha Sahai after I met her during my MIT Media Ventures Class with Professor Joost Bonsen.

Research about MOOC users showed us that over eighty percent of them were undergrads, belonging to the six percent of the population with college education. Due to my personal interest in Autism, I found out that only a third of people with autism are attending college, enrolling in fifty six percent of colleges in the US.

In the first iteration of *Curious Learning*, the group wanted to increase the number of students on the autism spectrum who would go on to apply for college. We wanted to do this by exposing them to MOOC videos in a fun online environment. My researchable question about learning styles of gifted individuals was tested in this project. I wanted to create a platform through which students with autism could use, to learn from each other. I wanted to test this with both neurotypical and gifted ASD students.

Educational Theories behind *Curious Learning*
A near-infinite amount of free educational materials online is leading to confusion and information overload. For students with ASD, reliance on open educational resources is cost effective, but remains a challenge, particularly those with greater needs for inclusion. Cheap access to powerful smartphones is a large opportunity that did not exist a decade ago. Learners would engage with artifacts and locations in the real world based on their curiosity and interests.

We wanted them to have a platform which allowed them to take a photo with their smartphone, post it online with a question and have friends and a teacher use it to start a conversation. The photo posted online would be the social prompt, and this idea of *Connectivism* would allow students to find co-learners who shared their own interests. *Connectivism* was proposed by Stanford's Albert Bandura, a psychologist who said that people learn through contact with each other, an idea called social learning theory. These understandings emerged after Noam Chomsky published his criticism of B. F. Skinners book *Verbal Behavior* in 1959, based on disparity between stimuli-responses and revelations about language learning through the study of linguistics.

"Too many educational practices and technologies require the student to be passive, isolated learners, versus active, self-inspired and collaborative in their learning. More teacher expertise and student input are needed to create a more interactive learning experience."

Jim Lewis, EdSurge.com
Dec 26, 2013

Critique of Online Learning Experiences

A survey from the University of Pennsylvania was published in the *New York Times* in 2013, which said that around 80 percent of those taking the university's MOOCs had already earned a degree of some kind. I wanted people out of college and those with learning disabilities to have an inclusive learning experience, and initially saw an opportunity to close this gap, using free MOOC videos.

Design process

To facilitate brainstorming and the creation of common directions, IDEO guided us using the Design Thinking for Educators Toolkit. The class wrote ideas on sticky notes, tackling the general education space by subdividing it into AEIOU: Activities, Environments, Interactions, Objects and Users.

Activities are goal-directed sets of actions. What are the pathways that people take toward the things they want to accomplish, including specific actions and processes? How long do they spend doing something? Who are they doing it with? These were some answers: informal conversations, asking questions, reading, exploratory, on a device, teaching.

Environments include the entire arena where activities take place. For example, what describes the atmosphere and function of the context, including individual and shared spaces? These were some of the answers: media lab, Forums, social media.

Interactions are between a person and someone or something else, and are the building blocks of activities. What is the nature of routine and special interactions between people, between people and objects in their environment, and across distances? These are some of the answers: Google Maps, community, customized learning, accessibility, special education.

Objects are the building blocks of the environment; key elements sometimes put to complex or even unintended uses, possibly changing their function, meaning and context. For example, what are the objects and devices people have in their environments, and how do these relate to their activities? These are some of the answers: shared apps, games, mobile devices.

Users are the people whose behaviors, preferences, and needs are being observed. Who is present? What are their roles and relationships? What are their values and prejudices? These are some of the answers: teenagers, children, researchers, people without college degrees, lifelong learners.

Framing common directions as design thinking "how may we" type of questions, our group came up with:

- How might we make learning more agile?
- How do we sustain curiosity?
- How might we take learning beyond necessities?
- How might we make learning nonlinear?
- How might we make learning accessible to accommodate diverse learning styles?
- How might we make learning a continuous adaptive experience?
- How might we make learning independent of state/availability of technology?
- How might we shift learning focus from outcomes to competencies?
- How might we promote transmission of knowledge through sharing?
- How might we cater to multiple intelligences?

Keeping the scope and immediate MIT Media Lab context in mind, the group came up with a single question: "How might we inspire curiosity in adult learners outside of the Media Lab through question-based, collaborative interactions?

Personas

In this context, I created two neurotypical personas for the kinds of neurotypical learners who may benefit from my research into inclusive interface design. For the first use case, we imagined how each of the three might behave in an outdoor environment like Yosemite Park.

Persona 1: **John** — an international student.
ASD equivalent to Jacob Barnett.

This user is young, curious, gifted and wants to learn more about his favorite subject. Shy but is able to use technology and computers well. He feels out of place due to young age among older learners. Single minded, focused, interest-based learner.

Incentive to Go to Yosemite Park:

John is a 19 year old student with good verbal skills that just came from Japan to pursue an undergraduate degree in English Literature from UCLA. He's heard rumors about Yosemite being a "must-see" park before classes start so he decides to go on his own with a tour bus. His hobbies include video-games, comic-books, cooking, and zip-lining. He hopes to take nice pictures of Yosemite to put on *Facebook*, *Twitter*, and Instagram.

After Visit to Yosemite Park:

He uploads pictures to *Facebook*, *Twitter*, and Instagram. He has a large following both in Japan and in the United States. He likes to put filters on his pictures so they will look more artistic. He captions the photos using witty statements. Many people, even people who he's never met before, "like" his photos or re-tweet his photo.

Persona 1: **John**

Persona 2: **Bob** — A socially awkward engineer.
ASD equivalent to Temple Grandin.

55 year old engineer, has hearing disability, likes to walk around outdoors, digital immigrant, has flip-phone but does not use SMS. He has an iPad that he received from his family but he's still learning how to use it. He is very opinionated, routine based visual learner. He likes reading about geology and rock formations in his spare time.

Incentive to Go to Yosemite Park:

He documents what he sees and experiences with a note pad, sketch pad or a voice recorder. He likes to read *National Geographic*. He hopes to just relax and get fresh air.

After Visit to Yosemite Park:

He shares the sketches with his family after dinner. He posts about the colors and the history of the Half-Dome at a geology forum online, writing about his about his past experience at the rock, which he visited 3 years ago. He mentions the next places he'd like to visit and encourages online users replying to his post to visit Yosemite Park as well.

Persona 2: **Bob**

User Experience Flow

The fastest way we could test this experience would be to simulate the experience of posting a question on social media with a geo-tagged photo. We asked our classmates at the MIT Media Lab to visit a tourist monument close by, such as the John Harvard statue. They would take a photo of the statue and post it on *Twitter* with the hashtag #John-HarvardX, asking people online questions about the historic statue. Some of them were told to try replying to a question that they were curious about.

While some students were carrying out our experiment, we observed many international tourists there, who were taking photos of the John Harvard statue at the Harvard University yard. We saw that they took turns with each other, posing with the statue, touching the left leg of the statue as a gesture of respect. We asked a few of them why they were taking photos and how they would use them later. They were taking the photos so that they could share them with their families and friends back home.

We started thinking about the question that we had to address with our potential users. How might we motivate a user with social or communication challenges to visit a public artifact like the John Harvard statue, and then motivate them to not only take a photo, but to post it online with a question, to start a global conversations with others.

A learner with ASD may lack the verbal skills, eye contact or confidence to ask a question in public from a stranger. I designed *Curious Learning* to look as familiar as a social media application such as *Twitter* or, using geo-tagged photos and leaving questions on the map. In future versions of *Curious Learning*, nearby users would be notified about the question, leading to initial online conversation on the platform, and possible answers to the question. Spatial association with ideas and knowledge leads to deeper learning for gifted learners, as outlined in Temple Grandin's research on spatial learners.

Above: Testing the experience at the John Harvard Statue
Right: The first design iteration of *Curious Learning.*

Use Case 1
For example, let's consider John, a 19 year old male international student is visiting a friend in Boston. Reading about the MIT Media Lab on social media and online for a long time, John finally has a chance to visit it. If John was a gifted person with ASD like Jacob Barnett, he would be a visual learner, driven by strong interests to the point of obsessing over them. A interesting building such as the MIT Media Lab, with public displays of ground-breaking science and art projects, would be a good location for John to take photos, posting them online and asking questions about particular objects that make him curious.

John wanders inside the Media Lab and notices an interesting piece of art next to the entrance. Curious about it, he snaps a photo, posts it on *Curious Learning* and asks "What is this made of?" Soon people start discussing the question and based on more than half of the answers, it seems like the interesting piece of art was made by hundreds of silkworms.

Use Case 2
For an older user, let's consider Bob, a retired engineer. He does not want to travel to the MIT Media Lab in Cambridge as he lives on the West Coast in the US, which is too far for him. He uses the *Curious Learning* application to look at the different geology category questions from around the world, based on his deep obsessive interest with the subject. He sees somebody post a question from the MIT Media Lab referring to a new tool displayed there that could help geologists identify rocks. The person who posted a picture of the prototype and a rock sample asks, "What kind of rock is this?" Bob does not know what kind of rock it is just by looking at the picture, but asks a question back to the person, "can you describe the texture of the rock?" He hopes that by knowing more about the colors and texture of the rock, he will be able to help the person discover what kind of rock it is, through the online platform. Bob may find others here who share his interests in geology.

Design Iteration 1
Learners are increasingly overwhelmed by the information in online learning environments. How does learning manifest itself outside the classroom? My group knew that curiosity is imperative for cognitive development and authentic learning.

We designed *Curious Learning* as a lateral counterpart to MOOCs. While MOOCs have been immensely successful in addressing topics within the virtual walls of a classroom, *Curious Learning* focuses on Socratic, collaborative, and inquiry-based discussions. If learners are increasingly relying on technology for information, I wanted a minimalistic yet fun experience to keep them engaged long enough to find co-learners. I did not want to deliver learning, but wanted it to emerge through learner experiences (Dewey, as cited by Pattie Maes 2013).

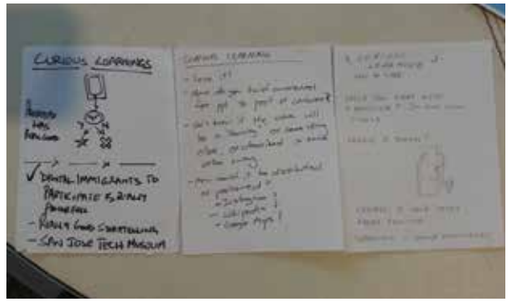
Curious Learning would convert places, artifacts, monuments, and nature into triggers for learning, supported by peer-to-peer interactions. I saw weaknesses in existing MOOC platforms that I wanted to address with *Curious Learning*. I saw MOOC students confined to virtual classrooms, relying on facilitator evaluation and drawing from academic curriculum, as opposed to the knowledge of other students.

While the desired aim is to seek factually correct responses, the app will expose generally held perceptions surrounding concepts, enabling deconstruction and rebuilding of knowledge, causing the learner to think and evaluate between competing answers, verifying each by independent online research, to satisfy their curiosity. Designed like a social media interface, responses would have 'likes', incentivizing other learners to post better answers to questions. *Curious Learning* is an interface to explore personal interests as much as it is to explore one's environment.

Feedback from IDEO
Referencing the IDEO *Design Thinking for Educators* toolkit allowed selection of ideas and deeper thinking about a dynamic educational experience, with a different interface. Team members from IDEO Cambridge were invited to the MIT Media Lab to critique project ideas made by students of MediaLabX.

Some feedback that I received from IDEO, after presenting the first iteration of my *Curious Learning* app:

- They liked the idea of asking people to learn more, but hinted that some incentives may be needed to retain students.
- Instead of older users, digital natives i.e. young technology users would be the first adopters of such a system.
- They wanted the user to start with a question and then wanted people to answer it collaboratively after visiting the location where the question was placed on the map.
- Long-term engagement with the question would be important, particularly when seeing updates left by others in that same location far away.
- They pointed out that maybe I should look at contributing, rather than asking, on the premise that people are already taking photos and posting them online.
- Making an innovation that would allow asking a question easier would help fit into the always-posting/sharing user experience work-flow. Question-based platforms such as Quora or Reddit were not designed for smooth, minimalistic mobile engagement or simplicity.
- The app should have a simpler, seamless workflow, encouraging learners to get started asking questions based on an area of interest.



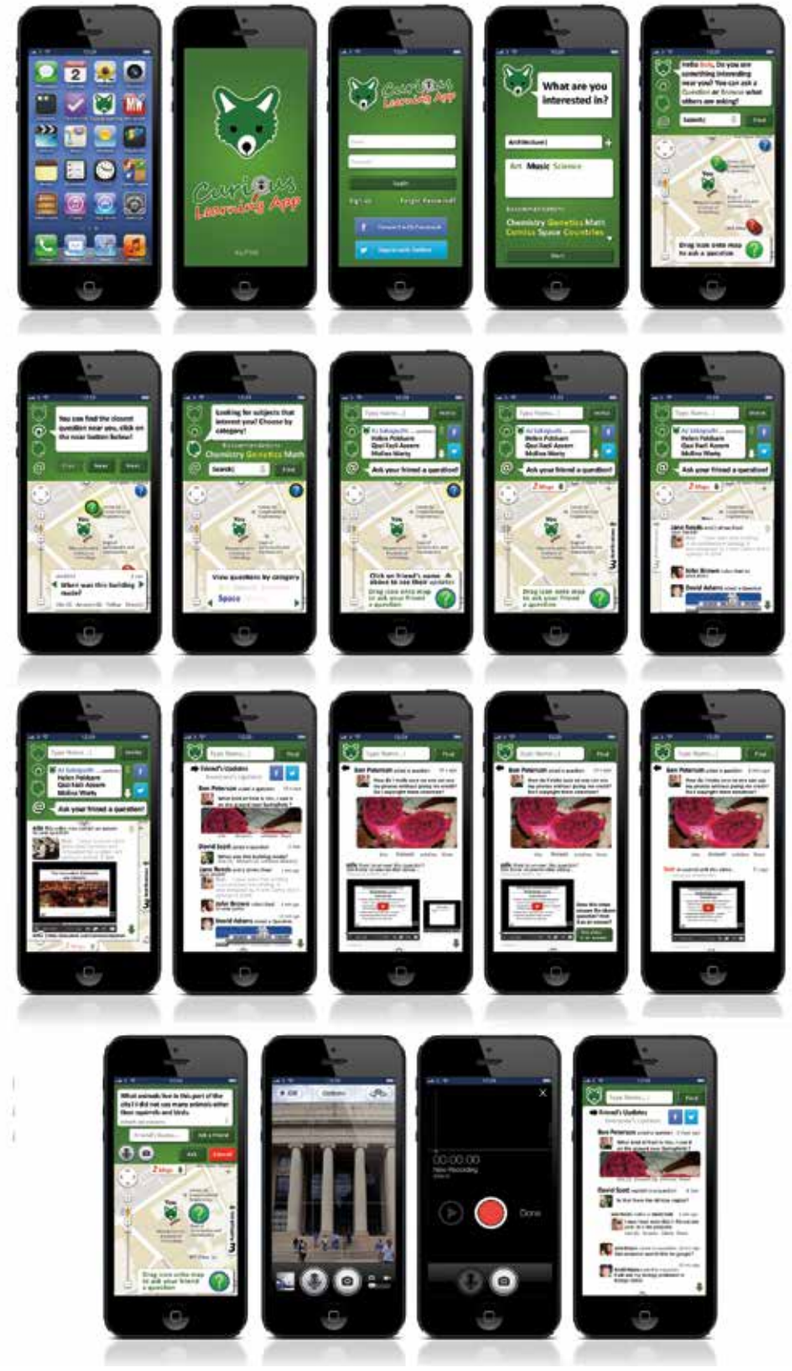
Top: The MediaLabX class used IDEO's design thinking toolkit for educators to create ideas around the changes we wanted with online education.
Middle: David Goligorsky of IDEO Cambridge and his team members giving feedback for my *Curious Learning* app design, during the fall 2013 Media LabX class at the MIT Media Lab.
Bottom: Hand-written feedback noted for *Curious Learning* by IDEO Cambridge.

Feedback from College Teachers and Students
The first iteration of the app design was shown to college teachers and students in Boston. The feedback we received was:

- The app may be a reversed Google, learning about things around you.
- Being more observant and curious may need incentives to be encouraged.
- We wouldn't care for the badges or gamification.
- How do we create meaningful conversations on the platform in a limited amount of space?
- Should answers given by real "experts" in the field be given special priority?
- There are already companies that are trying to "geotag" every location in the world. Could we work with them?
- Perhaps look into the mindfulness movement and see how they are getting people to stop and look at different places.

Design Iteration 2
My reason for thinking about edX as a potential partner was due to my participation in their datajam in Cambridge, MA in December 2013, which led me to present the *Curious Learning* app at the White House Office of Science and Technology Policy (OSTP) Education Datapalooza during January 2014. I had been made familiar with their system after meeting their head, MIT Professor Anant Agarwal. The non-profit mission of edX to provide equal access to students around the world resonated with my long-term vision for *Curious Learning*. I changed the animal mascot to a curious fox and re-designed the interface for a simpler social-media integrated user experience, working with graduate education students from the Harvard Graduate School of Education, AJ Sakaguchi and Helen Poldsam. I designed the user interface to be familiar to a tech-savvy smartphone using audience.

Top: *Curious Learning* group member AJ Sakaguchi getting feedback about the app from a high-school educator at the 2014 Department of Ed. Datapalooza in Washington D.C. Jan 2014.
Middle: With Virginia Maurer, Associate Director of the Derek Bok Centre for Teaching and Learning at Harvard University and *Curious Learning* group member AJ Sakaguchi and Helen Poldsam at the 2014 US Department of Ed. Datapalooza in Washington DC. Jan 2014.
Bottom: *Curious Learning* group member AJ Sakaguchi gives a TED talk on *Curious Learning* at the 2014 TEDxBeaconStreet TEDx conference in Cambridge. Jan 2014.
Right: The second design iteration of *Curious Learning*.



edX Integration
I designed two ways to integrate *Curious Learning* with edX MOOC videos:

1. If the *Curious Learning* user asks a question, individual words from the question or post would be converted into searchable hashtags, which would search the text video transcript of existing MOOC videos for relevant matches.
2. edX MOOC videos could be searched based on their text audio transcript, the city determined on where the video was filmed. Seeding MOOC video icons on a campus location may spark curiosity for users of *Curious Learning*, leading to viewing content that would otherwise not have been of interest. This may or may not lead to early awareness of MOOC videos and specialized fields, but this would be my optimal goal.

Feedback from 2014 Education Datapalooza
My team received feedback from teachers attending the US Department of Education — White House Education Datapalooza in January 2014. They were looking for ways to monitor progress when students were outdoors finding examples mapped to their in-class curriculums. I thought about having a teacher 'dash-board' that would allow high school educators an easy way to manage a large number of student posts, choosing unique examples to share in class. Many teachers that we interacted with in D.C. had inclusive classrooms. Some even had gifted children working with their IEPs, at their own speed.

Feedback from 2014 Harvard iLab Residency
My *Curious Learning* group won a spring 2014 residency at the Harvard Innovation Lab (iLab), and was paired with ed-tech mentor Chris Vento, founder of *Intellify Learning.* Based on feedback received from Chris, the group decided to work further on these points:

- Add value to education using dashboard for educators, with basic analytics.
- What happens when no one is around to answer a question?
- Teachers need to have some control over content, add a topic, put in some of their own content.
- Students should only be able to see posts from their class mates.
- Encourage to start with just simple text question and a photo for each post.

Based on the feedback above, these features would have to be designed for the next iteration of *Curious Learning*:

- Teacher log in screen
- Teacher can look at the map in real-time and see where students are posing questions
- Teacher can pose challenges to class which will show up on their app
- Teacher can pull analytics
- Teachers can monitor or participate in online discussions

Left: MIT classroom 26-100, after my SPARK-ESP lecture (March 16, 2014) to over a hundred 7th and 8th grade students.

Feedback from 7th and 8th Grade Students 2014 MIT ESP Spark
Professor of Physics Walter Lewin returned to MIT lecture hall 26-100 on May 16, 2011 for his famous "last lecture" physics talk and book signing, complete with some of his most famous physics demonstrations. The videos of Professor Levin's unconventional techniques in teaching physics became famous all over the world, leading to a permanent video display at the MIT Museum and becoming the first success story for the MIT Open Course Ware (OCW) Project. Seeing this video had influenced my perspective about the positive potential of online education, long before I arrived (Aug-2012) in the US for my Fulbright scholarship.

On March 16, 2014 — I taught in the same MIT 26-100 lecture hall, that Professor Walter Levin gave his last lecture in Physics. I presented my thesis research to more than a 100 students from the 7th and 8th grade, at the MIT 2014 Spark ESP (Educational Studies Program) — encouraging them to take autism research as a future career. This was a rare opportunity to experience what it felt like teaching in a room famous for so many successful MIT Open Courseware online lectures and Open Educational Resources (OERs), crucial to my thesis research. From the show of raised hands, there were close to a dozen students diagnosed with ASD and based on their questions and responses, I assumed that some of them were gifted. The majority of students in the class had siblings or family members diagnosed with ASD, this was one of the main reasons for attending my presentation, based on the summary they had read before applying to MIT-Spark.

I was able to show the *Curious Learning* app to the students at the end of my lecture. Some of the feedback that I received was:

- Students with ASD want to learn specific subjects based on their interests, helping connect them with like-minded co-learners would help them engage deeply with the app
- Allowing students to comment on and like each other's posts would encourage others to contribute and engage for longer
- Making the experience of posting on a map into a seamless two or three step process would encourage posting more questions
- Enabling student post privacy by only allowing classmates and teacher engagement (as opposed to making the platform open to everyone), this may encourage early adopters and curriculum related testing.

There is evidence for smartphone and tablet apps being used to help people with ASD communicate better. Mobile apps can help people learn by providing a fun social experience, very different from the noisy unstructured classroom environment.

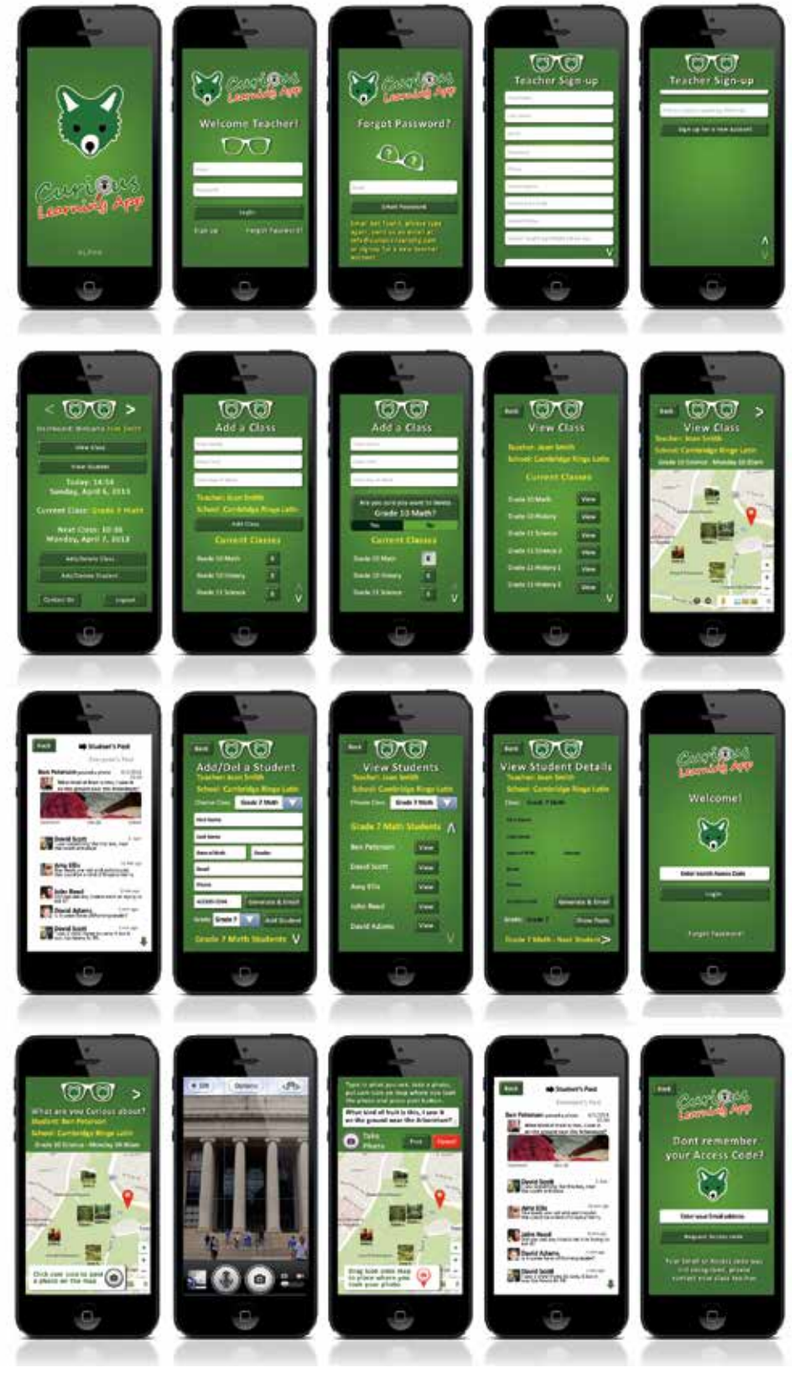
The competition for students' eyeballs is with social media websites like *Facebook*, *Twitter* as well as a question-based social network, Quora. None of these give classroom or curriculum mapping solutions for teachers.

Quora is question and answer based platform with social-media login support, where users post and answer questions for points. However, it does not allow posting images, videos and audio files that is central to the *Curious Learning* application. Based on our research, Quora is not actively used in classrooms. While *Facebook* and *Twitter* are rarely used by teachers in classrooms, those products do not provide a dashboard for teachers to keep track of student activities. In addition, *Facebook* and *Twitter* are not geo-located to allow students to easily leave and find questions and answers anywhere in the world. Furthermore, *Facebook* and *Twitter* do not provide education specific recommendations for additional content to explore. Gifted learners prefer to learn more about their subjects of interest, referred to as Interest-based-learning by educators. I wanted to make this the main feature of *Curious Learning*, to have deeper and longer engagement.

Design Iteration 3
The next iteration of the app was to bring real world observations to the classroom. I worked with my team to design an experience for pre-college and high school students both on and off the autism spectrum, with research showing higher occurrence of distraction similar to challenges that students face with ADHD (Attention Deficient Hyperactive Disorder symptoms).

This iteration was designed to map school curriculum to real world objects for subjects like biology, physics, chemistry and math. Based on in-class lectures, students would go out and photograph examples of what they learned in their class.

Through re-enforcing curriculum with real life outdoor experiences, the learner could find examples to enrich and validate what they learn in class. Teacher would be able to see that student's homework and also single out the most compelling examples. Tight connection between the real world practice and curricular theory strengthens interest-based learners (a common trait for those with ASD).



Above: The *Curious Learning* work-flow. 2014
Right: The third and final design iteration of *Curious Learning.* 2014

Feedback from the Asperger's Association of New England (AANE)
AANE — The Asperger's Association of New England (AANE) is one of the first Asperger Syndrome(AS) organizations in the United States. It was founded in 1996 by a small group of concerned parents and professionals, shortly after the diagnosis of Asperger Syndrome (AS) first appeared in the U.S. Diagnostic and Statistical Manual (edition IV). AANE builds a supportive community by providing education, information and referrals to individuals with AS, their extended families, and the professionals who assist them. The staff of AANE consists of board-certified professional social-workers and educators. They also have strong personal ties to Asperger Syndrome.

Above: A group photo with the team at the Asperger's Association of New England (AANE). Their Director, Dania Jekel, the grand-daughter of Psychologist Sigmund Freud, can be seen on my left. Feb, 2014.

After meeting with Nisha Narvekar, AANE LifeMAP Assistant Director and Eva Mendes, ASD Specialist at UMASS Lowell, I was able to get feedback on the *Curious Learning* app from students with ASD. Their students were higher on the autism spectrum (Asperger's Syndrome, higher functioning autism), and a few were gifted individuals.

I was able to get a group of students to volunteer using my app mock-up through my Android smartphone, explaining each step to them.

Some of the feedback that I received was:

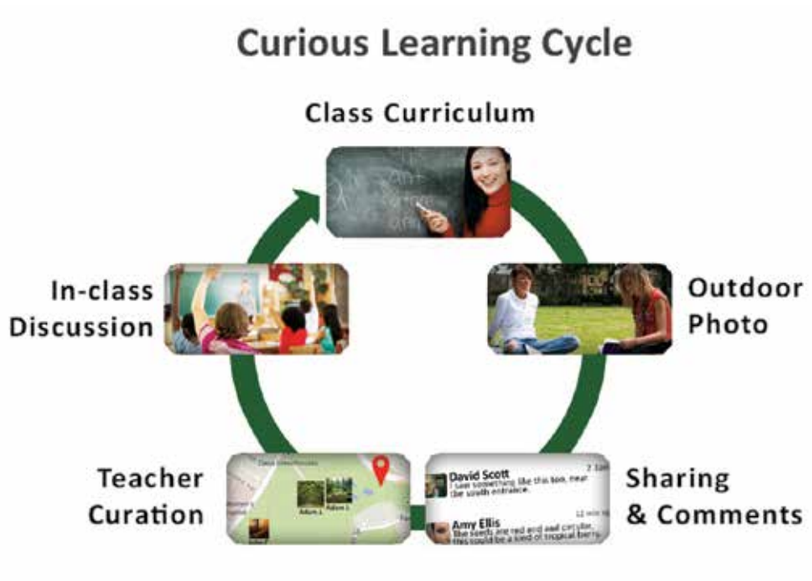
- Subtle colors should be used, maybe black and whites and lighter (instead of brighter) tones, due to high color intensity being a distraction for some students
- The app should say something or have audio vibration and sound feedback each time something relevant happened, and the intensity of the sound volume should be in the control of the user
- *Curious Learning* needed to have more user relevant content already on the map, to engage student interest and give hints and ideas to student as to what kind of questions to ask
- A few students used their tablet more than a smartphone, and wanted to use the app there in a horizontal (as opposed to the current vertical prototype) layout
- Many students liked the idea of asking each other questions and getting replies online, at their own comfort, while they were outside the classroom environment
- More than half of the of students wanted to customize the *Curious Learning* fox character with their own favorite comic or cartoon characters
- Five of the students were less concerned about the learning and more about the fact that they could use the app as a personal social network with their classmates, using it as an excuse to get access to their parents or siblings smartphones at home
- The teachers and students did appreciate a curriculum-based focus as that would allow them to use the smartphone is class, making it more 'fun' for them
- The majority of the students saw the app as a game, trying to increase the number of likes for the posted questions and replies. They did not see it as an educational tool, which was what i intended, when I designed it. This may have been a result of their association of interactive characters (in this case, my green fox) with computer games.
- Four of the most interested students were shown the last two iterations of the app. They remarked on the simpler work-flow of seeing and posting a photo with a question.

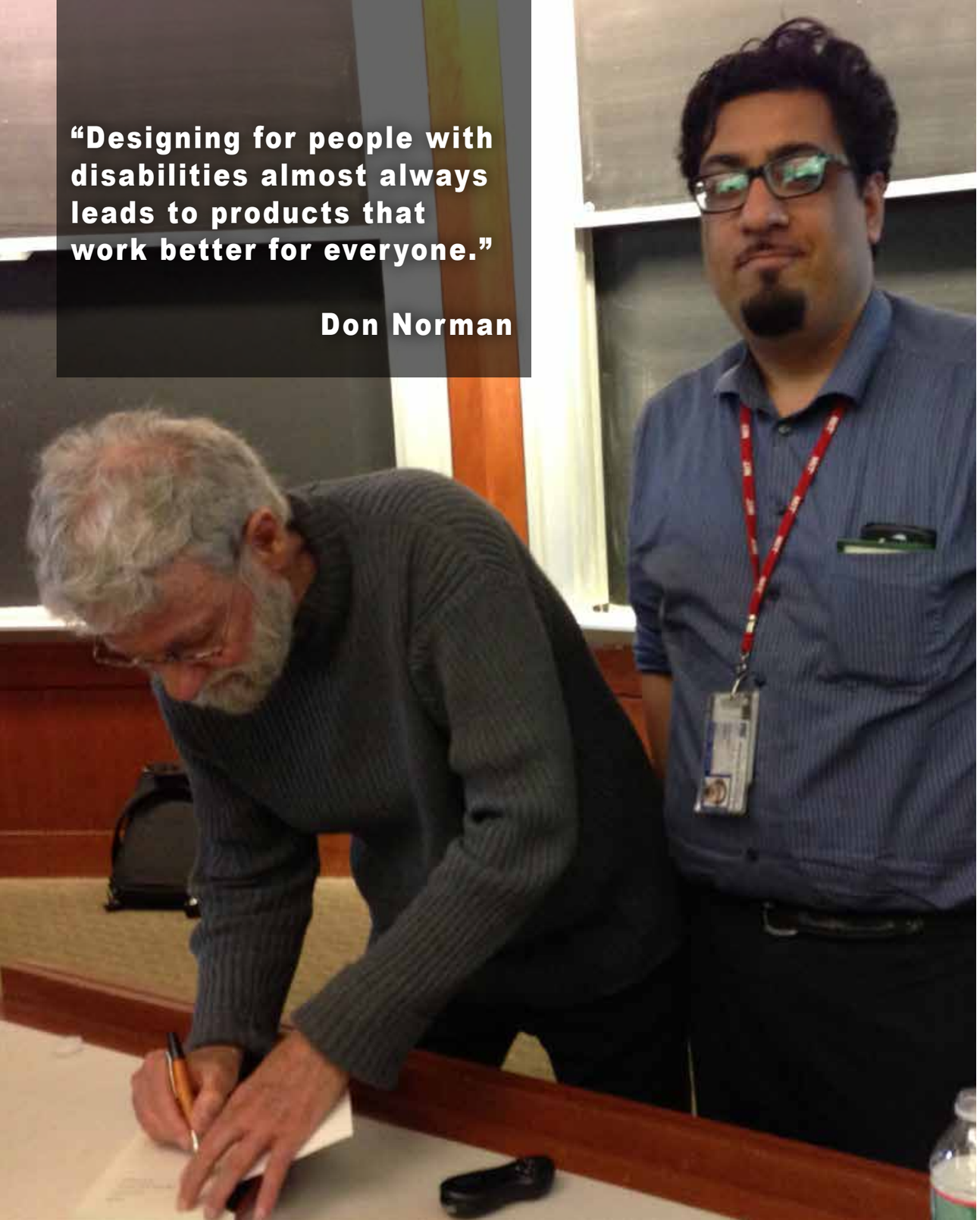
Above: A group photo with education and creative learning researchers at the 2014 ACM CSCW Peer Supported Learning workshop, Baltimore, Maryland. Feb 15, 2014.

What I learned:
The experience of a geo-located app with a social-media interface was fun, engaging and allowed deeper and prolonged interactions with the online content. I did see evidence of interest-based learning being evident in the information seeking work-flow of these students (some of them gifted ones) with ASD.

I used neuroscience and educational technology research as well as DSM symptoms to guide the experience, which influenced my design choices. I did not want to make the underlying philosophy too apparent to the students and teachers who I intended to be the users of *Curious Learning*. I did not want to shift the conversation from fun and social engagement to educational theory and boring neuroscience (for the students, who were explained why *Curious Learning* out might be relevant to their learning).

To simplify the underlying idea behind the app, I showed the students and teachers the *Curious Learning* cycle of learning, a recursive iterative process that would re-enforce their learning based on their interests. My *Curious Learning* group decided to continue the project beyond the scope of academics. I wanted neurotypical students to learn from the interest-driven learning cycle of gifted (and above average) students with autism. Having college students evaluate the earlier prototypes and gifted learners evaluate the last prototypes gave me further insight into the learning process. I learnt from feedback, coming closer to designing a better interface which could make class room learning inclusive, by catering to the individual interests and strengths of learners of all kinds.





CONCLUSION

Inclusion through Interface

Industrial designer Don Norman is credited to have said “When we design something that can be used by those with disabilities, we often make it better for everyone. This resonated with my researchable question as well as my career as a designer, design educator and my role as the South-Asian self-advocate for the autism spectrum. My research on *inclusive interfaces* was inspired by inclusive movements within design, such as *universal design*, a human centric approach focusing on accessible solutions. All of us have impairments at one time or another when we get sick, or when our needs change as we age. *Universal design* addresses this life-long cycle, as the word disability is taken in the bigger context of super-inclusive design, or design for life.

My *Numerology Visualization* project was the first interaction I had with *dynamic media*, resulting in a concept that I would later prototype. Using what I learnt, I moved towards making an interaction-design solution to make educational interfaces inclusive.

My *Perfect Customer* prototype allowed me to design hands-free interfaces to engage users with sensory issues. This allowed me to experiment with early ideas of constructionism and social learning (which influenced my *Curious Learning* project).

Little Drop gave me a greater appreciation of industrial design and how it relates to *universal design* by attempting to design for everyone, but at the end, negotiating and narrowing it down for a particular user persona, due to lack of resources, time and practicality.

My *Inclusive Interface* group of projects allowed me to provide choices for learners who use online education. I learnt interfaces needed to use common gestures for immediate deployment with little training. A balance between visual and haptic feedback was explored, along with tactile sensitivity, particularly for those with ASD. The *Inclusive Interface* was an exercise to simulate a personal interface for interacting with open educational resources such as MOOCs and video training.

Through the *Spatial Learning* project, I learned that the virtual room format was not the best solution for a single-user MOOC lesson plan (based on my observations), but a good solution for multi-user social engagement through avatars.

With *RoboTeacher*, I tested the skeuomorphism of having a face for a voice activated interface that would encourage eye contact and communication for learners with Autism.

In *Curious Learning*, I continued with a smartphone screen based interface, learning from diverse user feedback, working on a geo-located platform. I catered to individual interests and strengths of learners, prolonging interaction with online content.

The process of my research was inspired through my prior life experiences and interests, fostered by in-class discussions about *dynamic media* technology and new media, with my Professors and fellow DMI classmates. I consulted a wide variety of sources, from websites to live interviews to new published research in the field, trying to balance my opinions with current research and complementary opinions. I learned by doing, making and writing about what I made, using iterative feedback cycles to guide my design process. The overall process went well, so much that I created too many projects and had to cut down those that seemed too experimental, abstract and unrelated to my thesis question.

Reliance on “found materials” worked well for me, as all of the *dynamic media* technologies I used to design my prototypes were introduced to me during DMI. I tried to polish my projects as much as I could, later realizing that I did not have to continue working on them longer than I need to, a very different way of working compared to my prior commercial design background.

My role as a *dynamic media* designer is not a coincidence, going through the DMI program made me think about my early childhood experiences which made me what I am today. Thinking about my own learning challenges earlier in life gave me the determination to come this far, leading me to become a self-advocate for people on the autism spectrum in Pakistan and South Asia. The process of researching solutions to learning challenges has made me a better educator and designer. I will include *universal design* as a central part in my future educational projects and classes.

Future Design Research

During my time at DMI, I was introduced to more *dynamic media* technology, tools and ideas than I could try out and use in my research and experiments. I will continue pushing forward and iterating, particularly with my mobile app *Curious Learning*. I will further develop my S*patial Learning* prototype, working with the Oculus VR headset which shows great potential for virtual learning environments.

My non-profit autism awareness work and my professional background as a design educator intersected during my DMI research, working with *Inclusive interfaces*. I have made strategic connections here in Boston (e.g. Asperger's Association of New England) and in the US. I will remain in contact with them as I return to a career in design education. I want users (both on and off the autism spectrum, some of them gifted individuals) to test some of my prototypes. Heading back to my native Pakistan, I will partner with schools, universities and special education centres to test out my prototypes in a South Asian developing world environment, and see if I could create lower-cost versions of my projects. Most of my design research will be used to teach my future students.

The interactions I had with the research community in Boston shaped much of my thinking, particularly the incredible work happening at the MIT Media Lab. I will use social media to keep in touch with friends and mentors, particularly on projects of mutual interest. I knew of many researchers working with inclusive technology and *universal design,* but could not reach out to most of them due to time restrictions. I will try contacting them with my prototypes and ideas, so that I can get expert feedback online, with the possibility of future collaboration.

One of the immediate projects that I look forward to is multidisciplinary design research for social entrepreneurship. I hope to start this at a university in Pakistan, when I return there this year. My work and research will continue with interaction design for educational inclusion.

Advice for Designers and Students

It is inevitable that students, researchers and even those on the autism spectrum will go through my research in the future. The increasing epidemiology of autism Spectrum Disorders and the move towards inclusion (in education and in design) make my work relevant advice and a path to continue on. I hope that some of my work remains relevant and inspires researchers to continue making education inclusive through designed interventions.

The fifth version of the DSM came out in 2013, in the middle of my MFA and design research, removing Asperger's syndrome and making the autism spectrum wider. There may be changes in the future that re-classify autism, but the underlying educational models and research I worked with will not be affected, as it is based on the symptoms of ASD.

What would I have said to myself when I first arrived in Boston, starting the MFA at the Dynamic Media Institute? For future students of DMI and academics working in the Boston area, I wish you luck. I took the advice of those who came before me, DMI alumni, Fulbright alumni, students who had studied in Boston and in Cambridge. Document your work, take high quality photographs (for publication later), make high-definition videos (for your video abstracts and prototypes) and most relevant of all, take advantage of all the talented academics and students around you.

Boston is a unique educational city where you can interact with people from all over the world. It is inevitable that you will find those who share your passions and interests. The close proximity of Harvard, MIT and leading centres of research will continuously draw some of the world's best researchers, artists, designers and scientists. Social media will help you find free events where you can meet them and even collaborate in future projects.

Take care to document not only your research materials but the conversations you have with potential users as well as field-experts. Make backups of your work on usb drives and have business cards ready to give out to people that you meet, with ample online profile data so that people could connect with you later. MassArt will make you fearless, but before that can happen, take risks, try new things, even if you fail from them, you cannot innovate unless you fail and learn from the process.

The alumni at the Dynamic Media Institute will always be a resource you can rely on, online or in the real world, for advice, feedback and war stories of thesis days. If you want to do something specific in your art, design or career, be clear about it from the earliest part of your student life. Express your interests by specializing in a particular area, mastering a few *dynamic media* technologies while making your portfolio diverse.

For future autism and inclusive education researchers, I shake your hand (virtually) and hope that your work and research makes a difference, for our collective future. The resources and people who helped me during my time here at DMI were a factor of probability (they happened to be here during my time at MassArt) and active research. I actively pursued experts in the field, attending lectures, emailing professors at other universities and applying to speak or attend relevant conferences. MassArt and the Dynamic Media Institute will offer much more if you are able to network, use all available resources and connect with alumni who were interested in the same areas as you. I hope I am still around, active online and in the real world, when you read this thesis book. If so, feel free to contact me, we could collaborate and make the world a better place. If I am not, I leave you with my personal philosophy, something that has guided me for many years:

"Listen to everyone, follow no one, look for patterns, work like hell"

Never stop thinking differently, be creative, take risks and most importantly, do things that mean something to you. Trust your heart and inner voice. I trusted mine, and my life changed, for the better. I became a voice for others, a change maker and a *dynamic media* designer.

Qazi Fazli Azeem

Dynamic Media Institute
May 20, 2014

Above: Alchemical Jackal, 90in x 12 in inkjet print, 2013. Inspired by the Painted Jackal short story by RUMI. Digital Painting.

APPENDIX

My Autism Awareness Interview

Kathleen Tehrani, Orlando-Florida based CEO of www.autismbrainstorm.org interviewed me in June 2011, about my new media art being inspired from being on the autism spectrum. This was a year before I came to the US through the US State department's Fulbright scholarship. The complete interview can be read at http://www.examiner.com/article/autism-artist-fazli-azeem-of-pakistan-interview

Autism artist: Fazli Azeem of Pakistan-Interview June 27, 2011

Kathleen: Today I am joined by graphic designer, university lecturer, autism awareness activist, numerologist and asperger, Fazli Azeem. He was born on August 20th, 1981 with asperger's syndrome and savant abilities which include memory, pattern recognition, hyperlexia and more. He is the first person to come forward in Pakistan with asperger's syndrome and has graciously agreed to share some of his story with us today. Hello Fazli and thank you so much for taking the time to speak with me.

Fazli: Hello, nice to be here today.

Kathleen: My understanding is that you have basically been the "face" of autism in your area of the world.

Fazli: Yes.

Kathleen: What an amazing story. In becoming an outspoken advocate, you actually improved the quality of your life and that of many others. On a much lighter note, poetry is a very large part of the history and culture of the east and Middle East. I see in your artwork that you have a particular piece that I am VERY fond of the Painted Jackal, from the Rumi story. You are one of the contributors to the *ARTISM: The Art of Autism* US coffee-table books by Debbie Hosseini. How has your art influenced your life or rather how has autism influenced your art?

Fazli: This is a deep question and has had great influence on me. I was drawing at age 4, sculpting things out of play dough and the encouragement i got from it, made me put in time and effort in my art. I was hyperactive as a child. It made me sit down and spend time on something aesthetic. Art laid the future for me as a designer, what I am today, what makes me happy is creating something that people will get happy when they see it. Sometimes images have double meanings and hint at something more. I like deep thought and double meanings and symbolism in art. It makes me say a lot without saying much.

Kathleen: The writings of Rumi are extremely deep and I enjoy them very much. What you just said, "It makes me say a lot without saying much."

This is intrinsic in all of the enlightened teachers and poets. The enlightened ones always remark that the spoken word is one of the weakest forms of communication, and that what travels from heart to heart or from soul to soul is energetic.

Fazli: Art is incredible. You show people an image and they get it. They know the story. They know the idea behind it. This makes it very positive for me. People can appreciate all that I am saying without listening to me, and since I am a teacher, it's positive that I don't have to talk all the time and my work speaks for itself. I hope to bring about wider autism awareness though my art.

Kathleen: I know that you will and will be extremely successful. Can you talk a bit about the piece I mentioned, *The Painted Jackal* and what inspired you both to do the original piece of work as well as the fascinating digital rendition?

Fazli: Yes, it holds a lot of personal meaning for me. I had heard of the story before in children's books. It's a small and short story, the jackal pretending to be a peacock so he could get close to them and eat them but his friends would make fun of him calling him fake for pretending to be something he is not. In life, people pretend, they wear masks, saying something and mean something else. I have met all kinds of people. Many people used my abilities for their own purposes, not rewarding me and taking credit for my hard work. This is why I chose this subject and chose to work purely in a digital medium, which allows me to overcome limitations. The context of artificiality and beauty is there, a dichotomy that when the jackal pretends to be a peacock the world remarks on the beauty. With the world today we all conform to stereotypes. We must 'behave'. We must act a certain way. We can't be who we truly are. We are born free but everywhere are in

mental chains. This is an allegory to that idea, that sometimes we have no better option than to pretend. We must change our appearance since the world will not change for us, just to fit it. It's a moral sacrifice. Our own comfort sacrificed for a gain in stability and acceptance, even though that acceptance does not mean anything. But then again, it's a means to an end. We as people on the spectrum must conform since we must 'appear normal', there is no other way, people may not accept us for the truth, but they will accept us for wearing the mask of conformity.

My websites are www.autismpakistan.org and www.fazliazeem.com

Below: Sky (Tien-Yun) Huang, graduate student at DMI, uses the Perspective interface at the MassArt Bakalar gallery, to browse online learning videos. April 23, 2014.

Interview of a Neurotypical College Student

Sky (Tien-Yun) Huang is a Taiwanese student at the Massachusetts College of Art and Design in Boston. My research objectives intersected with college and university students as a target user group for my interface projects. I wanted a perspective from a foreign student, a non-native English speaker to mirror that of my college students back home in Pakistan. Most Open Educational Resources and MOOCs are available in English and only a small percentage have been translated with voice-overs or subtitled into foreign languages (with the exception of Khanacademy). I wanted to see how much existing English MOOCs appealed to a busy international graduate student, and what type of device they would prefer to learn from. I used Tien as a persona while designing some of my interaction design concepts.

Q. Where do you learn more? Smartphone, tablet, YouTube?

A. I would watch video on the laptop. I see video online but it depends on the content if I may or may not learn from it. I saw a friend post a video on *Facebook*, an interaction technology video. The video was about optimizing handwriting. I have a tablet, an iPad, the Wi-Fi signal is not good so i don't use it. My nieces learn English vocabulary on the iPad. I have seen video training on lynda.com and have used Coursera to follow a free MOOC, but I never finished it. I only saw a few videos, I was not motivated to finish because no one was pushing her to finish it. I liked the online class, but had other things to do; I left it for a while and forgot it. I have used both Coursera and lynda.com to learn from videos, but a personal choice, I preferred Coursera due to the interaction with other students and the professor. I think I learnt the same way, even from static lynda.com videos, I learn from all videos equally, but the experience depends on why I am seeing the videos in the first place, e.g. to increase my professional skills through lynda.com or curiosity in the case of MOOCs on Coursera. I prefer to learn at home, alone, where I have a quiet environment. I don't play music, and it depends on what I am learning. I would prefer to print out a document since I like to highlight text for deeper understanding, in the case of writing an essay about it later or discussing it for an in-class interactive dialogue. I prefer paper for my university assignments as I feel comfortable with it, based on my years of experiences using it.

Q. How many browsers tabs do you have open at once?

A. I can only open up-to 8 on iPhone. I normally open around 10 tabs on the laptop, switching frequently between them.

Q. If you are seeing a video online, do you pause it, do something else, or finish that video before moving on to other things. Suppose you are doing homework and designing, and someone sends you a video, do you break and see it.?

A. That depends on why I am seeing the video in the first place. If the content is interesting, I would see it right away, stopping what I am currently doing. However, if the content is not interesting and I still have to see the whole video, I may pause it and then do something more interesting or urgent and return to it later.

Q. If you are seeing a movie on the computer, do you see the whole movie, or pause it and return to it later after doing other more urgent things?

A. I see the whole movie till the end. However, If I was distracted and I was seeing a video with breaks in the middle, I would still remember and continue and understand the whole video, even if I was distracted away from it.

Q. If you have a choice between seeing many small video clips instead of one long joined video, which one would you prefer?

A. I would prefer to see one longer clip and then move on to other things, since I am lazy and don't want to download videos separately.

Q. How many things can you do at once? Can you multi-task easily? Suppose you are watching TV, the music is on, you are replying to an email on your laptop while you get a phone call or text message. Can you easily do all of these things at once?

A. Yes, I multi-task often, doing many things, one by one, every few minutes. I am a frequent user of my smart phone and laptop, and hence multi-tasking comes naturally to me. I check the definition of a word online when I hear of it in class for the first time.

Q. Do you learn more while standing, sitting or lying down? Have you thought about this? If you are in a class and you could choose to sit or stand, what would you choose?

A. I think there is not difference except for my comfort. If I don't feel well or am tired, sitting may be better than standing. I would prefer to sit close to the teacher but hide behind a student, normally choosing the second row.

Q. Would you prefer using the remote control to change the channel on a TV or do it yourself with your own hands?

A. I think I would do it myself.

Q. If somebody send you text, do you feel comfortable reading on the screen of your phone?

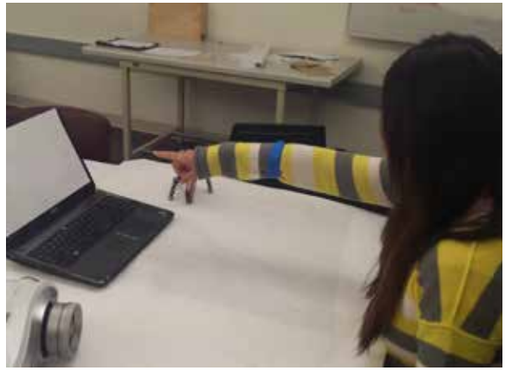
A. I don't like reading on my phones screen or my laptops screen. If I have a choice, I would print it out and then read it on paper.

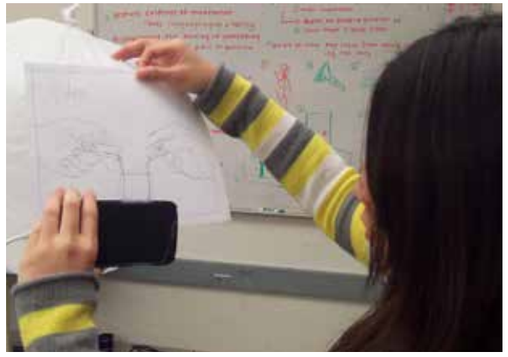
Q. Have you ever played a *Nintendo Wii* game with the wireless remote or any wireless game such as using the Microsoft *Kinect*?

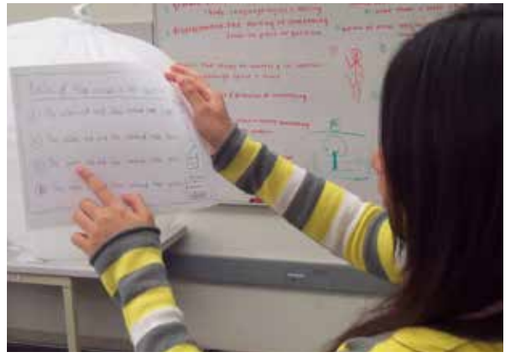
A. No.

Q. If you could have the choice of using a muscular controller to control video, activate a learning MOOC user interface, taking your learning outside your room, outdoors, would you like that?

A. I don't think I would want to learn outside my room. Even if I was using it to control slides in a presentation, I already have a remote control. I move my hands so it may jump to the next slide accidentally. I can click and do that already, I will not do this, not even to impress a new client; it is not a better experience to me.







Q. Suppose you are chopping vegetables in a kitchen and have your hands busy. Would you use the *MYO* muscular controller to play/pause video of a recipe on a tablet or screen?

A. I don't know, since I have never seen a recipe video while actually cooking or chopping vegetables. I never had this need and cannot imagine me using it. I may be interested in using it for controlling a game, but I don't like wireless controllers. I don't generally play computer or console games.

DMI Fresh Media and MFA Art Show 2014

I displayed my *Perspective* project during the 2014 DMI Fresh Media group art shows at the Boston Cyberarts gallery, Nave Somerville gallery, as well as during the first 2014 MassArt MFA Thesis show. This was my last project, an artistic response to my thesis research on autism and *dynamic media* in education. I created the experience of being overwhelmed with video content, seen through a camera lucida lens. With time and concentration, the user wearing the headphones and hearing the mixed sounds would be able to concentrate and focus on the video of their choice. The message that I wanted the viewer to understand was that for a person on the autism spectrum, learning is battle against their own senses, and success only comes with patience, struggle and concentration.

Perspective, 2014
Tablet, camera lucida len, 3D printed lens holder, lamp base, video montage.

Information overload is a common symptom of too many media outlets and choices on the internet. Through my self-advocacy for Autism in South Asia, I wanted to simulate the experience of "sensory overload" among learners on the Autism spectrum. The use of technology in educational media has evolved from being a political tool of governments to the click-through-rate of search engine optimizers and websites targeting users with advertisements. As freedoms and choices are being challenged in the new frontier, new media has responded by accelerating the distribution and consumption of online content. Increasing internet censorship in developing countries such as my native Pakistan, continues to distort perceptions of culture and reality, insulating youth from free online educational materials.

My role as an educator for design technology overlapped with online activism for educational inclusion and internet freedom. Living and working in a culture of self-censorship, online proxies and anonymous web browsing tools challenged me. Education has become a matter of perception, everything changes depending on who is teaching and who is being taught. This cognitive polymorphism is the subject of my thesis and my art. We adapt and learn through our environmental and personal lens, our biases and stereotypes that we are indoctrinated into. To overcome them is a struggle that is mirrored in biological evolution through adaptation. The desire to survive, thrive and live necessitates our change of perspective, leading to a change in how we learn. My perspective on life changed, as I learned from people on the Autism Spectrum. Through trial and error, I learned how focus on things which make a difference in the world around me. I want the observer to experience my struggle in making sense of the world. I hope this experience moves the observer towards understanding the other, the person on the Autism spectrum, appreciating inclusion through a change in their perception.

Right: Visitors at the 2014 MFA Thesis Show and the 2014 DMI Fresh Media Shows (Boston Cyberarts and Nave Somerville) experiencing my interactive video display project, *Perspective*. (show below) March-April 2014.

Left: Sky (Tien-Yun Huang), graduate student at DMI, uses the Perspective interface at the MassArt Bakalar gallery, to browse online learning videos. April 23, 2014.

WORKS *Cited*

Adam Feinstein. *A History of Autism: Conversations with the Pioneers.* John Wiley & Sons. pp. 233–. 7 July 2011. Print. Web. Retrieved April 8, 2014

Christy Oslund. *Supporting College and University Students with Invisible Disabilities: A Guide for Faculty and Staff Working with Students with Autism, AD/HD, Language Processing Disorders, Anxiety, and Mental Illness.* Jessica Kingsley Publishers. pp. 55. 21 November 2013. Print. Retrieved April 8, 2014.

Seymour A. Papert. *Mindstorms: Children, Computers and Powerful Ideas*. Basic Books. pp. 223. 4 August 1993. Print. Retrieved April 8, 2014.

Marshall McLuhan; Quentin Fiore. *The Medium Is the Massage: An Inventory of Effects*. Gingko Press GmbH. pp. 26. June 1, 2011. Print. Retrieved April 8, 2014.

Frank Moss. *The Sorcerers and Their Apprentices: How the Digital Magicians of the MIT Media Lab Are Creating the Innovative Technologies That Will Transform Our Lives.* Crown Publishing Group. pp. 172. June 7, 2011. Print. Retrieved April 8, 2014.

Lev Manovich. *The Language of New Media.* MIT Press. pp. 124. 2001. Print. Retrieved April 8, 2014.

Edgar Stones. *Readings in Educational Psychology*. Routledge. pp. 332. 4 May 2012. Print. Retrieved April 8, 2014.

Marshall McLuhan; Quentin Fiore. *The Medium Is the Massage: An Inventory of Effects.* Gingko Press GmbH. June 1, 2011. Print. Retrieved April 8, 2014.

Andrew A. Zucker. *Transforming Schools with Technology: How Smart Use of Digital Tools Helps Achieve Six Key Education Goals*. Harvard Educatio Press. Print. 2008. Retrieved April 8, 2014.

SRI March 2014 Research brief. Web Report. Retrieved April 28, 2014. <www.sri.com/sites/default/files/publications/2014-03-07_implementation_briefing.pdf>

CAST – Web-http://www.cast.org -Retrieved April 28, 2014

Centres for Disease Control and Prevention. *Autism Spectrum Disorder (ASD) Fact Sheet.* March 20, 2014. Web. Retrieved April 8, 2014. <www.cdc.gov/ncbddd/autism/facts.html>

Darold A. Treffert. *The savant syndrome: an extraordinary condition. A synopsis: past, present, future*, Phil. Trans. R. Soc. B 27 May 2009 vol. 364 no. 1522 1351-1357. 12 April 2009. Web/Print. April 8, 2014. Retrieved April 10, 2014 <rstb.royalsocietypublishing.org/content/364/1522/1351.abstract>

Darold A. Treffert. *Hyperlexia: Reading Precociousness or Savant Skill?*, Wisconsin Medical Society. WMJ, Volume 110(6). December 2011. Web. Retrieved April 8, 2014. <www.wisconsinmedicalsociety.org/professional/savant-syndrome/resources/articles/hyperlexia-reading-precociousness-or-savant-skill>

David Wiley. *The Primary Challenge for the OER Movement, iterating toward openness*, OpenContent.org. Oct 10,2011. Web. Retrieved April 8, 2014. <opencontent.org/blog/archives/2042>

WORKS *Cited*

Juliana Marques. *What is a Massive Open Online Course Anyway?*, MOOC News and Reviews. Jun 7, 2013. Web. Retrieved April 8, 2014. <moocnewsandreviews.com/what-is-a-massive-open-online-course-anyway-attempting-definition>

Barbara Prashnig. *Learning Styles vs. Multiple Intelligences (MI).* www.teachingexpertise.com. Issue 9. Autumn 2005. Web. Retrieved April 8, 2014.

Catherine Dawson. T*he Complete Study Skills Guide: A practical guide for all students who want to know how to learn.* How To Books. pp. 18. 28 January 2011. Print. Retrieved April 8, 2014.

Oxford Online Dictionary. Web. Retrieved April 8, 2014. <www.oxforddictionaries.com/us/definition/american_english>

Adam Feinstein. *Keynote address to the NAS Professional Conference.* Manchester, UK. March 1, 2011. Web. Retrieved April 8, 2014.

Centres for Disease Control and Prevention. *Autism Spectrum Disorder (ASD) -Data & Statistics*. Division of Birth Defects, National Centre on Birth Defects and Developmental Disabilities. March 24, 2014. Web. Retrieved April 8, 2014. <www.cdc.gov/ncbddd/autism/data.html>

Adam Feinstein. *DSM-5 Diagnostic Criteria.* Autism Speaks USA. AutismSpeaks.org, 2014. Web. Retrieved April 8, 2014. <www.autismspeaks.org/what-autism/diagnosis/dsm-5-diagnostic-criteria>

Darold A. Treffert. *The savant syndrome: an extraordinary condition. A synopsis: past, present, future.* Phil. Trans. R. Soc. B 27 May 2009 vol. 364 no. 1522 1351-1357. 12 April 2009. Web/Print. Retrieved April 8, 2014. <rstb.royalsocietypublishing.org/content/364/1522/1351.abstract>

Katharina Boser; Matthew Goodwin; Sarah Wayland. T*echnology Tools for Students with Autism: Innovations That Enhance Independence and Learning.* Brookes Publishing. pp 79-80. 16 October 2013. Print. Retrieved April 8, 2014. <www.parorobots.com> Retrieved April 28, 2014

David J. Feil-Seifer. *Data-Driven Interaction Methods for Socially Assistive Robotics: Validation With Children With Autism Spectrum Disorders.* University of Southern California, Los Angeles, CA, Oct 2011. Retrieved April 8, 2014.

Temple Grandin; Richard Panek.*The Autistic Brain: Thinking Across the Spectrum.* Houghton Mifflin Harcourt. pp 69. April 30, 2013. Print. Retrieved April 8, 2014.

Gary B. Mesibov; Victoria Shea; Eric Schopler. *The TEACCH Approach to Autism Spectrum Disorders.* Springer. pp 34 January 12, 2005. Print. Retrieved April 8, 2014.

Carol Gray. *The New Social Story Book.* Future Horizons. 2010. Print. Retrieved April 8, 2014.

Nish Sonwalkar. *Advanced Learning Technologies and Learning Networks and Their Impact on Future Aerospace Workforce.* National Aeronautics and Space Administration, Langley Research Centre. pp 49. 2003. Print. Retrieved April 8, 2014.

Nishikant Sonwalkar Sc.D. MIT. *Changing the Interface of Education with Revolutionary Learning Technologies: An Effective Guide for Infusing Technology Enabled Education for Universities and Corporations.* iUniverse. pp 64. September 16, 2004. Print. Retrieved April 8, 2014.

Huffington Post. *Jacob Barnett, 14-Year-Old With Asperger's Syndrome, May Be Smarter Than Einstein.* November 5, 2013. Web. Retrieved April 8, 2014.

Jim Lewis. *What Didn't Happen in Edtech in 2013: Four CEOs share thoughts on what we can do better in 2014.* Dec 26, 2013. Web. EdSurge.com. Retrieved April 8, 2014. <www.edsurge.com/n/2013-12-26-what-didn-t-happen-in-edtech-in-2013>

Tamar Lewin. *After Setbacks, Online Courses Are Rethought.* Dec 10, 2013. Web and Print. New York Times. Retrieved April 8, 2014. <www.nytimes.com/2013/12/11/us/after-setbacks-online-courses-are-rethought.html>

MIT Museum. *The Wonders of Electricity and Magnetism.* Web Video. Retrieved April 8, 2014. <video.mit.edu/watch/the-wonders-of-electricity-and-magnetism-9964>

Open Courseware Consortium. *New MITx course by Walter Lewin has potential to be the largest MOOC ever.* Jan 23, 2013. Web. Retrieved April 8, 2014. <www.ocwconsortium.org/news/2013/01/new-mitx-course-by-walter-lewin-has-potential-to-be-the-largest-mooc-ever>

MIT Spark. *Autism Spectrum Disorders: Introduction, Implications and technology.* MIT Spark / ESP. March 15, 2104. Web. Retrieved April 8, 2014. <esp.mit.edu/learn/Spark/2014/Classes/S8237/index.html>

Don Norman. *What is the relationship between Universal Design and Emotional Design?* Web. Retrieved April 8, 2014. <http://www.jnd.org/dn.mss/what_is_the_relation.html>

Pullin, G. *Design meets disability.* 2009. Cambridge, Mass. MIT Press. Print. Retrieved April 8, 2014.

BIBLIOGRAPHY

Books

Boser, Katharina & Goodwin, Matthew & Wayland, Sarah. *Technology Tools for Students With Autism*. Brookes Publishing, 2013. Print.

Grandin, Temple. *The Autistic Brain: Thinking Across the Spectrum*. Houghton Mifflin Harcourt, 2013. Print.

Kelley, David & Kelley, Tom. *Creative Confidence: Unleashing the Creative Potential Within Us All*. Crown Business, 2013. Print.

Kelley, Tom & Littman, Jonathan. *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm.* Crown Business. 2013. Print.

Norman, Donald A. *The Design of Everyday Things*. Basic Books, 2002. Print.

Barnett, Kristine. *The Spark: A Mother's Story of Nurturing, Genius, and Autism*. Random House, 2013. Print.

Hosseini, Debra. *The Art of Autism: Shifting Perceptions*. AutismToday.com, 2012. Print.

Shore, Stephen. B*eyond the Wall: Personal Experiences with Autism and Asperger Syndrome.* Autism Asperger Publishing Company, 2003. Print.

Khan, Salman. *The One World Schoolhouse: Education Re-imagined*. Twelve, 2012. Print.

Minsky, Marvin. *The Society of Mind.* Simon & Schuster, 1988. Print.

Manovich, Lev. *The Language of New Media.* Cambridge: The MIT Press, 2001. Print.

Papert, Seymour A. *Mindstorms: Children, Computers, and Powerful Ideas*. Basic Books (2nd edition), 1993. Print.

Rusk, Natalie & Resnick, Mitchel & Cooke, Stina. *Origins and Guiding Principles of the Computer Clubhouse:* from Kafai, Yasmin B. & Peppler, Kylie A. & Chapman, Robbin N. *The Computer Clubhouse: Constructionism and Creativity in Youth Communities.* Teachers College Press, 2009. Print.

Dweck, Carol. *Self-theories: Their Role in Motivation, Personality, and Development (Essays in Social Psychology)*. Psychology Press, 2000). Print.

Gladwell, Malcolm. *Outliers: The Story of Success.* Back Bay Books. 2011. Print.

Gardner, Howard. *Frames of Mind: The Theory of Multiple Intelligences.* Basic Books, 2011. Print.

Kurzweil, Ray. *How to Create a Mind: The Secret of Human Thought Revealed.* Penguin Books. 2013. Print.

Gullans, Steve & Enriquez, Juan. *Homo Evolutis*. TED Books. 2011. Print.

Films and Videos

Ito, Joi. *Keynote to Open Educational Resources meeting.* Hewlett Foundation. 2012. Video. <llk.media.mit.edu/courses/video.php?provider=youtube&vid=8HQbQa3va6o> Retrieved Nov 13, 2013

Leth, Jørgen. *The perfect Human (Det Perfekte menneske)*, video, Denmark, 1967.

Articles and Interviews

Baer, Drake. *Creativity Is Really Just Persistence, And Science Can Prove It. Fast Company.* Published 20 Sep 2013. Retrieved 15 Nov 2013. Web. <www.fastcompany.com/3017850/leadership-now/creativity-is-really-just-persistence-and-science-can-prove-it>

Monroy-Hernández, Andrés. *Designing a Website for Creative Learning*. Web Science Journal, Article. 2009

Rigg, Jamie. *Forget devices; the future of technology is seeded in biology.* Engadget. Published Nov 9th, 2013. Retrieved Nov 15, 2013. Web. <www.engadget.com/2013/11/09/the-future-of-technology>

Shepherdess, Electric. *Making Music From Markers: Looks Like Music Project.* Mass Electronic Dance Music Community. Published October 26th, 2013-Retrieved November 15, 2013. <massedmc.com/making-music-markers-looks-like-music-project>

Resnick, Mitch. *Still a Badge Skeptic.* HASTAC blog. 2012. http://hastac.org/blogs/mres/2012/02/27/still-badge-skeptic
Petrich, Mike & Wilkinson, Karen & Bevan, Bronwyn.

It Looks Like Fun, But Are They Learning? Design, Make, Play. Web. 2013. Article. <tinkering.exploratorium.edu/wp-content/themes/tinkeringsite/resources/PetrichWilkinsonBevan-ItLooksLikeFun.pdf>

Ito, Joi. *Formal vs Informal Education.* Feb 28, 2010. Web. Retrieved Nov 13, 2013. <joi.ito.com/weblog/2010/02/28/formal-vs-infor.html>

Ito, Joi. *Reading the Dictionary.* Apr 10, 2012. Online. Retrieved Nov 13, 2013. <joi.ito.com/weblog/2012/04/10/reading-the-dic.html>

Kay, Alan. *Powerful Ideas Need Love Too! Written remarks to a Joint Hearing of the Science Committee and the Economic and Educational and Opportunites Committee.* Article. 1995.

Research Papers and Journals

Moocs Forum, Online Journal. Mary Ann Liebert Inc, 2013.Print.

Millner, Amon. *Computer as Chalk: Supporting Youth as Designers of Tangible User Interfaces*. Constructionism 2012 conference. Paper. 2012.

Brennan, K. ScratchEd: *Developing support for educators as designers.* In E. Reilly and I. Literat (Eds.), Designing with teachers: Participatory professional development in education. Paper. 2012.

Papert, Seymour. *What's The Big Idea? Toward a Pedagogy of Idea Power.* IBM Systems Journal, Vol 39 No 3&4, 2000. Paper.

Brown, John Seely & Adler, Richard. *Minds on Fire: Open Education, the Long Tail and Learning 2.0*. Educause Review. 2008.

Beary, Vanessa E. *The NFTE Difference: Examining the Impact of Entrepreneurship Education.* NTFE. Paper. 2013. <www.nfte.com/sites/default/files/nfte_difference_final_report_2013.pdf>

Liberty, Joseph. *The Dynamic Learning Process.* The Dynamic Media Institute, Massachusetts College of Art and Design. 2011. Print.

Websites

fazliazeem.com

autismpakistan.org

dynamicmediainstitute.org

www.cast.org/udl

llk.media.mit.edu

civic.mit.edu

tangible.media.mit.edu

fluid.media.mit.edu

gse.harvard.edu

gsd.harvard.edu

d-lab.mit.edu

khanacademy.com

lynda.com

cscw.acm.org

coursera.org

udacity.com

edx.org

ocw.mit.edu

oeconsortium.org

autism-society.org

cdc.gov/ncbddd/autism

autism.org.uk

awares.org/conferences

wrongplanet.net

meetup.com/autism-77

chronicle.com

howardgardner.com

jnd.org

mnsfoundation.org

dsm5.org

arts.mit.edu

olafureliasson.net

processing.org

arduino.cc

oculusvr.com

www.leapmotion.com

makeymakey.com

scratch.mit.edu

computerclubhouse.org

tedxbeaconstreet.com

ted.com

daroldtreffert.com

specialisterne.com

autism-india.org

tonyattwood.com.au

bornwithaspergers.com

autismasperger.net

autismresearchcentre.com

the3doodler.com

hackingarts.com

zibitr.com

learn.media.mit.edu

solveforx.com

designthinkingforeducators.com

"I particularly appeal to our intelligentsia and students to come forward and rise to the occasion. You have performed wonders in the past. You are still capable of repeating the history. You are not lacking in the great qualities and virtues in comparison with the other nations. Only you have to be fully conscious of that fact and to act with courage, faith and unity."

M. Ali Jinnah, Founder of Pakistan

"The preservation of our free society in the years and decades to come will depend ultimately on whether we succeed or fail in directing the enormous power of human knowledge to the enrichment of our own lives and the shaping of a rational and civilized world order....It is the task of education, more than any other instrument of foreign policy to help close the dangerous gap between the economic and technological interdependence of the people of the world and their psychological, political and spiritual alienation."

US Senator J. William Fulbright