Socos

Maximizing Human Potential

Jade Dominguez, 26, was living off credit card debt in a rental in South Pasadena, Calif., while he taught himself programming. He had been an average student in high school and hadn't bothered with college. However, his level of programming was high enough to be picked up by algorithms Socos founder Vivienne Ming, PhD, created to find potentially talented software developers. Importantly, these algorithms assess a person's potential not based on standardized measures such as the ones found in schools, but based on naturalistic data from the real world. And successfully so: Jade was located and hired by a software company. Unfortunately, there are millions of adults and children around the world not so fortunate to have their potentials discovered.

Jade's hiring process reveals that something extremely important happens when an individual becomes a successful autodidact – in control of his own learning process instead of passively absorbing another's teachings. Student exhibit increases in metrics actually predictive of life outcomes that range from motivation and creativity to self-regulation and metacognitive ability (Roberts et al., 2007; Luhmann et al., 2012).

Socos believes that these increases are not just limited to autodidacts, but they can be triggered by small interventions applied at the right time. It has been repeatedly demonstrated in scientific studies that small adjustments can create life-long changes. A famous example is a study for which families of severely underprivileged toddlers in Kingston, Jamaica were educated in simple nutrition, social and motivational skills. Twenty years later those individuals were found to be indistinguishable from more wealthy populations (Gertler, Heckman, et al., 2014). Those simple interventions were able to effectively erase the fact that those children came from impoverished backgrounds.

Similar impacts from low-grade interventions were found in addressing health problems of children from families of low socioeconomic status in the United States. Eight years after the interventions, the youth who participated had significantly fewer health problems than controls (Miller, Chen, et al., 2013).

Socioeconomic status and health have been demonstrably impacted as the result of small interventions. There is even more potential for impact when processes are triggered that are relevant for successful learning. In fact, the reason why these interventions are so effective is that they target personality characteristics such as persistence, motivation, and mindset, which prove to be key to development and life-outcomes (Yeager, Walton, and Cohen, 2013). For example, in the oft-cited marshmallow study a child's early-life ability to delay gratification has been shown to be predictive of life-long measures of success (Mischel, Ayduk, et al., 2010). However, such interventions, when poorly designed, can have contrary effects: In a lesser-known variant of the same study, prior to being given

their first marshmallow the children were promised crayons or similar enticement by an adult who did not deliver on the promise. In each case of this reneging on a promise, children ate their first marshmallow right way (Kidd, Palmeri, and Aslin, 2013). Children were trained to take what was available because they could not rely on a future promise, which has implications for the future success of those children.

Characteristics like the ability to delay gratification in the marshmallow study are relevant to "21st Century Skills." These learnable skills include creative problem solving, critical thinking, and collaboration, and are important to aspects of life (Pellegrino & Hilton, 2013; Binkley, Erstad, et al., 2012). Students and professionals would benefit if these complex skills were studied in schools and taught in the workplace.

Unfortunately, educational systems fail to teach to these goals, instead focusing on training domain-specific knowledge under the assumptions that these more complex skills will come about naturally. Specific knowledge is valuable, but in the modern era information is abundant and relevant knowledge changes very quickly. What actually matters most is the ability to learn whatever new information may be important, and to use it productively.

There exists a disconnect between what is measured in education and what is relevant in the rest of life. Academic institutions focus on grades and test scores as the most common measures of student success. There exist few resources, in or out of the classroom, for connecting assessments with feedback that can describe, predict, or improve relevant life-outcomes. Dimensions of competency that are relevant for life are evaluated through the lens of these assessment, thus defining success through the assessments developed. Well-designed tests do facilitate learning and assess learning outcomes (William, 2011), but most often tests are intrusive, over-generalize across people, exaggerate the impact of the limited snapshots they take, provide feedback too delayed to be useful, and are poorly aligned with students' and teachers' needs.

One prominent example of ineffective assessments are the SATs. While SATs are predictive of first-year college grade point average (Geiser & Studley, 2002), they are more characteristic of high school demographics, do not predict subsequent career performance, or how far students will get in life (Rothstein, 2004). By contrast, in a study testing students motivation, internal drive was predictive of life-long outcomes, and not merely of success of graduation (Grant, 2008). The flaw is in using assessments that are divorced from the reality of learning experiences.

Socos fills the gap between real-world outcomes and the assessment-based feedback provided in schools. We define dimensions of competencies relevant for life and use non-intrusive assessments to evaluate what feedback is necessary to further those outcomes. Feedback is based on unstructured data that stems from naturalistic environments, irrespective of the standardized assessments used in schools or learning environments.

Solution

Socos is developing and implementing technologies that allow the learning experience to become the core of education by integrating assessment, feedback, and lifelong outcomes into one unified experience. The implementations of these solutions require the combination of human capital and technology.

Education requires direct human participation. Parents, caregivers, colleagues, and teachers all play an important role in a learner's development. This includes education in nurtuant parenting (Gertler, Heckman, et al., 2014), implicit education which fosters a growth mindset (Dweck, 2006), and positive framing and affirmation (Cohen & Sherman, 2014). Socos is building on pre-existing research, but mainly in the realm of "hand analysis" of complex data. One study that demonstrates that how students take notes over several weeks of a course is highly reflective of self-regulated learning aspects (Glogger, Schwonke, et al., 2012). Socos will be using the demonstrated importance of human participation in education to further the goal of lifetime outcomes.

Technology is sufficiently advanced that algorithms can accurately predict lifetime outcomes. When that information is provided recursively to the students and teachers it becomes actionable. However, the current integration of technological assessments occur in tightly regulated environments. While they might provide flexibility in their assessment strategies, they can only do so by offloading standardization onto the environment.

The solution proposed by Socos is to take naturalistic student experiences and perform predictive assessment on lifelong outcome. In the case studies previously described, lifelong outcomes of test subjects were changes by slight alterations to their environment. Children denied crayons immediately ate their first marshmallow and parents given weekly interventions in Jamaica raised children indistinguishable from less socioeconomically limited families. Minor real-world interventions have a major impact.

By examining all the variables of a students' learning experience to improve their learning and real-world efficacy, the Socos technological interventions let teachers focus on teaching and students enjoy the process of knowledge acquisition.

Some examples of pre-existing material include teacher dashboards, online profiles, discussion boards, and learning portfolios. An important part of the Socos technology is to feed back the information gleaned from these materials in an easily interpretable way to teachers and educators.

Socos is using timely feedback as a catalyst of internal processes of students that are rich resources, akin to social psychologists using interventions to just bring about a small change in a students' perspective. This triggers very different self-perceptions and actions, enabling the student to engage in a positive feedback loop with the environment.

About Socos

Everyone at Socos has a very personal relationship with educational technology, research, and teaching. Co-founder Dr. Vivienne Ming, PhD, named one of 10 Women to Watch in Tech in 2013 by Inc. Magazine, is a theoretical neuroscientist, technologist and entrepreneur.

She is a visiting scholar at UC Berkeley's Redwood Center for Theoretical Neuroscience. She sits on the boards of StartOut and Our Family Coalition and speaks on issues of LGBT inclusion and gender in technology. Previously, she was a junior fellow at Stanford's Mind, Brain & Computation Center and earned her Ph.D. from Carnegie Mellon. Her work and research has received extensive media attention including the New York Times, NPR, Nature, O Magazine, Forbes, and The Atlantic.

Ming's career lead her to work at Guild as Chief Scientist, where she applied her computational neuroscience to create algorithms to finding within a database of ten million software developers, the diamonds-in-the-rough, individuals with the prerequisite talent who had been overlooked. Ming left her role at Guild to devote all of her attention to Socos, and brings with her the computational knowledge gleaned working with millions of professionals to Soco's mission of optimizing human potential.

Dr. Ming co-founded Socos with her wife Dr. Norma Ming, a learning scientist and educational technology thought leader who works at the intersection of research and development, policy, and practice.

Dr. Ming merges a pragmatic understanding of the teaching enterprise with a long-term, systemic vision of how research can illuminate and policy can facilitate better learning. Her experience in teaching, professional development, assessment design, and curriculum evaluation crosses multiple disciplines and spans elementary through postgraduate students, teachers, administrators, and faculty trainers. Research projects have explored relationships among predictors, processes, and outcomes across a range of student populations and instructional models, from case studies to massive scale, individual or collaborative, with and without technology. Her policy advocacy highlights issues of equity in creating flexible paths and innovative resources to enable all learners to meet high expectations.

The Dr. Mings are joined by Engin Bumbacher, also a theoretical neuroscientist and Director of Research at Socos. Engin is devoted to the development of the company's core cognitive modeling and predictive analytics technology. He did his master's thesis project at the Redwood Center for Theoretical Neuroscience at UC Berkeley under the supervision of Dr. Vivienne Ming, applying and further developing elaborate models of information processing to human speech and music. Engin earned his master's degree with honors in Neural Systems and Computation from the Swiss Federal Institute of Technology Zurich and the Institute of Neuroinformatics, both researching in the field of theoretical neuroscience and exploring models of collective intelligence through

implementation of interactive flocking algorithms to control computer sound synthesis and 3D sound positioning. Prior to that, he finished his B.S. with honors in Physics at the same university.

The Socos team is the only group currently taking naturalistic student experiences as the basis for assessments. The solution to improving education and the learning gap is to close the educational loop, and provide relevant feedback to educators and parents on what they can do in naturalistic setting to improve life-outcomes. Socos is in the position to make this possible.

Case Studies

Kindersight

Interventions in early childhood are of great interest as they can have significant impacts down the road (Karoly, Kilburn, et al., 2006). However, interest in improving early childhood learning across school and home settings is colliding with movements to increase standardized testing at younger ages. While testing proponents are rightfully concerned about measuring children's learning, the design and use carry many problems. Tests are valid only for the population and purpose for which they were designed; eliminating cultural bias from tests is extremely difficult; and tests are often designed as sequestered experiences stripped from authentic contexts. Standardization narrows the range for what is considered acceptable progress regardless of developmental variation, and testing is intrusive, displacing instruction which might yield better learning.

Working with researchers at a major university, Socos is building an alternative method for assessing young children's linguistic and metacognitive development in richer detail and more naturalistic contexts. The new system extends our existing assessment algorithm for adult learners to deliver rapid, actionable feedback for parents, teachers, and caregivers based on the broad range of learning experiences already taking place in the classroom and at home.

Analysis of young children's linguistic experiences from audio recordings have demonstrated the feasibility of automatically tracking word exposure and adult- child conversational turns. We are in the process of deploying similar technology throughout kindergarteners' learning environment in conjunction with location data and analyze them with our continuous passive assessment algorithms. We are producing a map of the conceptual space of young learners with which we can explore the predictive value of the individual language experience, including self-generated as well as child-to-child and adult-to-child speech in each language. Combined with student artifacts and information about classroom activities, these data sources would serve as multiple inputs illuminating students' knowledge and skill that can then be connected with externally validated assessment outcomes. By distinguishing between what students generate and what students experience, the predictive system further elucidates school and home interventions with the greatest potential to boost learning.

The implications for this work are far-reaching: the ability to assess student knowledge from existing learning experiences removes the burden of testing and enables teachers to focus on instruction with the greatest learning impact. Evaluating the benefits of different experiences at school and at home would better inform teacher and caregiver choices of interventions, in addition to facilitating more productive collaboration. It could clarify the relative effectiveness of parental contributions in reinforcing school lessons (repeating the same language) or elaborating upon them (adding new language). It exemplifies a minimally-intrusive technological innovation that would advance what instructors know

about their teaching, rather than immediately requiring drastic changes in practice.

Beyond simply increasing and enriching children's vocabularies, supporting their linguistic development in real-world contexts directly advances their skill in using language to monitor and guide their own learning. Our system augments the critical support of caregivers through brief messages informing and guiding their interactions with the children. Our ultimate goal is not only to provide daily, personalized interventions to decrease the word gap, but to drive the development of broader lifelong meta-learning skills.

Innovative Competency-Based Online College

Socos is in the early stages of a project with a new, competency-based online college, which Wired Magazine has named among the most innovative organizations in the world.

This organization has taken an entirely new approach to self-directed learning. There are no grades or professors. Instead, progression through the curriculum is driven entirely by competency. Students work digitally with coaches who support students for the duration of their projects. Students' work are then given a pass or fail by an unbiased panel of assessors, and the student either moves on to the next project, or attempt the work again. Students are considered done with a specific project when they have master that competency. If they have not mastered that competency, they are given recommendations about how they might improve.

Socos is working with this organization to implement new approaches to direct assessment in their competency-based learning paradigm. This project continues to build on our interest in continuous passive assessment as an innovative method for real-time assessment of unstructured student work. We validate our assessment algorithms based on their ability to predict concrete outcomes such as persistence and progression, as well as mapping them to established program goals and competencies. Linking this competency map to employers' needs can further help gauge progress in students' career trajectories, via an adaptive guide for leveraging student strengths. By offering more timely and specific feedback based on automated analyses of student work and interactions, such a system can more effectively guide self-assessments, instructional coaching, and peer learning arrangements.

The optimal feedback is derived from the data of student-coach interactions (phone and email). By examining the data of student-student interaction, student-coach discussion, and student-reviewer feedback, Socos will be able to make predictions both about individual student's future performance and provide constructive feedback to coaches and reviewers about how students may improve in school and life outcomes.

We will be using this data combined with comprehensive student profiles to evaluate their engagement with the school. Socos will be able to offer coaches warnings of disengagement and recommendations of known interventions.

Online Student Discussion Predictive of Grades

Socos has conducted and published research based on online class discussion data at one of the world's largest universities. Socos partnered with this university and subsequently published multiple journal articles describing how grades in a course could be successfully predicted based on free form interactions between students during week one. In academic studies, Socos has successfully predicted final grades by analyzing unstructured student text in online discussion forums, which also yielded preliminary topic maps that can be used to trace different trajectories in student thinking (Ming & Ming, 2012).

Using only student discussion data from introductory courses in biology and economics, both probabilistic latent semantic analysis (pLSA) and hierarchical latent Dirichlet allocation (hLDA) produced significantly better than chance predictions which improved with additional data collected over the duration of the course. Results indicate that topic modeling of student-generated text may provide a useful source of formative assessment to support learning and instruction.

Our goals in this research were to identify facilitation strategies that encourage productive discussion, and to explore text mining techniques that can help discover meaningful patterns in the discussions more efficiently at scale. Based on a close reading of selected discussion threads from online undergraduate science classes, we observed a variety of facilitation strategies associated with discussion quality. These observations informed our selection of a larger dataset of discussion threads to analyze via text mining techniques. Using latent semantic analysis to produce topic models of the content of the discussions, we constructed visualizations of the topical and temporal development of those discussions among students and faculty. These visualizations revealed patterns that appeared to correspond with specific facilitation styles and with the extent to which discussions remained focused on particular topics. From a case study focusing on six of these discussions, we documented distinct patterns in the types of facilitation strategies employed and the character of the discussions that followed. In our conclusion, we discuss potential applications of these analytical techniques for helping students, faculty, and faculty developers become more aware of their participation and influence in online discussions, thereby improving their value as a learning environment.

Concluding Remarks

At Socos we are developing and implementing technology which turns learning experiences into predictive analytics for fostering development of 21st century skills relevant for positive life-long outcomes. Current methods of assessment are often intrusive, biased, and misaligned with meaningful outcomes. Interventions that target more general characteristics of people have shown to bring about long-term improvements of qualities demanded by sophisticated employers and life skills.

Over the last 5 years, Socos has researched and developed technology capable of predicting outcomes based on naturalistic data, and is now specifically focused on turning commonplace learning experiences directly into assessments aligned with life outcomes through a combination of non-invasive technological interventions and human capital guidance.

Socos currently has two main areas of focus. Though our project Kindersight we are focused on assessing and improving the linguistic environment of kindergarteners. In our work with several different colleges and online universities we are implementing technology to predict outcomes and providing relevant feedback that can maximize learning potential.

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