VISION EXTENDED

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Introduction and Overview

Joordens and Paré believe that our current education system is out of balance. The ease with which we can assess information learning has silently altered what and how we teach and, more importantly, what we neglect. We teach information, but we give our students little to no practice with the core cognitive skills that define the leaders and innovators of the future: critical thought, creative thought, effective communication and the ability to accurately know one's strengths and weaknesses (meta-cognition). In truth, we have never taught these skills as well as we might, but now we hardly teach them at all.

Luminaries in the field such as Michael Fullan, John Hattie and Sir Ken Robinson have highlighted the lack of core cognitive skill development as the major problem facing educational institutions globally. They have described the educational system we should aspire towards, one in which the teaching of these skills is prominent, resulting in higher levels of both student success and engagement. They have also provided insight into the factors that might guide transformation, such as Hattie's assertion that any changes to education should be evidence-based. However, what has been missing from this discussion is any clear way of getting "from here to there." What exactly can educational institutions do? What tools or processes should they use to move the education system from being information-heavy to developing core cognitive skills (aka., 21st Century Skills)?

The challenge of teaching these skills is linked to a globally-shared desire to make educational experiences widely available irrespective of factors like gender, culture, or socio-economic status and to ensure that all students are treated as equitably as possible. This sharing of education should not just be a sharing of information; it should also be a sharing of processes that develop the ability of all students to work with information in innovative and relevant ways. This is true empowerment, and a novel, resource-friendly approach to the development of cognitive skills is in much need.

This is where the research of Joordens and Paré fits into the world of educational transformation. Joordens and Paré have crafted an evidence-based learning process that effectively teaches skills like critical and creative thought, effective communication, and meta-cognitive awareness, at any scale with minimal resource requirements. Whereas others are highlighting where we need to go in the field, Joordens and Paré provide a concrete approach and innovative solution that gets us there.

The resulting technology that supports this process, known as *peerScholar*, allows educators to quickly and easily create and share extremely powerful learning activities that can replace traditional assessments like essays while amplifying the skill learning exponentially. Critically, this technology does not only exercise these skills, it also quantifies them in ways never considered or attempted previously. At the highest level, the goal of Joordens and Paré is to rebalance the education system to be one that places more emphasis on core cognitive skills. The ability to quantify these skills is critical to this endeavour.

The Pressing Problem: Teaching Core Cognitive Skills

The central goal of every educational institution is to enhance the intellect of their students, and that typically means two different things. First, we want to teach our students the facts and information that we feel they should know. Second, and arguably more important, we want to teach our students the cognitive skills they need in order to work with information in innovative ways. For example, we would like students to be able to think critically about information they are exposed to, think creatively about new or potentially better ways to address various challenges, express themselves well verbally and in writing, listen or read critically and, finally, learn from others about themselves.

At a general level, educational institutions are teaching information well but are increasingly failing when it comes to core cognitive skills. Critical thought, creative thought, expressive communication, receptive communication, and meta-cognitive awareness are core cognitive skills that students need to

participate meaningfully in a rapidly changing, cross-disciplinary and increasingly interconnected world. These skills, sometimes combined with others, are also referred to as transferable or 21st Century skills. Whatever term one applies, these are the skills that define leaders, innovators, and those who have a positive influence on social change. Not surprisingly, these are also the skills that are most valued by prospective employers.

One reason we are failing to teach these skills well is because skill learning – and thus skill teaching – is governed by different cognitive systems than is information learning. The learning of information is governed primarily by our episodic and semantic memory systems. These systems allow information to be learned from simple exposure and, in some cases, as little as one exposure is sufficient. Thus a powerful lecture, well-written text, or digital presentation (e.g., a simulation) can impart information quickly and easily.

Skill learning, however, is governed by procedural memory and works differently. For example, it is possible to acquire a lot of information about guitars from good books or teachers. However, learning to play a guitar requires the much slower process of repeated deliberate practice. With sufficient practice, proficiency continues to develop, especially if the practice occurs within a learning context that provides the support and feedback required to maximize that learning.

The cognitive skills of interest in education do not include the same "muscle memory" components of learning to play an instrument, and yet the same basic process applies (Joordens, Paré, Collimore, 2014). And therein lies the problem for educators. Teaching skills takes time and effort, and skills only reach high levels of proficiency within a well-designed learning context. Athletes join organized leagues within which they "drill" their skills; musicians take lessons and have defined regimes that give them structured practice using their skills. What our education system needs is a powerful "gym for the mind" wherein students can exercise their thinking and communication skills in the same repeated and structured manner.

The fact is, educational institutions have never excelled at providing this kind of learning environment. More often than not, the strategy has been to put students in some context that we hope will give them exercise with the skills we value. One such "context" is classrooms with small student-to-teacher ratios. Our hope is that students who learn within this context will share their ideas about their learning and will critically listen to and dynamically interact with other students, thereby exercising all the skills of interest here. Anyone who has taught a small class though knows the reality is much different. In most cases, it takes great effort to get even most of the students interacting in this way, and some always remain quiet. In addition, this sort of learning context does not scale well, and scalability is critical if we are going to provide the open and equitable educational experiences we all desire for our students.

Another "tool" used to encourage cognitive skill development is the essay. With a suitably engaging topic, the hope is that students will critically read background information and then creatively craft an essay practicing their written communication skills. Note that once again this is a very unstructured and "hopeful" approach to skill development as it depends critically on the topic provided, the task students are actually asked to do, and the support that is or is not provided to scaffold the learning. In addition, essays are expensive to grade, in terms of both financial and time resources. Thus, the use of essays also does not scale well in educational institutions, and yet this practice continues to be used ubiquitously to assess skill development.

What Joordens & Paré provide is a new, innovative approach to deepening the educational experience by emphasizing cognitive skills while also being scalable and resource friendly. In the remainder of this document, I describe the process they have crafted and the technology that allows that process to be used in any learning context in ways that range from resource light to essentially resource free. I will then highlight their more recent efforts to quantify these skills, which is an important step towards affecting policy at the highest levels. If we can measure, say, critical thought, then we can better understand and evaluate how well it is being taught, just as we now evaluate institutions based primarily on their ability to teach information. This a critical step to maximizing the transformative potential of the work they are doing and where your support could play a catalytic role.

The Optimal Learning Process

Professors Joordens and Paré were personally confronted by the challenge of teaching core cognitive skills when they inherited a 1200-student Introduction to Psychology class that consisted only of textbook reading, lectures and multiple-choice assessments. They combined their expertise in Cognitive and Experimental Psychology with research in Educational Psychology, with the goal of devising an optimal evidence-based process for developing these skills.

Specifically then, their Optimal Learning Process requires students to perform an activity across three sequential phases: Create, Assess and Reflect. These activities are intended to be used in place of an essay and should constitute a significant portion of the grade. Students are the most motivated and engaged while being assessed and, as such, assessment provides the ultimate context for training.

The remainder of this section steps through each phase in order to highlight the extent to which the peerScholar learning process has been inspired by research to maximize students' practice with core cognitive skills and support their use of these skills throughout the activity.

Create. The Create Phase is primarily focused on creative thought, critical thought, and expressive communication. Many instructors require students to submit a written assignment like the traditional essay described previously. Submissions to this phase, however, can be from an array of digital sources including images and/or other multimedia. In the case of an essay submission, students must consider available evidence to come up with a position on some issue, exercising receptive communication (i.e., critical reading) and critical thought in the process. Next, students must consider how to present and express their position in a meaningful way, exercising creative and critical thought in the context of written communication.

Assess. The Assess Phase leverages both peer- and self-assessment to significantly amplify the development of skills. As a point of contrast, in traditional assessments students are given some assignment, they perform it, submit it, and eventually receive it back with a grade and comments. Unless students take the initiative to interact with their peers, they never see any work other than their own. This traditional way of learning is suboptimal because students are surrounded by exemplars that they are never allowed to see, some of which are superior to their work and some inferior, and all of which could provide the potential for learning how strong their work is relative to their peers. In fact, there is now an ever-expanding literature documenting the educational benefits of exposing students to the work of their peers. Benefits are apparent even when students see the work of only one peer and are aware of whose work they are seeing. But these benefits become larger if (a) students are required to analyse and provide feedback for the peer work rather than just view it, (b) students see the work of multiple peers thereby giving them a richer set of compositions to learn from, and (c) students assess the work anonymously.

Within the Assess Phase then, students see a subset of peer work, and having them assess about 5 or 6 peers is recommended. In this phase, each peer's work is presented anonymously, as research shows that students provide more direct and useful feedback in contexts of anonymity. Anonymity also makes any form of bias impossible. The only information an assessor knows about any peer is the work they submitted. There are no names that might give rise to cultural or gender biases that have also been well documented in educational contexts. This ability to eliminate bias by allowing anonymous assessment fits very well with our highest aspirations of providing an equitable educational experience to all.

It is important to highlight that as students assess the work of their peers, the task they are performing is "quality-based discrimination," a cognitive task that Joordens and Paré have argued as being the core of critical thought. Specifically, in order to justify why students view certain compositions as superior to others, they must carefully read each composition, exercising receptive communication and critical thought, and assess each in light of the grading rubric and any other support materials provided. Students then must justify their assessments in a pro-social manner by identifying some facet that, if adjusted, could greatly improve the quality of the composition. Students engage in critical thought and

translate the products of that thought into clear, useful feedback, thereby exercising expressive communication skills. Also critical is that students repeat this use of skills for each peer composition, exactly the sort of repeated structured practice with skills that is most effective in allowing those skills develop.

The final step in the Assess Phase is one of self-assessment. After performing the critical analysis of peer assessment, students can be asked to formally assess their own work while they are still in the critical mindset used to assess their peers. Self-assessment has been shown to benefit a student's ability to detect weaknesses in their own work. In this case, students have just seen the work of peers; the poorer work makes them aware of mistakes they need to avoid while the stronger work provides an explicit example of how their own work can be improved. By seeing both, students get a very clear signal of where on the spectrum their own work lies, which provides valuable information to guide subsequent learning.

Reflect. In the Reflect Phase, students are challenged to intelligently use the feedback they received. That is, while they were providing feedback to their peers, an equal number of peers were providing feedback to their work. In this phase, students are first asked to assess each piece of feedback in terms of how useful it is in helping them improve their work. After assessing all of the peer feedback, they then are given the opportunity to revise their work based on the positive suggestions they received. They can also be asked to explicitly justify the changes they did or did not make within a brief reflective composition.

Note that the delay between students creating their work and seeing the peer feedback is short, as short delays support enhanced learning from feedback. There is also research examining how students consume and use feedback. When students simply receive a grade with comments, they do not think about or learn from the feedback very deeply. A better approach is to provide feedback and then immediately give the students a chance to use the feedback to improve their work. Via this "formative" approach, students are motivated to improve their grade by reading and carefully assessing feedback to determine what is useful and then implementing that learning in an improved revision of their work.

Note also that relative to feedback provided by an expert, peer feedback is noisy; some of it is extremely useful, some of it is useless. This is a positive experience from a learning perspective, because noisy peer feedback provides another opportunity for "quality-based discrimination." Students are explicitly told not to follow every suggestion but, rather, to think deeply, assess it, then either revise their work in accordance with the feedback or not. Performing a revision while engaging in quality-based discrimination of the peer feedback received further exercises students' critical thought, receptive communication and expressive communication.

Summary. The primary reason for stepping through this Optimal Learning Process in this manner is to highlight two things. The first is the extent to which this process exercises relevant cognitive skills. To make this concrete, assuming an assessment of (and by) 6 peers, students will engage creative thought in 2 distinct contexts, critical thought in 16 distinct contexts, receptive communication in 15 distinct contexts, expressive communication in 9 distinct contexts, and meta-cognition in 9 distinct contexts, all within a single activity. No other learning process comes close to packing this much skills practice into an assessment experience.

The second critical point is the extent to which this process is grounded in research. Through its use of peer-assessment, self-assessment, formative-assessment, anonymity, reflection, active learning, and scaffolding, all occurring within an assessment context designed to provide deliberate practice, great care has been taken to leverage all of these evidence-based learning experiences to maximal effect. It truly is an Optimal Learning Process for core cognitive skills.

A final critical point is that the Optimal Learning Process is inclusive and equitable in the sense that ***all*** students must equally participate in an activity that does not allow any sort of bias. The importance of this point is perhaps best illustrated by referring back to the small classroom mentioned earlier within which some students remain disengaged from the learning experience, attempting to become invisible. In contrast, within the optimal learning process, ***all*** students put forward submissions, ***all*** then critically analyze and provide feedback to their peers' work, and ***all*** then critically analyze and then use the feedback

that peers applied to their work. Thus the learning experience is much more equitable across students, with all students experiencing the same process and playing the same roles throughout.

Maximizing Access and Minimizing Resource Demands via peerScholar

The complex logistics involved in copying compositions, distributing them randomly and anonymously to peers, collating and redistributing feedback, and keeping track of all the various assessments occurring along the way made it obvious from the outset that a technological vehicle was needed to allow the optimal learning process to be widely used. Joordens and Paré created the original version of this technology themselves and called it peerScholar as it harnesses the power of peer- (and self- and formative) assessment to help transform students into scholars.

Given their training as researchers, Joordens and Paré immediately began performing research on the efficacy and usability of peerScholar. Their research guided further development, and their work was published in international peer-reviewed journals and presented at international conferences. Some noteworthy findings about peerScholar are that it is valid to use the average peer-ratings as grades (Paré & Joordens, 2008), that students report enjoying and appreciating the process (Collimore, Paré & Joordens, 2015), and that the peerScholar process can successfully quantify critical thought and meta-cognition with repeated use, showing positive effects on both (Joordens, Paré & Collimore, 2014). In addition, when used in a large class, peerScholar can increase the sense of community within that class (Paré et al., 2015).

The research visibility of peerScholar inevitably resulted in demand from other educators the world over who were searching to find a solution to such a ubiquitous problem in education. That demand prompted Joordens and Paré to create a start-up company called Cogneeto that now includes seven teammates and has brought peerScholar to 163 institutions in Canada, 25 in the USA, and 33 outside of North America. The latest version of peerScholar incorporates everything learned from the research and from beta users to produce a highly usable and scalable application that can stand alone or integrate with other technologies commonly used in educational settings (e.g., Learning Management Systems). This latest version of peerScholar is now emerging from a thorough beta testing period that included over 40 instructors and well over 6000 students. The product and company are now ready to expand their user base much further.

Touching on the scalability of peerScholar, one prominent example is the successful use of this tool in Coursera's massive open online course (MOOC) offering of Introductory Psychology in 2015, a course that included over 60,000 active students. The creation of this MOOC was sponsored by the Bill and Melinda Gates Foundation as an instance of a course that brought deep learning in the context of a high-demand topic to a worldwide audience. As such, the use of peerScholar within the MOOC provides a clear example of Joordens & Paré's dedication to support wide-reaching, globally-relevant education.

Another example of peerScholar's scalability is its collaboration with the Global Teenager Project (GTP) organized by Bob Hoffman from the Netherlands. The GTP has brought together over 20,000 students from over 42 countries into online "learning circles" wherein they learn about, and perform, projects related to some core global issue, such as access to clean water. Having access to peerScholar over the past 4 years has allowed project participants to easily share their projects and get feedback from fellow students from all over the world, while also expanding the learning experience to include practice with core cognitive skills as highlighted throughout this document.

As another example of Joordens & Paré's desire to positively impact education beyond their country's borders, they have recently entered into a relationship with Javier Acquella from COGx to tackle low retention rates and to help Syrian refugees succeed in US Colleges. COGx provides an evidence-based form of tutoring aimed at helping high risk students gain skills like resilience and grit. When coupled with the highly scalable peerScholar, the two provide complementary forces aimed at student success.

This is an appropriate place to highlight some of the recognition this duo has been awarded from the educational community. Joordens and Paré have won awards from the institutional level (e.g., University of

Toronto's Inventor of the Year Award and UTSC's Special Merit Award for Innovation in Teaching) to the Canadian National level (e.g., The Learning Partnerships' National Technology Innovation Award and a 3M National Teaching Fellowship, the highest national award for sustained and significant impact on education). The students they supervise also have won awards such as the MITACS Commercialization Award, another top level National Award given to Lisa-Marie Collimore for her work assessing the commercialization potential of peerScholar in the Canadian K-12 sector. Both Joordens and Paré regularly give keynotes at international conferences related to education and educational innovation, for example Joordens was very recently a keynote at Dociente, a major Mexican conference that brings together teachers from all of Mexico to learn about research relating to their craft, and he about to be one of two panelists at Montgomery College's President's Innovation Forum focused on the effective use of educational technologies. I consider them fantastic ambassadors for the importance that the University of Toronto places on innovation in general and educational innovation especially. For example, when I needed someone to speak to our alumni in Silicon Valley, they were our go-to team!

Finally, in addition to the skills learning it provides, the other major benefit of peerScholar is that it respects resource limitations. Note that the learning occurring in both the Assess and Reflect Phases is driven completely by the students via the comments and ratings that they are providing to one another. Thus no teacher participation is required, and this is true even with respect to grading the contributions of students. Paré & Joordens (2008) have demonstrated that if 5 or more peer grades are averaged, that average peer grade provides a valid mark. Thus it is possible to assess both the quality of the compositions students produce and the quality of feedback they provide via the average ratings they receive from peers. This means that a teacher can provide this incredibly deep learning experience and their only time cost is setting up the activity within peerScholar (i.e., less than 20 minutes). Of course, teachers can choose to also add grades and comments, which makes the learning experience richer still, but the extent to which they do so is completely under their control. Thus peerScholar can be used in extremely large courses, such as the MOOC described above, or in small, intense learning environments like the learning circles in the Global Teenager Project.

This one-two punch – providing an extremely powerful educational tool that meets the biggest current educational challenge in a very resource friendly way – is transformative because peerScholar provides educators with a highly implementable and concrete approach to rebalance education that respects the importance of teaching core cognitive skills in addition to area-specific information.

Looking Forward: Quantifying Cognitive Skills

Providing a technology that allows any educator to easily harness what is ostensibly the best process devised for teaching core cognitive skills is no small feat! A technology like this has the potential to rebalance an educational system skewed in part by a technology from the 1970s, the Scantron machine. It is important to note that the use of Scantrons became widespread not because they improved the learning of information (as peerScholar improves the learning of cognitive skills), but rather because they offered a quick and easy way to quantify information learning.

The importance of quantification cannot be overstated. So long as skills like critical thought remain vague qualitative concepts, it will be difficult to document and reward their development even when an evidence-based tool like peerScholar is available. This is especially true when information learning can be measured and compared quickly to other assessment scores (take the Programme for International Student Assessment (PISA) scores as an example). However, if core cognitive skills could be easily quantified and their development reliably measured, then it may be viable to reshape educational policies to include teaching and documenting the learning of core cognitive skills.

Thus, it is now the time to develop reliable and valid indicators of core cognitive skills, and Joordens and Paré are leading that charge. For example, in Joordens et al. (2014), the duo provided a simple quantitative approach to measuring a student's critical thinking ability. The concept of "critical thinking" is seemingly broad and complex, but Joordens and Paré argue that it can be measured by

quantifying a student's ability to discriminate on the basis of quality, and they provide a relatively straightforward formula for doing so. In addition, they demonstrate that this measure shows improvement with repeated exposure to the peerScholar process. A similar computation and empirical support is provided to assess a student's meta-cognitive skills.

This marks the beginning of a very important line of work to find valid and reliable ways of quantifying all the core cognitive skills we value, and the Higher Education Quality Council of Ontario has already expressed an interest in supporting Joordens and Paré in this work. Such measures can inform us about which educational practices have the strongest impact on which skills. They can allow us to design and implement balanced and complementary learning strategies. Perhaps most important though, they allow us to measure the quality of the education we provide to our children in terms of both the information we deliver and the skills we help them develop to use that information powerfully. As such, these measures can drive changes in policy and mobilize what a technology like peerScholar brings to the table.

References

Collimore, L., Paré, D. E., & Joordens, S. (2015). So what do you think? Canadian students' attitudes about peerScholar, an online peer-assessment tool. Learning Environments Research, 18, 33-45

Joordens, S., Paré, D. E. & Collimore, L. (2014). Taking Learning Outcomes to the Gym: An Assignment-Based Approach to Developing and Assessing Learning Outcomes. Toronto: Higher Education Quality Council of Ontario.

Paré, D., Collimore, L., Joordens, S., Rolheiser, C., Brym, R. & Gini-Newman, G. (2015). Put students' minds together and their hearts will follow: Building a sense of community in large sized classes via peer- and self- assessment. Toronto: Higher Education Quality Council of Ontario.

Paré, D. & Joordens, S. (2008). Peering into large lectures: examining peer and expert mark agreement using peerScholar, an online peer assessment tool. Journal of Computer Assisted Learning, 24, 526-540.