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A STEAM School using the Big Picture Education (BPE) design for learning and school - what an innovative STEM education might look like

by **John Hogan** (Co-Founder and Co-CEO, Big Picture Education Australia) and **Barry Down** (Professor of Education, Murdoch University and Co-Principal Investigator for the Big Picture Research and Evaluation Committee)*




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Collaborative Innovation in Education - STEM, STEAM and the Economy

Vivienne White
Co-Founder and Co-CEO
Big Picture Education Australia

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Address: Big Picture Education Australia PO Box 544 Strawberry Hills NSW 2012
Phone: 02 9590 5341 **Email:** info@bigpicture.org.au
Website: www.bigpicture.org.au

A STEAM School using the Big Picture Education (BPE) design for learning and school – what an innovative STEM Education might look like

John Hogan and Barry Down

Corresponding author: john.hogan@bigpond.com
Murdoch University, Murdoch, WA, 6150, Australia

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Abstract

Recent reports coming out of Australia proclaim a number of "STEM in school" issues among them the need for more students to engage in STEM at school; insufficient numbers of students pursuing STEM pathways post-school; and the school Australian Tertiary Admission Rank (ATAR) pathway that results in too many students missing out too early. Succeeding in STEM at school is one thing but being passionate about working on society's great challenges is another. We need young people who are passionate and committed to continuing their study in STEM related areas. Traditional strategies like trying harder, committing more funding and adhering to current practices are clearly not working. We argue that innovation in school design and pedagogy is required.

In this article we will describe how this kind of innovation might look in three ways by first, expanding STEM to STEAM and explaining how the A(rts) can contribute to STEM education in more engaging ways; second, using the Big Picture Education (BPE) design for learning to create opportunities for deep learning around student interests through internships; and third, illustrating how students' interest in the compelling challenges of our time can generate motivation, depth of learning, and better outcomes for STEAM areas in the future. We conclude by illustrating how a BPE school can make a substantial contribution to both the local and wider community and serve as a national model for alternative STEM/STEAM schools.

Why the focus on STEM in school education?

Recent national reports argue for an increased focus on STEM education in Australia highlighting a STEM skills shortage in the workplace and the growing demand for STEM related skills and knowledge (Office of the Chief Scientist, 2013, 2014). However, this is not just an argument for more scientists and mathematicians being developed. Research indicates that 75% of the fastest growing occupations now require STEM skills and knowledge (Office of the Chief Scientist, 2013, p. 10). Ian Chubb (2016), Australia's Chief Scientist neatly summarises the importance of science:

> *Science and the application of scientific principles can be found everywhere. Our nourishment, our safety, our homes and neighbourhoods, our relationship with family and friends, our health, our jobs, our leisure are all profoundly shaped by technological innovation and the discoveries of science* (p. 1).

It appears we need all citizens to be more confident and capable users of STEM knowledge. Most people will have to deal with a life where the specialist knowledge and skills that develops the innovations, the scientific claims, and the technological breakthroughs remains

unknown and incomprehensible - even if not hidden inside the "black box". Nonetheless, all citizens are required to vote on issues that affect the environment, sustainability, technology, health, the economy, and planning. In this context, young people need an education that not only prepares them extraordinarily well as future workers but as citizens capable of dealing with large amounts of information, making decisions and taking action for the future.

Furthermore, STEM is happening and changing in the workplace and industry in ways that school is not - and cannot - keep up with. In our view, students are far too isolated from the adult world and authentic forms of learning in real contexts. If we are truly serious about enhancing student engagement with STEM then it seems to us that schools have to find new ways of blurring the boundaries between school and community based learning around the big issues confronting society today. The essence of this approach is captured in the title of Washor and Mojkowski's (2013) book "Leaving to learn" which describes the benefits of out-of-school learning under the guidance of expert mentors. They argue that these kinds of experiences promote not only the physical, intellectual, emotional and creative energies of young people but deeper forms of learning. In the section to follow we argue that this kind of learning requires a fundamental shift in the ways our schools are designed in terms of structure, pedagogy, culture and relationships.

Some problems with STEM in schools

It would seem that Australia has some problems associated with STEM in schools. There are not enough students enrolling in STEM related subjects and consequently pursuing STEM academic pathways. Adding to the problem is a chronic lack of trained specialist teachers in STEM (AIG, 2013; Hackling et. al., 2014). Therefore, it should be hardly surprising that this general lack of interest at school is translating to low enrolments at tertiary level (Anlezark, et. al., 2008). A central proposition of this article is that young people need to be critically engaged in STEM related areas in order to tackle the big ideas and challenges facing society. This kind of endeavour provides another level of complexity - it is much more than simply getting students to enrol in STEM subjects.

We believe a more fundamental problem is that far too many students are being "pushed out" or "left out" of the STEM ATAR pathways in schools. The structure of school tends to divide students into "academic" and "non-academic" and this leads to a lack of engagement in learning, rigor and relevance for large numbers of students. This occurs too early in a student's school career. Students are streamed out of "top" maths/science classrooms from early in their high school life leaving only a small fraction of the school population to choose STEM subjects in years 11 and 12. Far too many students are failing to complete school, complete school with minimal qualifications, or complete school with little interest in ongoing study. Evidence shows that access to the benefits of the "competitive academic curriculum" are largely based on one's class, race and gender (Lamb, Jackson, Walstab & Huo, 2015; Teese & Polesel, 2003; Connell, 1993).

There are problems too with the way the STEM curriculum and teaching is constructed in schools. This may cause students to vote with their feet. Students are taught solutions to problems they don't find relevant or interesting. They are not doing experiments or theorizing solutions to issues that really matter to them. They don't do experiments, they copy demonstrations mandated by curriculum and syllabus authors. This is not an argument for simply making STEM "fun" or "exciting" as helpful as this might be. Whilst this approach might have some value compared to abstract teaching divorced from the realities of

students' lives, it is insufficient. We contend that a much deeper understanding of student engagement is required, one that moves beyond a compliant view of "mastery of academic work" to encompass a more progressive, critical and democratic view of "active citizen" (McMahon & Portelli, 2004). In short, we don't believe the answer lies in either mandating enrolment in STEM related subjects or developing yet another list of 'tricks' to make STEM "fun". Instead, we seek to advance a fundamental shift in school design including a reconceptualization of curriculum in order to create a greater sense of authenticity, relevance, rigor and relationships which young people crave.

New possibilities for innovation

The solutions being presented in recent reports are at best a "confusion" of ideas: a mix of more of the same (e.g., all students should study mathematics and science); more trained mathematics and science teachers; earlier specialisation to force students do more science and mathematics; and more rigour in the training of teachers in STEM related areas. Whilst appealing at one level these kinds of responses are inadequate. In essence, they tend to reinforce the way things are, something that has demonstrably failed students and teachers and the wider community so far. Despite calls from various pressure groups for innovation and new solutions to old problems, the architecture of schooling remains largely intact. The barriers to school reform are indeed formidable and cannot be underestimated (Tyack & Cuban, 1995, p. 135). Trying harder, committing more funding and adhering to current practices are not working. Doing the same old things although more intensely won't work either e.g., more testing, streaming, didactic teaching, standardised syllabuses and so on. Innovation is required in the way we think and act around these matters. For this reason, we want to explore what an innovative school design and pedagogy might look like and why it should be at the heart of STEM related school change.

Such a move involves changing the way we do school - curriculum, assessment, structure, organisation, relationships, pedagogy, family and community. It requires a different way of "doing" school from the way students enrol in school to the ways in which the curriculum is organised around student interest. In short, there is a need to fundamentally change the "grammar of schooling" (Tyack & Cuban, 1995) to put the needs and interests of each student at the heart of everything that schools do (Wood, 2005; Meier, 2002).
Furthermore, we want to keep our eye on the big questions, the compelling questions of our times, the questions all young people are concerned about. According to the Chief Scientist (2013):

> *The five most significant societal challenges that we presently face are:*
> - *Living in a changing environment*
> - *Promoting population health and wellbeing*
> - *Managing our food and water assets*
> - *Securing Australia's place in a changing world*
> - *Lifting productivity and economic growth* (p. 5)

Central to this revitalised approach to education is student interest and the ways in which it connects to these bigger ideas. The irony is that young people are quarantined from the big challenges facing society, at least physically and we would argue intellectually and creatively. One promising approach to breaking down the barriers between school and community learning is by linking students with adult experts in the community for two days a week around their interests – in universities, businesses, industry, and non-government organisations – where students engage in socially worthwhile projects. Drawing on the Big

Picture Education design for learning, students are encouraged to do extended pieces of work around a particular issue, question or problem of personal interest. Such approaches combine head, hand and heart. The intent is to support students by building school cultures based on relationships, relevance and rigor *for all* students. To this end, students are supported by an Advisory Teacher, Advisory (classroom), family members, teachers and adult mentors throughout their school years (Littky & Grabelle, 2004).

If more students are going to engage with STEM then more students need to access an interesting STEM curriculum. This can only be properly achieved by challenging the practice of streaming and the ways in which it excludes many young people from the HARD maths and HARD sciences or those "powerful forms of knowledge" (Young, Lambert, Roberts & Roberts, 2014). Rather than streaming students "out" they should be encouraged to pursue their interests drawing on interdisciplinary knowledge as the main driver of learning.
This orientation to learning is about new opportunities – new opportunities for students (not previously headed for a STEAM future), new opportunities for pathways to university, new opportunities for teachers to be innovative, new opportunities for the university in research, partnership and student enrolment and new opportunities for education systems to lead STEM innovation in Australia. Again, the Chief Scientist (2013) has drawn our attention to the imperative of innovation around school design and pedagogy:

> *To reverse the trend for decreasing STEM participation in schools, federal and state governments will need to cooperate to drive the school education system away from educating students as we used to, and towards preparing students for a future increasingly bound to STEM, These changes encompass educational values, curriculum, and accreditation procedures so that school leavers will be well-equipped to participate in the then contemporary workforce* (p. 14).

Expanding STEM to STEAM

Design and creativity of the arts are crucial underpinnings of the successful mathematician, scientist and engineer (design, form and function). It provides a link that is currently missing from many STEM initiatives. By way of example:

1. Representations of science and mathematics models are used in practice e.g., cartographer, carpenter, architect, engineer and digital animation. In many of these contexts there is strong interplay between technology, science, and design.
2. STEM applies to the creative arts, for example, in fashion industry, industrial design, interior design and the creative arts applied to STEM through for example, advertising and promotion, music and model making.
3. Models of mathematical structures can be used to create art and artistic models of the mathematics to explain the mathematics.
4. The world of video game design and development encompasses a wide array of fields from STEM and the Arts.

We know that young people flourish when given the opportunity to use their imagination (Greene, 1999) and creativity through the arts (Robinson, 2011) and vice-a versa. STEAM approaches to learning advance the view that students don't have to choose between the arts and sciences - they can do both. The big questions confronting society today provide important insights into the integrated nature of the world. Solutions to complex social, economic and political problems are not simple, linear or one-dimensional. Nor can answers

be found in any one discipline, for instance economics. Maeda (2013) describes the pivotal importance of inserting the A(rts) into STEM to address societal problems:

> *Science, Technology, Engineering and Math – the STEM subjects – alone will not lead to the kind of breathtaking innovation the 21st century demands. Innovation happens when convergent thinkers, who march straight ahead towards their goal, combine forces with divergent thinkers – those who professionally wander, who are comfortable being uncomfortable, and who look for what is real* (p. 1).

He (2013) goes on to explain how:

> *Design creates the innovative products and solutions that will propel our economy forward, and artists ask the deep questions about humanity that reveal which way forward actually is* (p. 1).

The Big Picture Education (BPE) design for learning

Therefore, doing more of the same doesn't seem like a good option. Students need different contexts and opportunities to pursue their learning in different ways. Reports (Office of the Chief Scientist, 2013) on STEM argue that innovation is a key to the STEM strategy so our education solution needs to be innovative too. But we struggle to innovate within Australian schools. The traditional model of schooling continually pushes back to the way things have been historically. If we are going to be innovative this work needs to be done from the ground up using a Greenfield site unhindered by layers of bureaucratic rules and regulations. It needs to be a different kind of school with the freedom to think and act differently. This means a willingness and preparedness by education systems and schools to question conventional orthodoxies - assumptions, beliefs, routines, habits, behaviours and practices - with which we have become so comfortable. It requires imagination and a spirit of hope to build a vision of a different kind of school where students and adults can explore new ideas and strategies about what it means to be truly educated.

In pursuing this vision, Big Picture schools aim to educate one student at a time, within a community of learners. These schools are lively proof that all young people, and especially our underserved students, can succeed in school, careers and life. It happens by adhering to four basic principles:

1. Learning must be based on each student's interests and needs.
2. Curriculum must be relevant to the students and allow them to do real work outside of school.
3. Students must connect to adult mentors outside the school who share the interests and support the learning of the students. This will take the student into the community, into the universities, into the labs, into the field … they find expert mentors through connection and relationship.
4. Students' development and their abilities must be measured by the quality of their work and how this work changes them.

By way of some background, Big Picture Education Australia (BPEA) was founded in Australia by Viv White and John Hogan drawing on their own experience in school change and teacher development, and supported by a committed and experienced team of innovators. BPEA is a not-for-profit company. It is supported by philanthropy and from payment for provided services, including for professional learning and coaching. From just one school in 2007, BPE has reached 44 schools across Australia, trained 1633 teachers and impacted on

the lives of almost 5000 students[1]. Big Picture Learning began in the US in 1995 and has since spread across the globe, with networks and schools in five continents in countries such as Australia, New Zealand, the Netherlands, Israel, Italy, Kenya, and Canada with conversations underway in India, Singapore and Korea.

The focus of BPE is on whole school change around twelve design distinguishers[2]. These distinguishers arose out of the deficiencies of previous sporadic and often piecemeal attempts at school reform. Importantly, there is a well thought out implementation process to reflect on our own experience of successful school innovation growing out of the work of teachers and school leaders.

Educators will recognise all the distinguishers, indeed some have characterised innovative practice for years. But it is *every single one* of the distinguishers, in combination, which create the innovation in school design. The twelve distinguishers influence everything that Big Picture Advisory Teachers, leaders, students and families do – and this extends to the way the school is structured, managed, and operated. These distinguishers are:

1. Academic rigour
2. Leaving to learn
3. Personalization
4. Authentic assessment
5. Collaboration for learning
6. Learning in advisory
7. Trust, respect and care
8. Everyone's a leader
9. Families are enrolled too
10. Creating futures
11. Teachers and leaders are learners too
12. Diverse and enduring partnerships

In the section to follow we shall elaborate on how these design distinguishers are translated into real school practices. A short student narrative - in the words of the student or teacher/observer – is provided to help illustrate how the practice is enacted and experienced.

Key design elements of a BPE School

1. Each student will have a personalised learning plan. The student creates the learning plan with support, guidance and assistance from their Advisory Teacher, family members and mentor (where appropriate). The learning plan is developed around the student's interests, talents and needs. The learning plan makes explicit links to the Big Picture learning goals (Empirical Reasoning, Mathematical Reasoning, Communication, Social Reasoning and Personal Qualities) and describes the work, the activities, the products and expected learning that the student will undertake and achieve over the term.

   Norah is a student at a Big Picture campus, she is learning astrophysics and epidemiology with a mentor at a University. Why? Because her big project is writing

[1] See Bonnor, C., & White, V. (2015) and Hayes, D., et. al. (2014) for further discussion.
[2] See www.bigpicture.org.au for more information.

a science fiction novel and she is adamant the science has to be right.[3]

2. Project-based Learning (including inquiry based learning) will be used to focus on each student's interest providing a context and structure for integrating academic, technical, and career skills into learning. Students are challenged to apply their academic skills and understandings to real world problems through individual and small group projects.

   Sajeet is a Nepalese immigrant living now living in Australia. He has a passion for engineering, specifically bridges, because in his village he could see the positive impact a bridge would have for his community. At a Big Picture school, he was able to pursue this passion by interning at an engineering firm. His mentor supervised Sajeet as he took responsibility for planning and leading a special project for lighting a compound. Sajeet is now studying engineering at university.

3. Learning through Internships (LTIs) provide students with opportunities to learn outside of the school, in settings where they can observe and work with adults addressing real world problems and challenges. LTIs are typically 2 days per week – each term for every year of high school. LTIs are set up following excursions, and students conducting Informational Interviews and Shadow Days in order to identify the best place for the interest and person for a mentor.

   Simon had an internship with the Wilderness Society with his mentor Rebecca. He planned a project related to documenting the endangered species in a significant Wilderness Region in Tasmania. Simon documented some 69 endangered animals. Before he had even finished his internship over 60 people had accessed and used it.

4. Every student is in an Advisory group, with an Advisory Teacher, of between 15 – 20 students. Advisory groups remain intact for 2-5 years. Advisory is a key part of every school day. In Advisory the students - with their Advisory Teacher - explore their interests, develop and review learning plans, investigate opportunities, new ideas and concepts, work on their literacy and numeracy. It is their home base at school. Academic achievement is the primary focus with deep emphasis on literacy and numeracy. Students work in classes, small groups, and in one-on-one tutoring sessions including online learning (where appropriate). Kiki, a student at a Big Picture school describes the importance of the Advisory in her own learning:

   "The most amazing thing here is the friends you make here and how much they are different to you and how much they help you and everyone is just like one big community like everyone says it really is that. That's what is missing from most mainstream schools is that community - the connections and the relationships. But I can kind of understand because the teacher has so many students walking through their door - like every year. So you can't really build that relationship with a teacher. But (here) you've got (four) years with one teacher you build an amazing relationship with that teacher."

5. Authentic assessment (in addition to traditional assessments) is employed to monitor

[3] Student stories in this section are based on examples from the public record and/or personal communication with students and their advisory teachers involved in Big Picture academies and schools. Pseudonyms have been used.

and measure student progress. Such assessments include Exhibitions of work and learning on individual and group projects, community service learning, other courses and classes, and Internships. Students do an Exhibition each and every term.

Marissa has concentrated on all things musical and her recent exhibitions have been outstanding, exemplary expositions. Choosing to explore areas within which she possessed minimal understanding, an initial exhibition relayed her findings on the physics and mechanics of domestic speakers. After setting out the technical details in a series of posters and physically arranging a representative array of speaker components on the conference table, Marissa provided her audience with a clear, articulate and lucid explanation of the "what" and the "how" of domestic sound propagation. Those present remarked on her ability to stay on-task for the entire, lengthy exhibition and how the extensive, technical, scientific and mathematical information had all been "translated" and put into her own words. A natural by-product of her exhibition was the clear demonstration of just how the Big Picture design philosophy of learning worked so well for her.

One of the aims of a successful exhibition relates to its ability to generate new fields of enquiry and this initial foray was no exception. Marissa's subsequent project work flowed from questions that arose directly from both her research and her presentation. While she had begun by first investigating and illustrating how domestic speakers worked, Marissa then set about answering the even more fundamental questions of how sound itself worked, how it was generated in the first place, and how we as humans, capture and interpret it.

These follow-up exhibitions were outstanding as she showed what mesmerised and captivated her interest. Now utilising even larger static and electronic visual displays, Marissa produced a series of interconnected posters and spoke at length about the physics of sound followed by in-depth, illustrated expositions on the physiology of the human ear and the mechanics of microphones. Again, all present were impressed with her breadth of knowledge and the articulate manner in which she shared her exploratory journey.

6. Family involvement in a student's education is required through meetings each term to ensure parental engagement in their child's personal learning plan and parental review of student exhibitions of learning and work.

Henry is in Year 10. He has an interest in Forensic Science. After discussions between his family, Henry and his Advisory Teacher Henry met with a Professor in Forensic Science. They chose a first year unit for him to do. Henry and his family sorted out travel as it required a family member to have a break from work to drive Henry to and from the university (it was many kilometres from the school and his home). Not one session was missed even through public holiday sessions. Henry experienced a number of lecturers and special guest expert lecturers. The whole Advisory back at school fed-off Henry as we all wanted to hear and see what he had done. He was being exposed to current practices in the forensics field which more than whetted his appetite for science. The Professor attended Henry's end of term exhibition and then made arrangements to continue the relationship between the student, the school and the university.

7. Post-school readiness and transition are an integral part of the entire experience and students complete a Post-School Project in their senior years.

   Sasha is a Year 11 student who is an elite junior Australian representative in her chosen sport and plays in the women's national competition. She is realistic though about her chances of 'making it big' in the sport and has spent time thinking about alternative careers. She soon realized that her intense involvement in the sport had led her to a deep interest in the work of the physiotherapist. So she formalized her connection with the team's physiotherapist and set up an internship connected to her and coordinated by her Big Picture advisory teacher at school. So she has worked with her mentor a further one and sometimes two days per week for a year. So in addition to being involved when 'on the road' with the team she has worked in the clinic on regular basis.

   In Sasha's words "Learning science in school…I hated it. Now I'm learning it through working closely with my mentor Physiotherapist and I'm loving it". Her mentor said "She has been involved in more patient treatments than many first year phsyio students would get to see". She has designed a program to minimize injuries that the club now uses at training. Her first internship project involved coming up with a diagnosis of injuries leading her to researching anatomy books. Her mentor has observed Sasha at all her exhibitions and is "amazed at what she is learning and how well she is learning it".

   But Sasha is also realistic about the possibility of being accepted into Physiotherapy at University (given the very high ATAR score required and the demands of her national and international commitments would make such a score unlikely). She is working at this issue in two ways. Firstly, to develop a rich BPE portfolio to demonstrate her expertise for university entry. Secondly, she knows that she can gain entry to a Sports Science degree and then specialize after that.

8. Community partnerships are an essential ingredient for the school. The BPE STEAM School endeavours to change the nature of business and school partnerships from a pure funding model to a partnership that includes collaborative programs, curriculum design, mentoring and instructional support.

   Miki is 18. He has a passion for digital art design and visual display technology. Miki has invented a display that emulates holographic technology and has the potential to revolutionize the entertainment, media and marketing industries. He has developed a small-scale prototype and has been able to adapt the design to potentially scale up a holographic image to 8 metres. However, Miki wants to retain intellectual copyright of his invention so he is looking for industry and entrepreneurial partnerships and to sign a non-disclosure agreement. He is exploring the possibility of getting a patent pending and then a patent for the idea. For this he needs mentoring, support and new partnerships beyond his current experience.

Key elements of the design for the senior years

In Year 12 students in a Big Picture School/Academy are required to complete the following:

1. *An in-depth Senior Project*. The senior thesis project is the opportunity for students to take on a large-scale independent project and produce a substantial product that makes an impact on the community. Through the senior project, the student will learn how to

manage a large project, solve problems, work with outside adults, and delve deeper into the Big Picture Learning Goals. Each student will have a mentor (expert in their field), contact a resource person related to the Senior Project at least every other week and keep track of these contacts as well as the support of their advisory teacher.

2. *An Autobiography*. By the end of Year 12 students will have written an autobiographical piece. The Autobiography is a way for students to document and reflect on their life while creating something of value. Students build important writing and self-refection skills through this project and will leave high school with a bound 50-100 page book.
3. *A Post-school Project*. Post-school planning is an important opportunity for students to continue their growth and to prepare for the future. Although each student will make his or her own decision about whether or not to go on to further study, training or work, it is important that each student has options and understands how to create and follow the pathways that get them from school to the place of their choice. The student keeps a record of having visited and interviewed with at least four universities and/or TAFE colleges and their application for at least one including a post-high school learning and work plan.
4. *Book Reviews*. Read a range of books through the year including writing reviews on some.
5. *Other Projects*. All students complete a LTI project each time they have an Internship. After the initial couple of weeks of the Internship, the Advisory Teacher, LTI mentor and student have a project set-up meeting to discuss possible projects that are authentic, challenging, of benefit to the LTI site and that relate to the student's Learning Plan and Learning Goals. Students may do other types of projects through a year including for example: Independent Interest Projects, 'Who am I' Exploration Projects, and Service Learning or Community Development Projects. Some projects may be done in small groups and or as an advisory class.
6. *Graduation Exhibition*. Present the work, learning and reflections on learning at a graduation exhibition attended by mentors, teachers, students, family and other interested participants.
7. *Other Courses*. Students will also complete other courses where they have the interest and/or see the need.

Students create their Big Picture School Graduation Portfolio from the products of the above work. This can be tailored to meet the demands of the university course in which they want to enrol. Transcripts, reports and certificates completed will be included in their Portfolio.

Key elements of a BPE STEAM school

While the BPE School design described above forms the foundation for the school the STEAM focus brings with it a significant new dimension. The Office of the Chief Scientist (2013) cites The National Science Foundation (2008) on the importance of expanding scientific literacy through STEM in contemporary society:

> *Appreciating the scientific process can be even more important than knowing scientific facts. People often encounter claims that something is scientifically known. If they understand how science generates and assess evidence bearing on these claims, they possess analytical method and critical thinking skills that are relevant to a wide variety of facts and concepts and can be used in a wide variety of context* (p. 15).

In addressing these issues, we can begin to identify a number of key elements of a BPE STEAM school, like:

1. Embedding STEAM in each student's learning plan and work.
2. Establishing key themes to explore. For example, sustainability, design and the arts, new and emerging technologies, and entrepreneurial ventures.
3. Engaging learners through hands on, real world projects that incorporate "making", "tinkering", art and design.
4. Employing digital tools and online resources to engage and motivate students.
5. Developing agreements with community partners and postsecondary education partners that allow for new collaborations and forms of inquiry.
6. Employing an extended day schedule and a night school program that allows for personalization of learning opportunities for those students needing more time to achieve basic proficiency on core learning standards and/or flexible schedules to accommodate other life challenges.
7. Seeking Advisory Teachers and mentors from the community that represent the diverse cultural voices of the community wherever possible.
8. Employing a post graduation follow-up program to measure and ensure student success in postsecondary learning and work.
9. Exploring possibilities of the school being Years 9 to 14 and enable students to begin their science studies at university.

Engaging in the compelling challenges of our time – with those that are engaged with them

The BPE STEAM School is committed to out-of-school learning by which we mean students are engaging in and with the community around substantive issues. Schools can no longer continue to operate behind the school gate. As argued earlier, there is an urgent need to blur the boundaries between schools, communities and the world of work. Students need to learn to apply what they know, learn what they don't know, learn to deal with the uncertainty of the "real world", learn to develop new knowledge and skills, and they learn to do things "properly" – all the way through when they are developing a product for use by others. Such views are hardly new, there is a considerable body of evidence and persuasion about the benefits of authentic learning and assessment in the seminal work of people like Newman and Associates (1996) and John Dewey (1963).

It is also in the community where we will find the people who are working on the compelling problems of today's world. These are the people that are using and developing new approaches in their field. Students can learn with them. By way of example:

> *Noah has been working as an unpaid intern for class credit at San Diego Coastkeeper since January 2011. His main responsibilities are stocking kits for water sample collections. Volunteers then take these samples and test them for E. coli bacteria. Noah gathers the data and using Microsoft Excel enters it into the database. Water quality analysts then use this data to promote cleaner water in San Diego County. Noah occasionally tests water samples for nutrients and/or bacteria using standard lab procedures. This provides supplemental data for the analysts. He does the work under the direction of a highly skilled scientist and water technology expert. One of Noah's academic internship projects has been to test and compare household waters from tap to "clean" toilet bowl samples. Another project Noah spearheaded was designing an auto sampler for use by San Diego Coastkeeper to test rivers and streams during the rainy season. Because of*

> *Noah's concern about the world he will inherit, he wants to be part of the solution to ensure a healthy coastal ecosystem. He wants to learn how to make a positive impact on a decaying global environment. Noah is considering a double major of mechanical engineering and computer science when he begins college in the fall of 2014* (Big Picture Learning, 2014).

How a BPE STEAM school could make a substantial contribution to both the local and wider community

By its existence a BPE STEAM school would serve as a national model for alternative STEM/STEAM schools. But what difference would one school/campus make in the scheme of things? The key point is to get innovation happening for all to see. Otherwise innovation gets spread too thinly, only some elements get picked up. Worse, many reform initiatives especially around STEM leave the fundamental architecture of schools in place. Therefore, making visible an alternative way of doing school in the ways described in this article helps to create energy, debate and renewal at all levels – schools, students, teachers, parents, communities, government and employers. By not diffusing scarce resources into many projects but having it work all the way through in one place enables everyone to 'see' and to see how they might then apply it to their own setting.

By way of example, we can begin to see potential renewal around things like:

1. Professional development for teachers.
    - The school becomes a living laboratory for others to visit.
    - There is a capacity to host and offer professional learning opportunities for leaders and teachers across schools, district and states.
    - There is scope to build on-line resources, support and presence.
2. Partnership with universities.
    - Offering Years 9 to 14 and providing an opportunity for pathways to university e.g., associate degrees.
    - Expanding opportunities for STEAM post-graduate education for teachers.
    - Embedding training experiences for pre-service teachers.
    - Developing research opportunities to build local knowledge based on self-reflection, understanding and improvement in practice.
3. Producing and promoting partnerships with the community.
    - Over the first four years of a new school some 1000 community members would be involved as mentors for the students on Internships.
    - This creates a new sort of community. A new sort of relationship between school and community.
4. Building online resources and support.
    - Sharing professional learning and post-graduate education for teachers.
    - Creating new collaborations between students, mentors, families and teachers.
    - Providing support for Indigenous school communities in remote regions of Australia.

These are a few tentative possibilities that emerge from "doing" school differently. Other ideas and strategies will no doubt come from local contexts and discussions between stakeholders committed to STEAM.

Conclusion

In this article we have explored the pivotal role of STEM/STEAM in addressing some of the major challenges facing society at the beginning of the 21st century. We have argued that much of the rhetoric around the "crisis" in STEM in schools is due to the perceived irrelevance of school subjects (and school) to large numbers of students. If we are serious about engaging students in STEM then there is an urgent need to rethink the ways in which we do school. This requires imagination and a willingness to innovate around school design in terms of curriculum, pedagogy, relationships, community and interests. We have drawn on the work of BPEA to highlight what this might look like in practice based on evidence from real schools and real students. In short, if we want to engage young people in STEAM then we have to find new ways of connecting to lives of students especially those who are currently streamed out of the ATAR pathways in school. To engage these same students in STEAM we need to work through their interests, connect them to experts in the field, and work on projects that make a difference to the world in which they live. To do these things we need to create a different kind of school - one that has the culture, pedagogy, curriculum and structures to support the kinds of practices described in this article. Simply doing more of the same does not seem like a good option to us. We need to innovate. Let's start now.

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