

SPARCS¹ from the University of Victoria: Supporting Sustainable and Integrated Outreach Activities for Educators and Young Minds

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Abstract

Although IT industry is flourishing, student enrolment in Computer Science and related Engineering post-secondary degree programs is low. The causes and issues surrounding this trend are diverse, inter-related, and vastly complex; a consensus may never be reached regarding the nature of these issues affected by both global and local factors. Is a consensus regarding underlying causes and best practices required to create and sustain an infrastructure for effective outreach? Perhaps not. In this article, we discuss five key supportive mechanisms that are critical to sustained and integrated outreach initiatives at the grassroots level. We discuss these mechanisms using the example of SPARCS (Solving Problems with Algorithms, Robots, and ComputerS), an initiative at the University of Victoria, British Columbia (BC), Canada. We further consider the tradeoffs associated with a vertical/centralized infrastructure versus a horizontal/distributed infrastructure.

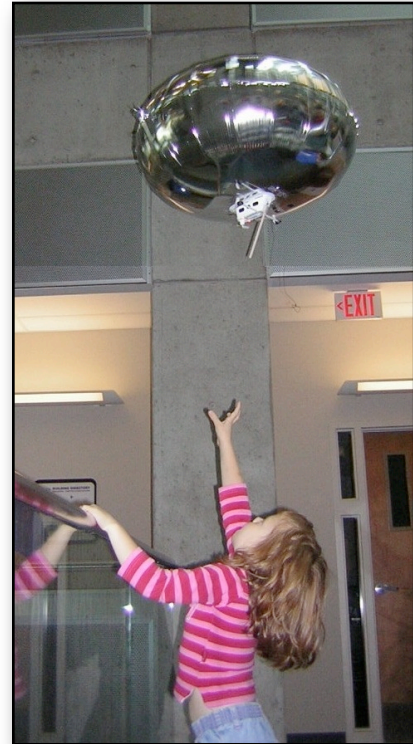
Introduction

The irony exists that innovative communications technology developed in North America is supporting the outsourcing of engineering and computing jobs. This irony is strengthened by a lack of initiatives that use technology effectively to broaden and advance technology education among youth. In Canada, “hi-tech” computing industry is growing (the information and communications technology services labour force grew 8.3% between 2000 and 2005 [1]), yet the output of graduates from related undergraduate university degree programs is declining (-13.3% during the same period [2]). Some sources suggest that enrolment in Computer Science across North America declined by as much as 70% between 2000 and 2005 [3]. Furthermore, the relative proportion of female undergraduate enrolment in Engineering has declined – an alarming retrogression [3]. Contributing factors for these trends cited by university administrators are diverse and complex, and include: poor public image of engineering professions, negative attitudes among students as well as parents resulting from (inaccurate) perceptions of job opportunities and IT market stability, and high school curriculum and resource changes that do not encourage an emphasis on sciences and mathematics.

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Despite the recent decline in enrolment numbers, women and people of aboriginal decent have been consistent minorities in Computer Science and Engineering fields since their beginnings; the evolution of these fields has not yet yielded any drastic changes in their demographics. Yet in Canada, a major hiring trend is towards diversity recruitment; recognizing the impact of workplace diversity on the bottom line, more hiring managers plan to aggressively recruit women, persons with disabilities, and those belonging to other underrepresented groups in the coming year. Universities may address enrolment issues, while simultaneously encouraging greater diversity in student populations, by targeting outreach initiatives toward “untapped” demographic populations. While enrolment quotas set by budget makers may be met through greater support of international students, offshore job opportunities threaten to take these individuals away upon graduation. Meanwhile, inhabitants of rural and indigenous communities in western Canada, women, as well as persons with disabilities face diverse challenges that may prevent equitable access to technology education early in life. Such populations have proven ability to enhance both diversity and innovation within IT sectors, while also serving to combat stereotypes associated with Computer Science and Engineering fields. At the University of Victoria (UVic), Canada, our outreach initiatives target these groups to promote social equity, support computing education among youth, and fight the stigma attached to Computer Science.

To date, the best practice for increasing the number of female engineering students is reaching early into the educational pipeline with targeted programs and camps—a strategy that is in place and evolving at the University of Victoria. But despite the rapid development of technology, the advancing of Computer Science and Software Engineering methods, and the huge array of interdisciplinary applications of these topics, “Computer Science” has not found its way into primary or secondary school curriculum in British Columbia (BC). Furthermore, current high-school curricula do not encourage an emphasis on sciences, mathematics, and technology. These arguments are strengthened by recent news reports, including an article in eSchool News online from September 21, 2007, which discusses how parents as well as children do not recognize a need for better mathematics and science education in schools; they would, in fact, prefer a weaker presence of the topics in K-12 [4]. While the “*Digital Divide*” (the gap between those who have access to the Internet and telecommunications technology and those who do not) continues to narrow in Canada, the “*Usability Divide*” (involving those who can and will use computers, communications, and related technologies and those who cannot or will not), remains an alarming reality among primary and secondary school educators. Decisions to close school computer labs, prompted by government spending cuts, are often met with little to no opposition from teachers who experience high stress when using computers and technology



A child reaches out for a mechanical remote-controlled blimp developed at the University of Victoria. The blimp was exhibited at an Open House event designed to spark public awareness and interest in Computer Science. This demonstration was developed by a student enrolled in the Mechatronics and Embedded Systems option.

as part of curriculum. Indeed, the obstacles which originate from a variety of sources serving to bar youth access to computer technology and computing education are diverse and complex (including social, economic, cultural, psychological, political, administrative, and academic components), interdependent, and are coloured both by local factors, as well as perceptions of national and global trends.

The complexity identified in the issues surrounding youth access to computing technology and student enrolment in post-secondary Computer Science and Engineering programs has for years barred attempts to reach consensus regarding their true nature and the mandates and best practices that should be applied in order to address them. There are no unequivocal explanations of the causes or solutions to these issues. Without a clear unequivocal understanding of the issues, can a unified mandate to solve them be formed? Can approaches and infrastructure developed to address access and enrolment issues make an effective and sustained impact without the need for consensus on the underlying causes? The answer to these important questions remains to be seen. However, we propose that there do exist key supportive mechanisms that are essential components of *any* outreach initiative in order for them to be both effective and sustainable.

SPARCS (Solving Problems with Algorithms, Robots, and ComputerS) is an interdisciplinary team of faculty, staff, and students based in the Faculty of Engineering at UVic that engages in research and outreach activities supporting technology education among youth and under-represented groups. Our primary objective is to encourage, excite, and educate young minds about Computer Science and Engineering. While many initiatives target youth ages 16 and over, we are spearheading efforts to provide integrated support for educators at all levels, from elementary school to first-year university, so that they may become facilitators of core Computer Science / Engineering concept-learning with minimal impedance and resource investment. We focus our efforts within the local community and among rural and indigenous communities across the province of BC.

Over the past two years, our programs have reached over 1000 K-12 students in BC, introducing them to key concepts in Computer Science. Specific goals of the group are to 1) promote Computer Science, focusing on underrepresented youth, 2) improve students' problem-solving and decision-making abilities, and 3) make Computer Science a "teachable" subject within BC's schools. We plan to meet these goals by 1) developing and delivering quality educational workshops to youth across BC, 2) offering Professional Development workshops for educators, 3) committing to the development and evaluation of innovative technology education tools and Computer Science enrichment resources for educators, and 4) promoting awareness of our efforts through the media.

SPARCS' long-term goal of providing opportunities and support for educators and young minds is driven by five key supportive mechanisms that we have identified as being essential to the sustainability and advancements of our initiatives. Furthermore, we propose that any outreach initiatives require support mechanisms in each of these categories in order to support long-term sustainable and effective initiatives. Each of these five key supportive mechanisms is expanded upon in this article:

1. *Supportive political environment*
2. *Promotion of academic research related to outreach objectives*
3. *Strong collaboration with existing outreach initiatives and non-profit organizations*
4. *Aggressive pursuit of unique funding opportunities*
5. *Promoting outreach activities using the media*

1. Supportive political environment

SPARCS-lead initiatives at the University of Victoria are supported by two of the province's leading mandates. The BC provincial government has illustrated dedication to enhancing computing-related technology education, both at the undergraduate and graduate levels, in order to meet the demand for innovative and highly-skilled workers [5]. Furthermore, a mandate exists to support "access and excellence" in post-secondary education for Aboriginal communities. Within the province of BC, the population aged 0-19 is among the lowest percentage of any province. Conversely, the BC population age 65 and older is among the highest percentage in Canada. The Aboriginal population in the province continues to grow faster than the non-Aboriginal population, yet complex and severe socioeconomic factors are currently affecting Aboriginals' access to and participation in post-secondary education programs. These demographic conditions have led to enrolment issues in many educational institutions and across diverse fields of study. However, Computer Science and Computer Engineering programs remain the hardest hit, and their associated enrolment statistics mirror North American trends.

The BC government further recognizes the global trend towards "alternative" sources for education, such as distance education and technology-based "e-learning". In a recent high-profile advisory report published by the government [6], a vision for post-secondary education for the year 2020 was laid out, and a set of recommendations made. Among these recommendations were several focussed on supporting teaching and learning innovation. The need was identified for resources dedicated to exploration of the potential of leading information and communications technologies for providing distance education, recognizing that the Internet both affords tremendous flexibility for learners, but additionally provides obstacles if not carefully implemented (for example, how can a learner differentiate a legitimate knowledge source from an illegitimate one on the Internet?). The document also notes the government's potential role in facilitating a province-wide infrastructure for supporting basic education, including introductory undergraduate courses, via distance education.

Behind both the mandate to increase education access within Aboriginal communities, and that which aims to provide resources to support the development of distance education models, infrastructure, and tools for post-secondary education, lies governmental recognition of the importance of a commitment to excellence in pedagogy. "*What is required is a willingness to experiment, the resources to pilot innovative approaches, and the discipline to study and assess the results*" [6]. As such, the recommendation has been made for a Pacific Centre of Excellence in Learning Innovation to be established in BC by the year 2009. A provincial-level call for exploration of this kind represents both a responsibility among researchers to carefully document and measure successes, and an opportunity to make large-scale coordinated and cutting-edge advances in communications technology-driven distance education (Will this be Web 3.0? 4.0?).

Following the lead of the BC government, the province's leading post-secondary academic institutions have aligned their strategic plans [7] with the government's mandates, translating into a pipeline of support through the University of Victoria, and into the Faculty of Engineering. Within the Department of Computer Science, the atmosphere is highly enthusiastic towards the initiatives of the SPARCS group, in part due to the provincial-level scope of its vision. This broad geographic scope is made possible because of the vertical support structure for initiatives focussing on Aboriginal communities and for those serving to increase enrolment in technical computing-related degree programs. Furthermore, many national funding agencies have similarly-aligned mandates, facilitating the potential for multiple sources of funding, while maintaining unity in the mandates and initiatives of SPARCS at the grassroots level.

2. Promotion of academic research related to outreach objectives

SPARCS (Solving Problems with Algorithms, Robots, and ComputerS) is an interdisciplinary team of faculty, staff, and students that engages in research and outreach activities supporting technology education among youth and under-represented groups. Our primary objective is to encourage, excite, and educate young minds about Computer Science and Engineering through innovative education initiatives that are fun, challenging, and relevant to youth.

SPARCS research activities are vast and broad, yet they remain unified by a common goal of establishing methods and best practices for making Computer Science accessible and exciting to youth, from kindergarten through to the end of first-year university. Our current research efforts primarily surround (1) developing and delivering innovative quality workshops that are both age specific and culturally customized to youth across BC; (2) offering Professional Development Workshops for educators; and (3) developing accessible Computer Science enrichment materials for educators.

Underlying all of our initiatives are innovative assessment strategies that we have identified as necessary in order to serve both our needs as researchers as we strive to establish best practices, as well as the needs of educators in their quest for curriculum materials and resources that are appropriate for their needs. We recognize that sustaining our flexibility with respect to the approaches we choose to explore is only viable if systematic evaluation strategies are employed to document our efforts. This facilitates identification of best practices, but also serves the dual purpose of promoting accountability and justification for the allocation of resources. As such, we are currently working to develop an efficient infrastructure for our assessment strategies that uses standardized methods for the collection and reporting of both qualitative and quantitative data.

Part of this assessment pipeline involves organized after-school workshops coordinated and run by members of SPARCS. These workshops, initiated in the Spring term of 2007 by an undergraduate SPARCS member, provide a fun after-school environment for interested students ranging from grades 2 through 7. This program has been extended and is now targeting two groups: grades 2 through 5 and also grades 6 through 9. These workshops teach elementary and middle-school children about Computer Science, with particular attention paid to problem solving and applied exercises in information technology that are fun and relevant to youth. Additionally, these after-school workshops form the basis of pilot studies for deployment of our developed

curriculum and teaching resources. Through innovative assessment strategies developed in collaboration with experts in learning assessment, we hope to facilitate further integration of initiatives, as well as widespread dissemination of our results and developed resources.

Many pilot projects initiated by various members of SPARCS are currently being run, including the projects LEARN! (Logic and Engineering Adventures in Robotics Now!) and ACCESS (Aboriginal Connections with Computing, Engineering, and Software Systems), both funded initially by NSERC Pacific grants.

LEARN! focuses on introducing CS concepts to primary and secondary school students both through computer technology and programming, and through the development and deployment of computer-related activities designed to be taught without computer technology (*unplugged activities*). Specifically, the programming activities developed in this project were offered as workshops by the WECS group to nearly 900 students across BC in less than six months. Motivation for *unplugged* activities stems from accessibility concerns, but also from the fact that educators often experience high stress when using computers and technology as part of curriculum and as such, decisions to close labs, prompted by government spending cuts, are often met with little to no opposition from teachers.

One of the LEARN! research initiative is to determine the appropriate age groups for teaching particular computer- and programming-related concepts. (For instance, how young can a child be and be taught to understand the concept of recursion, and what are the best practices for teaching it at this age level?) We compare our results between the different target groups (“general” student body, groups of female students, first nation students) and further investigate how to best motivate teachers to incorporate these concepts in their daily curriculum. For this, we must align the anticipated learning outcomes of developed activities with the prescribed learning outcomes found in BC’s curriculum. We collaborate with the Crystal Lighthouse Schools Project [8, 9] within the Faculty of Education at the University of Victoria. Until recently, the Lighthouse project concentrated its efforts on the development of excellence in classroom science education. This mandate has now been extended to include Computer Science and Engineering. The model applied here initiates teachers from one elementary school to develop sound pedagogical approaches to introduce computer science education into the curriculum. The teachers are then encouraged to share their new experiences with other schools in the district, both among other elementary schools and also secondary schools. An example of a factor used in measuring success of the project is how far the methods become distributed across different schools over the course of a few years.

A primary focus has been Lego Mindstorms workshops, in which children build and program toy robots, which extend from the early beginnings of our initiatives. We are actively developing activities that use the robots [10] and are currently working on a research project involving the robots’ Bluetooth technology; we are leveraging the communication possibilities among Lego robots to build collaborative mediums that can be easily understood and altered by students in order to grasp essentials of networking. Two major possibilities are: 1) to make use of robot-to-robot communication (which is somewhat limited given the current wireless capabilities of the Lego hardware environment) in order to introduce distributed wireless networks, and 2) to make use of central access points, such as a laptop or desktop PC in order to facilitate centralized communication between robots. These approaches can also be strengthened through

visualization of network state and traffic (e.g. topology views in which we can show where each robot is located and how the information is being exchanged).

In addition, we are developing best practices and stand-alone curriculum modules that make use of the state-of-the-art in terms of educational software for teaching programming, including graphical programming environments such as that used for the Lego MindStorms, and additionally, Carnegie Mellon's Alice and the Massachusetts's Institute of Technology's, Scratch [11].



SPARCS collaboration with a Let's Talk Science camp involving a class of Aboriginal students from the Tsawout Reserve (Vancouver Island, Canada). The purpose of this activity was to encourage environmental consciousness through learning about marine mammals. Students were also introduced to concepts of sound capture, digital audio, and sound synthesis as they visualized, analyzed and manipulated digital audio recordings of Orca whale calls using an open source software sound editor. Students were later led through an "unplugged" activity designed to teach them about the sound-based process of echolocation.

students' time spent with community elders learning the sensitive echo system of their local Cordova Spit, and included opportunities to explore their surroundings using new technology: Google Maps and Google Earth; real-time control of the motion of a camera placed on a protected nature reserve; and a Robotics Workshop. They also participated in an *unplugged* Activity, group problem solving activities, and had the opportunity to write a program to create their own version of a video game, "Pong". ACCESS continues to investigate ways in which Computer Science can be introduced to Aboriginal communities at both grade school and adult education levels using culturally-relevant curriculum material.

The OutREACH INside project, initiated in May of 2007 at the University of Victoria, was inspired by a desire to excite and encourage students currently enrolled in first-year Computer Science courses through problem-based projects and curriculum modules that are relevant to first-year students. We recognize that providing students with the practical skills they need to succeed in IT research and industry is possible through curriculum that also serves to motivate

The ACCESS initiative has the specific goal of investigating ways in which a sustainable infrastructure for Computer Science and Engineering literacy and education can be established, maintained and nurtured within the largely remote Aboriginal communities. Collaboration with the University of Victoria's Office of Indigenous Affairs has brought a wealth of experience, networking contacts, and enthusiasm to the project. Through ACCESS, activities have been developed and deployed within many remote communities. A three-week Aboriginal youth science camp that was coordinated in collaboration with a non-profit science outreach organization, *Let's Talk Science*, was designed with a biological theme. The camp was motivated by the

and inspire students through exciting real-world and interdisciplinary applications of Computer Science. At the same time, achieving a higher level of student satisfaction and involvement serves to secure and maintain student enrollment numbers in Computer Science degree programs offered by the University of Victoria. Increased student retention further serves to sustain the supply of well-training, motivated, and innovative graduates entering IT job markets.

As part of the OutREACH INside initiative, and in response to a call for Real-World Engineering Projects issued by the IEEE [12], we are currently working on introducing two projects into first-year Computer Science courses. The first project, entitled "Audio Forensics: Solving a Crime using Digital (Audio) Signal Processing", is inspired by the popular television program "CSI: Crime Scene Investigation". This project presents students with a Who-Done-It? scenario in which the use of object-oriented programming and digital signal processing techniques can be used to solve the mystery. The second project, entitled "HCI Alternatives using the Nintendo Wii", inspires students to explore new ways of interacting with the software programs they create. This second project has further prompted a look into the potential of certain software frameworks and curriculum modules focusing on game development in order to excite and motivate students about programming and the interactive entertainment industry - likely one of the top emerging and growing technologies for the next 10 years. Both of these projects have inspired a great deal of interest and collaboration among faculty, staff, and students within the Faculty of Engineering, and as a result we are currently working to adapt these projects to suit other upper-year courses as well as high school and elementary school populations.

Also as part of the OutREACH INside initiative, a new investigation into the application of "Web 2.0" and collaborative technologies to electronic distance education in Computer Science is commencing. As the flexibility and accessibility of distance education causes an increase in its prevalence in years to come, we must identify best practices that use the emerging communications technology effectively to achieve prescribed learning outcomes. In particular, we are working towards the development, implementation, and evaluation of an electronically-administered first-year-level computer science course that uses innovative multi-media rich learning objects within both synchronous and asynchronous collaborative environments. This initiative ties in with the ACCESS initiative to determine how e-learning distance education technologies can be utilized to fill identified technology education needs within Aboriginal communities across western Canada.

3. Strong collaboration with existing outreach initiatives and non-profit organizations

SPARCS emerged from the Faculty of Engineering initiative "Women in Engineering and Computer Science" (WECS), which began as a pilot project within the University of Victoria's Department of Computer Science in January 2003. Initial efforts reached up to 100 students per year, and since then the program has grown dramatically with the development of new workshops and activities due in part to the foundation of SPARCS. Further success was contributed by the incorporation of new technologies and interdisciplinary themes, touching more than 500 middle and high school students in both urban and rural communities in BC in 2006 alone. Lego Mindstorms workshops, in which children build and program toy robots, have engaged over 1300 children across BC in the past two years and have also contributed significant media attention and associated visibility to the activities of the SPARCS group.

In September 2007, SPARCS became a member of the Pacific Centre for Scientific and Technological Literacy, one of five Centres for Research in Youth, Science Teaching, and Learning (CRYSTAL) funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) [8]. CRYSTAL is housed within the Faculty of Education at the University of Victoria, and the collaboration has allowed SPARCS to extend further our interdisciplinary ties across campus, while providing us with the resources and knowledge base needed to develop effective assessment strategies for our initiatives. The SPARCS ACCESS initiative has the specific goal of investigating ways in which a sustainable infrastructure for Computer Science and Engineering literacy and education can be established, maintained and nurtured within the largely remote indigenous communities. Collaboration with the University of Victoria's Office of Indigenous Affairs has brought a wealth of experience, networking contacts, and enthusiasm to the project. In addition, leveraging Co-operative Education programs and student Work-Study programs supported by the university contributes additional enthusiastic student involvement in SPARCS activities.

Other close collaboration exists between SPARCS and the groups *Let's Talk Science* [13] and *Science Venture* [14], non-profit science outreach organizations striving to improve science literacy among students entering grades 1-12 through the design and delivery of innovative educational programs, research, and advocacy. Through collaboration with these organizations, SPARCS has been able to implement a number of workshops for classes of Aboriginal students, both in the university setting and on-site in isolated rural communities in BC's interior. A joint initiative between the three groups aims to coordinate and run workshops for primary and secondary school educators to be held on common BC-wide Professional Development days. Our Professional Development Teacher Workshops are intended to demonstrate the engaging nature of Computer Science enrichment programs, provide us with feedback on the presentation format of Computer Science enrichment programs in the public school system, and demonstrate how Computer Science concepts can support current curriculum's Prescribed Learning Outcomes (PLOs) using widely available state-of-the-art educational technology tools.

In addition to strong connections with non-profit organizations, SPARCS has found a collaborator in IBM with their labs in Victoria and Toronto. Support for the work with Aboriginal communities is found for example in the collaboration with IBM's Aboriginal Peoples Diversity Network and the IBM IGNITE camps [15]. Further, we are currently organizing in collaboration with IBM a workshop "Building the pipeline: Canada's IT industry and universities join forces" which is to be held at the IBM CASCON conference in October 2007 [16]. In addition, we have also begun to discuss possible collaborations with Microsoft Canada. We are currently working to organize a Game Camp, a full-day workshop introducing undergraduate students to game development using a software framework designed to teach students Computer Science concepts at the university level.

Without collaboration with non-profit outreach organizations and industry sponsors, the scope of SPARCS initiatives would be drastically compromised, and its financial sustainability would not be possible. Collaboration supports the leveraging of existing initiatives and supports the dissemination and evaluation of developed resources. In addition, collaboration serves to support further innovation and enthusiasm among individuals involved in the deployment of these initiatives. While a balance must be achieved between leveraging existing initiatives and supporting research into innovative initiatives that serve and advance the organization's own

mandate, in practice, a common ground between collaborators is often found that equally serves the mandates of the involved parties.

4. Aggressive pursuit of unique funding opportunities

In much the same way that international governments now acknowledge the environment as requiring significant resources to sustain and renew, a crisis in the number of skilled workers and educators in IT requires a sustained and coordinated pipeline of government- and industry-supported resources in order to reverse the trends. A widespread consciousness and ownership of both the local and global impact among the public and among industry stakeholders is the first step. Ultimately, however, a more centralized approach that provides efficiency through effective assessment methods and consistent dissemination in terms of delivery and content may ultimately yield better results than decentralized networked initiatives among institutions and industry partners with incongruent goals and mandates. The inherently interdisciplinary nature of SPARCS' mandate creates a wide variety of exciting funding opportunities. However, the need for financial resources to support outreach and retention initiatives brings about the potential for our efforts to become fragmented and unfocused in an attempt to fulfill obligations and contracts to funding providers.

SPARCS' has successfully aligned (rather unintentionally!) its operating mandate directly with key mandates of both the province of BC and, in turn, with those of the University of Victoria. These mandates include supporting enrolment in computing-related degree programs, a commitment to making Computer Science an accessible option to Aboriginal populations, and a recognition of the potential of current trends in communications technology to deliver media-rich e-learning environments to those isolated from physical institutions by geography or socioeconomic factors. In this way, we are afforded great flexibility in terms of the approaches we choose to explore beneath these mandates, while ensuring the best possible opportunities for sustained financial backing of a unified effort. In the BC government's Campus 2020 vision [6], the need for unity and a vertical infrastructure is identified, but it is also recognized that identification of best practices for distance e-learning requires flexibility and freedom in terms of the approaches that are deployed. Horizontal networking and collaboration with existing initiatives and funding providers may bring a breadth to our efforts, at the cost of unity. A careful balance between focus and flexibility can only exist efficiently and effectively through the rigorous application of effective assessment techniques for deployed learning resources, and the subsequent widespread coordinated dissemination of the results obtained.

5. Promoting outreach activities using the media

The media represents a porthole that enables SPARCS to disseminate information regarding all aspects of its activities. At the core of our efforts must lie a willingness and desire to collaborate in our efforts, share information and developed resources, collect and present results, and disseminate pedagogical knowledge gained regarding best practices through communications targeted to students, parents, educators, and members of the general public.

Among our initiatives, Lego Mindstorms workshops (in which children build and program toy robots) have engaged over 1300 children across BC in the past two years and have received significant media attention [17, 18] in the form of newspaper articles, radio interviews, and television news-broadcast stories. Additionally, recent international collaboration in SPARCS' efforts have been reported in a German newspaper [19]. The media attention has provided WECS (Women in Engineering and Computer Science - the precursor to SPARCS) and SPARCS with a tremendous amount of visibility, leading to enhanced public interest in our initiatives. This public interest has taken the form of both increased enrollment in workshops, as well as increased interest in volunteering to help coordinate and run workshops and other initiatives. The media attention has also brought an increased sense of responsibility towards the public in terms of the consistency in quality that we deliver, and the image that we as an organization portray; meanwhile, the support infrastructure that SPARCS has developed allows us to deliver the level of quality required to maintain the public trust developed.



Volunteers assist with an outreach activity involving programmable mechanical LEGO robots.

A current focus for the SPARCS group is the development of an integrated web presence that facilitates effective dissemination of information and resources to students, educators, parents, etc. We recognize that a limitation within current practices for disseminating resources is a lack of standardization and centralization of available resources, and a lack of assessment data and reviews made available alongside these resources. Furthermore, at the grassroots level, development of an online resource center with a unified consistent feel represents a very large undertaking requiring significant allocation of human resources. We feel a centralized legislative body could efficiently and effectively aid grassroots initiatives through the creation of a pipeline for widespread communication and dissemination of standardized and assessed teaching and learning resources.

Summary

The issues surrounding enrolment and retention in Computer Science and related Engineering programs within post-secondary institutions are vastly complex, and vary according to local factors. We maintain that discussion and controversy (though inherently valuable) surrounding the causes of low enrolment in Computer Science and related Engineering disciplines may never result in a consensus regarding the issues or the best practices to be applied in order to address them. However, there exist necessary support mechanisms that when present, enable a sustained and effective outreach effort that incorporates both unity within its mandates and flexibility with respect to the initiatives explored. Vertical collaboration of grassroots initiatives with governing bodies and policy makers may optimize a broader-scale unity and consciousness, communication and critical standardization within the dissemination of resources and pedagogical knowledge of identified and evaluated best practices. Meanwhile, horizontal collaboration with industry and non-profit organizations will yield optimal leveraging of existing initiatives using available resources, and provide diversity, flexibility, and local-market responsiveness within the approaches taken.

**Summary Table of the Five Key Supportive Mechanisms
for Sustainable and Integrated Outreach**

Antecedents to Success	Objective(s)	Demonstrated Real-World Significance (SPARCS)	Identified Risks and Potential for Failure
1. Supportive political environment	Unity; Efficient pipeline for communication; Effective allocation of resources at all administrative levels	<i>SPARCS' alignment of its mandates (outreach with a focus on Aboriginal and underrepresented groups) with those of the province of BC and the University of Victoria promotes unity, national and global consciousness at the grassroots level, and greatly enhances funding, and therefore also human resources potential.</i>	<i>Vertical alignment of mandates may limit breadth and exploration of innovative solutions; potential limitations to local responsiveness</i>
2. Promotion of academic research related to outreach objectives	Advancement of pedagogical knowledge; Identification of best practices; Effectiveness assessment	<i>SPARCS' allotment of academic research funding, human resources (dedicated graduate and undergrad students), commitment to assessment strategies and dissemination of results ensures focus, momentum, and wide geographic coverage, while advancing the state of the art.</i>	<i>Limited or short-term funding and (human) resources concerns may limit feasible scope and threaten sustainability.</i>
3. Strong collaboration with existing outreach initiatives and non-profit organizations	Leveraging of existing initiatives/ resources among industry, academia, government, and non-profit organizations	<i>A large percentage of SPARCS' events are efficiently brought about through collaboration and leveraging with existing non-profit and industry-sponsored initiatives, e.g. (SuperNova) Science Venture, Let's Talk Science, IBM E.X.C.I.T.E. camps, etc.</i>	<i>Must maintain and balance an independent outreach organization mandate with the identities/mandates of collaborators, while optimally leveraging existing initiatives.</i>
4. Aggressive pursuit of unique funding opportunities	Financial sustainability; Flexible integration of resources	<i>Diverse funding sources promote exploration of diverse strategies, e.g. e-learning in Aboriginal communities, XBox game development, collaborative learning environments, etc.</i>	<i>Multiple funding providers with disparate goals may fragment efforts (loss of focus and unity).</i>
5. Promotion using the media	Dissemination of ideals, activities, resources, learned pedagogy and best practices to the public/relevant professional bodies	<i>Website and newspapers elicit workshop participants; website for dissemination of resources to students/educators/parents; radio, newspaper, magazines create visibility, credibility, and public trust with wide geographic coverage.</i>	<i>Organization, coordination, and follow-through become critical in order to maintain credibility and public trust.</i>

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