HUMAN RESOURCE DEVELOPMENT IN THE CONTEXT OF SOFTWARE EXPORTS: CASE EVIDENCE FROM COSTA RICA

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ABSTRACT

Software industry development is acknowledged as an important engine of economic growth for many less developed countries. The role of national policy has been identified as a catalyst to software industry and software exports development. Software development is a service that is both labour and skill intensive thus an important aspect of related policy is concerned with provision of appropriately educated and trained human resources in sufficient quantity. This paper provides an analysis of human resources issues facing policymakers in less developed countries engaged in software exports policy formulation. The complexities are highlighted through the case study of Costa Rica where there is an ongoing strategic planning effort to increase software exports.
1. INTRODUCTION

Software industry development is acknowledged as an important engine of economic growth (Kambhampati 2002). Recognizing this potential, stakeholders in many Developing and Transitional economies (DTEs) have become actively interested in developing the software industry sector, particularly exports (Al-Jaghoub 2004, Carmel 2003). High profile success stories of India and Ireland have contributed to this growth in interest. A 50% growth of software firms in India has led to a 3% contribution of the software sector to the gross domestic product. Similarly, in Ireland there was more than a doubling of numbers of software firms (291 to 690) during the nineties. The growth in both countries had significant implications for employment generation, for example the Indian industry is reported to employ about 250,000 people with predictions of large future expansion, especially in the IT Enabled Services (ITES) sector. The growth in the software sector in India has contributed to productivity spillovers in other service companies and demonstration effects to other sectors (Arora et al 2001).

The role of national policy has been identified as an important driver of software industry and software exports development in both DTE and developed country contexts. For example Kambhampati (2002) describes the important role of policy measures in India. Watson and Myers (2001) discuss how policy has stimulated growth in Finland’s software industry. Policy formulation is concerned with an interconnected network of institutions, legislation, markets and finance. Software exports are especially related to telecommunications and human resources (Heeks and Nicholson 2002, Carmel 2003, Ein Dor et al 1997, Watson and Myers 2001). An important aim of policy, especially in DTEs, is to identify the export niche(s) in which the industry can operate and be marketed. This must take into account domestic strengths and weaknesses, global competition and the nature of global demand. Policy frameworks have contributed to shaping industry trajectories, for example the focus on products in Israel, foreign direct investments in Ireland and on software services in India.

Software development is both labour and skill intensive thus an important aspect of policy concerns appropriately educated and trained human resources in sufficient numbers (Carmel 2003, Heeks and Nicholson 2002). For example, Ireland consciously took measures to increase their computer science graduates. India has historically capitalised on large numbers of qualified staff at relatively low cost to satisfy the skills shortages of clients primarily in the USA and increasingly in Europe. While there are important lessons for policymakers in aspirant new entrant software export countries, policy makers need to recognize that the initial conditions for India and Ireland’s software industry development were characterised by very different exogenous and endogenous features than the contemporary situation. During the 1990s, IT skills shortages meant that the strategy for human resources could be based on quantity at low cost. Today’s scenario is characterized by demand for greater levels of sophistication and there are a larger pool of countries and firms to choose from. Along with these challenges, are also increased opportunities as global software outsourcing has become largely normalized as a business practice as contrasted to the situation in the eighties (Sahay et al 2003). There are presently many more firms and countries looking for offshore suppliers and relatively fewer barriers to entry, for example related to visas and immigration laws (for example, Germany’s Green Card
scheme). Supporting the creation of an appropriate “educational capital” is a challenge for policy makers to try and address these challenges and to capitalize on opportunities. Many developing countries are constrained by access to computers and Internet, English literacy and an educational curriculum that often tends to emphasize technical skills over critical thinking and management competencies (Kambhampati 2002 p25).

The aim of this paper is to analyse some of the complexities DTEs face in software exports policy formulation with a focus on human resources. These complexities are highlighted through the case study of Costa Rica, a nation where a strategy process is underway to strengthen its software export sector. The authors were part of the strategy formulation process and report from that experience. The learning gained from this analysis can provide insights to other countries at a similar stage to Costa Rica in order to evaluate their strategic options with respect to human resource issues.

The rest of the paper is organised as follows: in the next section we present a theoretical framework related to software exports policy and the role of human resources. In section 3, the Costa Rican case study and analysis is presented. Finally, in section 4, some implications are presented.

2. LITERATURE REVIEW AND THEORETICAL FRAME

A starting point for our analysis is based on the Software Export Success Model (SESM) (Heeks and Nicholson 2002). This exploratory model (summarised in Figure 1), was initially developed based on a review of relevant literature from development theory (Porter 1998) and literature search of offshore software exports policy frameworks (Correa 1996, Ein Dor et al 1997, Schware 1992,). An analysis of the experiences of Ireland, India and Israel helped to identify important “success factors” that were grouped into categories considered central to software industry development. Using secondary data, this model was subsequently applied to the analysis of three "second-tier" nations: Russia, China, and Philippines. The model comprises of five basic categories: demand for software, national software vision and strategy, international linkages and trust, national software industry characteristics, and national software-related infrastructure that includes human resources issues. The model was subsequently used empirically for the analysis of the software sector and to develop recommendations for policy development in Iran (Nicholson and Sahay 2002).

Insert figure 1 about here

Given the aim of this paper, we focus on the issue of “people related infrastructure” i.e. human resource issues. The software industry in any country is people intensive and is shaped by various issues including scale, costs, skills (technical and managerial) and availability. The software sector can be viewed as consisting of a “spectrum of labour” meaning the skills and qualities of human resources. The high end of the spectrum consists of very capable individuals known as “talent” who have critical thinking and problem solving abilities related to customised IS development projects; analysis and design, project management activities and the development of technical products. The lower end of the spectrum represents those with skills that can be learned in a relatively short period of time such as rudimentary programming.
Activities requiring skills at different levels of the spectrum thus require concomitant human resource development strategies. To illustrate this, in the following sub sections we briefly highlight key features of the strategy adopted by 3 relatively successful IT exporting nations (India, Israel and Ireland) and the concomitant human resource initiatives.

**India: addressing issues of scale and skills**

A majority of the initial software work in India up to the early 1990s was of the type derogatively called ‘body-shopping’ whereby the developers would go to the client site (mostly in the USA) for the length of the project. Work done in India at that time tended to be at the lower end of the spectrum such as coding operations and maintenance. While the initial challenge was addressing the required quantity of qualified staff, undertaking more complex and higher value added work for clients needed different kinds of skills for example, foreign languages and project management. This was important so that the Industry would be sustainable and not subject to easy substitution with new entrant suppliers in other countries. Therefore, human resource policy measures needed to address these two facets of quantity and higher spectrum skills. The industry tried to meet this challenge by recruiting engineering rather than only computer graduates (for example, mechanical, electrical and civil engineering) for software jobs. A number of universities also started Masters, Diploma and subsequently Bachelor level courses in computer applications (MCA, DCA, and BCA respectively). A number of training institutes like NIIT and Aptech played an important role in providing skill-based training (in Java for example) which to some extent helped to fill the gap caused by the inertia of university bureaucracy to revise curriculum in line with fast changing industry demands. Education programs geared to the especial “high spectrum” needs of global software work, such as related to project management, marketing, finance, and team working in conditions of cultural, temporal and spatial diversity are hard to find in India. However, an interesting approach in this regard is the Software Enterprise Management graduate course offered by the Indian Institute of Management, Bangalore. This program is designed for the specific needs of professionals working in the Indian Software Industry and started in 2002 supported by endowments from leading IT “partner firms”. Senior businesspeople served on the advisory board to enable better linkages between theory and practice. The program has been designed such that a participant can graduate with the diploma at the end of three academic years, while continuing to work at his/her regular place of employment.

**Israel: Developing R&D networks for software products**

Israel’s specialization in products for Internet security and the communication sector was fuelled by military-trained computing graduates who after completing their service would enter into a flourishing civilian computing sector. Jewish immigrants with scientific expertise who came from the Soviet Union between 1989 and 1991 provided another engine of human resource growth. The output of computer science graduates was expanded to meet the demands for a “high spectrum” educated workforce of sufficient quantity. Research institutions were provided with significant incentives to form linkages with industry, and the curriculum content was designed keeping in mind the criteria of relevance to the private sector. This link also provides mechanisms through which ideas generated can be commercialized and creates a
vibrant structure to move from “invention to innovation.” Interesting examples of efforts to stimulate collaborative R&D networks are the Yozma program, and the Bi-national Industrial Research and Development Foundation (BIRD) established in 1977 in collaboration with the United States (DeFontenay and Carmel 2002).

Ireland: Multinational driven human resource strategy

O’Riain (1997) traces the foreign direct investment driven growth of the Irish software industry after 1973 when major multinational corporations were attracted by the Irish Industrial Development Authority’s policies of financial incentives and significant investment in education and telecommunications. Unlike in India, Ireland avoided reliance on contract programming or body shopping. Instead, many large multinationals including Anderson Consulting, Intel, Digital, SAP, Sun Microsystems, Ericsson and Prudential Insurance were encouraged to locate in Ireland made possible by the ready availability of high spectrum skilled staff. Trauth (1999) discusses the specifics of how the Irish educational system was aligned with the skills needed by the “handpicked” multinational companies. Equality of access to education was established in 1968 and two new Universities were established in the 1970s and 1980s with a technical, vocational curriculum. Traditional universities were adapted to incorporate business and IT skills into the curricula and technical colleges were established around the country. Finally, adult evening classes were established. The government also sponsored training programs for those with a University degree but without requisite skills for work in the IT sector. The Irish government thus made focused attempts to scale up the numbers and capacities of computer science education programs and also increased their diversity by setting up joint degrees where computing was combined with foreign language. Incentives were also provided to attract the Irish diaspora to return to their home country, especially from North America.

The three brief examples presented help to infer how human resources strategies vary with the industry focus. We present this interpretation in Table 1 below. Newly aspiring countries need to interpret the strategies in the particular historical context within which they evolved and how the changing situation today requires a radical rethink of what may work and how difficult it is to implement in practice. We discuss this in relation to our empirical investigation in Costa Rica.

3. RESEARCH METHODOLOGY

This particular research was initiated when some key actors from the Costa Rican software industry invited the authors after reading some of their publications and proposed the project to support the Costa Rican government efforts of developing a strategy for enabling software exports. We responded positively to this request as we felt it would be a unique experience to work closely with the government in an “action research” framework (Baskerville and Wood Harper 1996). Initially, we developed a plan for the empirical work after conducting a literature search of the Costa Rican software industry to identify the current state, the key stakeholders, and particular technological and geographical focus of the industry. We were provided access to a recent report on the national software industry that helped to gain an initial
understanding of the character of the software industry. Very little was shown in this
document on export potential and strategies. Following the literature search and initial
information-gathering exercise, the authors visited San Jose for 3 weeks in August
2003. During this period, a total of 18 interviews were conducted covering a wide
range of officials including the Minister of Science and Technology and his advisor,
university administrators, faculty and researchers, managers and leaders of several
private sector companies, international aid organization, financial institutions, trade
associations and officials from various government and semi-government
organizations involved in marketing and promoting the software industry both
nationally and globally. Interviews were primarily semi-structured through which an
attempt was made to understand the background of the respondents, their interests
with respect to software exports, the issues they considered relevant in developing a
strategy, and to gauge their level of commitment to the development and
implementation of a national strategy. These interviews also provided a platform to
develop greater awareness about the importance of a national strategy and the aims
and objectives of our study. In addition to the interviews, two focus group sessions
were also conducted, one with representatives from the private sector and the other
with university staff. In these focus groups, discussions were held on issues such as
university-private sector linkages and problems experienced by small and medium
firms. In addition, one large national level workshop was held on the topic of global
trends in the software sector. This workshop provided the platform to bring together
various stakeholders from the industry, government and university sectors in order to
provide a broader awareness and gain their “buy in” to the strategy formulation
process. In addition, we conducted three smaller and more focused workshops on
identified themes relevant to policy formulation and implementation. In Table 1
below, a summary of the various sources of data collection are summarized. The
meetings, workshops and interviews were mostly conducted in English and when the
respondents preferred to discuss the issues in Spanish, the services of a local translator
was drawn upon. During the national level workshop and one of the smaller
workshops, professional simultaneous translation was provided.

Insert table 2 about here

A guiding frame of reference towards the interviews and their interpretation was the
Software Exports Success Model (Heeks and Nicholson 2002) that emphasizes the
importance of creating synergies between a complex range of interconnected factors
such as national policy, education, infrastructure and international demand. For
example, the SESM emphasizes an important precondition for effective exports to be
the existence of strong university-private sector linkages. We thus tried to identify
relevant actors from both the university and private sectors and discuss with them the
nature of existing linkages, the challenges experienced and how they felt these could
be best addressed. Data analysis took place through a process of extensive discussion
between the authors and with the various stakeholders responsible for the design and
implementation of the national strategy. A report was presented to them on conclusion
of the study and the feedback received on it provided further useful inputs to the
analysis.
4. CASE STUDY

The Costa Rican software industry is relatively recent and in 2002 consisted of about 100 firms, 75% of which could be classified as small and micro firms implying that nearly two thirds of the firms have less than 20 employees, and only 5% have more than 100 employees. The overall revenue of the industry was estimated at about US $170 million, about 60% of which was exports primarily to Central America and Mexico. The sector employs between 3,500 - 3700 persons, majority of whom are graduates from public universities. The software sector gained significant global publicity when the IT giant Intel established a development unit in San Jose, enabled through the direct involvement of the Costa Rican President. When focussing on human resources, a number of issues were identified in our study that reflect both the quantity and quality of human resources.

**Quantity: the problem of scale**

Micro-sized firms experience serious problems, especially when they try to scale up from less than 10 to about 20 persons, and the owners need to adopt management roles in addition to the technical. This problem was described by a chief officer of a software firm who had grown over a decade from a one-man garage start up to about 100 people:

“A challenge is when a company tries to move from micro (less than 10 people) to mini and small scale. The companies are not specialized to handle the management issues that arise and they don’t have the people to do that”

While growth in size often came with increased opportunities of exports, this was also accompanied with the challenge of lack of specialized human resources, for example related to financing and marketing. A manager of a small software company said:

“We know it is easier to sell locally, because of geography. Only for large companies it is easier to sell overseas because they have the money. We have problems in marketing, as we do not have the resources to hire specialized managers. Maybe we can have system of mentoring.”

Another aspect relating to scale was the absence of IT parks that could provide a cluster of geographically co-located software firms. Such clusters, as seen from examples of the Silicon Valley in the US and Bangalore in India enable sharing of knowledge, experience and resources. Also clustering IT firms alongside Universities, or priority sectors in Costa Rica (biotech or new materials companies) provide the potential for development of cutting edge applications and resultant patents. The increased scale that a cluster naturally provides allows firms to share resources for common activities like training or quality control that in the longer run could potentially contribute to developing human resource capacities.

**Quality of human resources**

Quality of people is crucial given the knowledge intensive nature of the software development activity. The potential to export is dependent on the quality of the university graduates that enter the work force. Three key issues were identified as contributing to quality:
• weak university-private sector linkages
• poor English language capabilities
• inadequate management capabilities of technical staff.

**Weak university-private sector linkages**

Contributing to weak linkages were a number of factors including poor intellectual property (IP) laws, the inertia of the university structure in responding to industry demands, a weak culture of applied research, and a lack of critical mass of researchers interested in supporting the processes of software exports. A senior manager of a private sector firm described how the links between his company and the university were steadily decreasing because of the weak laws of the university to support IP, and the reducing availability of funds to support long term research desired by the university:

“The intellectual property laws are poor and it is hard to keep secrets as there are no patents. Strange things can happen in the University. While we are interested in applied research, we do not have the funds to support long-term research. So, we are looking at internships rather than PhD kind of research”

However, while establishing student internships was relatively easy to establish, they were difficult to sustain because of the short period of internships limiting the production of useful outputs. A manager of a small firm described this problem:

“Interns need a lot of supervision, and by the time they become able to contribute, they are ready to leave. It was different with some interns we had from Canada; they were ready to contribute right from the start”

While it appeared that interns from foreign universities like Canada were better equipped than the local students to contribute to the work of the companies, there existed no formalized and institutionalized structure within which these linkages could be sustained. Another issue with internships was the university laws that made it difficult for private sector people to use public resources (such as computers and rooms) in public universities. Dealing with these irritants was very frustrating for private sector industry people who were used to “getting on with things” efficiently. A private sector manager described his frustration as follows:

“The linkage does not exist. While the public universities are the best, they are very difficult to link up with. They set a lot of limits. They have created foundations to be like intermediaries, but they really don’t get on well with the companies. What we would really like to have is research on what the rules are in the university and to document them and give to the companies. If we ask CENAT (the University governing body) to do that, it will take years before anything is done”

Another manager echoed similar thoughts:

“I can think of many projects but what are the rules of engagement and also who would I pay and what will happen with the intellectual property”
The university policy of “theoretical work takes precedence over applied” also contributes to widening the divide between the university and private sector, and as a result no effective interface exists for firms to approach universities to deal with their research inquiries. A senior staff member from a public university explained the problem as follows:

“There is a lack of culture in research and development, because both the academic programs and also the professors do not promote the culture. We cannot change anything until the culture is changed. We have to also make the research more applied and work more closely with the software firms”

Another senior staff member described the problem in similar terms:

“The factors which do not help to create a union between firms are universities are: no culture or conscience to spend money on research; no incentive from government to industry to support research; the universities have limited budgets that limits research; our buildings, laboratories, equipments are all obsolete; there is a lack of maturity in professors to do and learn and do research. We do not have a critical mass of researchers”.

The problem of lack of critical mass of computer science researchers was also emphasized by another senior Professor who contrasted this situation with Biological Sciences. In this instance an existing critical mass of researchers in the department had been successful in furthering their research agenda. There also was no culture in the computer science department to write grant proposals leading their faculty to be trapped in a “vicious circle” of no research funds leading to additional teaching loads and consequently even fewer opportunities to write grants. As a consequence, there existed no research centres around computer science in universities in contrast to the relatively strong biotechnology area. Public universities, as is the case in many developing countries, are poorly resourced and provide little incentives to do research. Poorly paid staff preferred to do consultancy rather than research work. While efforts like internships, company sponsored research etc are useful to bring about change, they are still not capable of changing the institutional conditions such as the poor salary of staff, lack of time allocated to research and the division between research and teaching staff in departments. A senior staff member in a public university lamented about this problem:

“The problem is that historically the public universities have very little resources, and because of that we cannot do research. We are doing our best, but that is not good enough to do quality research. So, what we need is more budgets to hire more people, and more incentives for doing research. Right now most professors will prefer to go to the university rather than do research because of problems of money”

Poor English language capabilities:

English language capabilities are a vital resource for software people working on global projects, especially given the primary market focus is the USA. This skill was currently seen to be deficient by many respondents, including this senior manager of a private sector firm:
“We must improve our English proficiency. It is good now, but it should be better. We should speak like a US citizen”

While English capability was not seen as a universal problem in Costa Rica, the problem was pronounced among technical staff including computer science. Most of the good English-speaking people were seen to be working in the tourism or hotel industry. This was an opinion echoed both by the industry:

“You find good people with technical skills, but if bilingual, that’s where we find bad people. The people that go for tourism study English, and so they don’t have technical skills. If we look for 10 English speaking software engineers, we cannot find them”

and also the university staff:

“In computer science, students can read English because they read a lot of technical things in English. But they are not able to speak or to even write”

While it is possible to have large-scale programs to develop English language capabilities, a paradox exists in that a bilingual work force would make the already relatively expensive people costs in Costa Rica even more costly. The average cost of a programmer in Costa Rica is significantly higher than in India. A senior industry manager told us:

“We also have a language barrier. It would be hard to translate some of the products into English. We would need to make a change in the composition of the labour force to make them more bilingual, but that would make them more expensive”

Inadequate management capabilities:

Another challenge with the existing educational system in Costa Rica was that people with technical skills often have limited management skills related to marketing, human resources, project and finance. There are no institutionalized programs, especially for practicing executives, to come for refresher courses to the universities and develop management capabilities. The lack of these management skills was seen as a crucial constraint to marketing products, operating in the global marketplace and for making financial decisions. In short, the workforce had limited “middle management” capabilities, a point emphasized in the quotes by two industry staff:

“We are very weak in marketing skills, we have good technical people but they have no idea about the kind of questions that are asked when we go to sell the product”.

“I realized that software companies have good technicians but they don’t know about marketing, managing or about intellectual property. So, a lot of companies were suffocated because they began with someone paying for a program, but there was no one to manage and so they were stuck”
Some attempts were being made by the government and private sector to try and address this challenge of developing management capabilities. PROCOMER, the national software export promotion council had put in place schemes designed to improve competencies in small and medium companies to conduct software exports. A private university “ULATINA” had designed curriculum improvement in collaboration with the Inter American Development Bank funded “Prosoftware” programme and identified gaps in the existing university programs especially at the middle management level. CENFOTEC, another private institution established through private sector venture capital, was trying to bridge the gap between industry needs and pace of university change by designing courses for practicing software staff for management skills. Another initiative had been undertaken by a consulting house under a project financed by ICCI-2 (Costa Rican Initiative for International Competitiveness) to develop specific courses to increase human resource capacities related to financial and innovation issues. This same agency had also developed a year long program called “The bullet proof manager” to develop a set of 24 soft-skills. In addition, reduced fees for ISO9000 and Capability Maturity Model training and accreditation had been introduced. However, efforts by the government to introduce schemes for developing human resource capacities were suffering because of poor dissemination of information amongst the industry about these schemes and lack of take up. For example, one manager in a small firm told us that he unaware of government’s schemes to financially support executives wanting to take up distance education courses. Many software firms did not see the benefit of formal accreditation such as ISO.

5. DISCUSSION AND CONCLUSIONS

In summary, with respect to human resources capability in Costa Rica, the following key points can be made:

- Costa Rica in general has a small labour pool and compared to the major competition at relatively high costs.
- The educational focus in Costa Rica is primarily on Computer Science, and information systems related management skills are generally weak.
- English speaking skills of the technical people in Costa Rica are generally weak.
- There are no technical training institutions aimed at providing software developers with technical skills in specialized areas like biotechnology and biodiversity both of which are key economic clusters in Costa Rica where linkages would be beneficial.
- Costa Rica lacks any diaspora returnees in any great numbers.
- The linkages between university and industry are fragile.

The Costa Rica case provides insight into the particular problems faced by many DTE’s in developing the software industry as a vehicle for economic growth. Specifically, the case illustrates the limits of the routes to development presented by successful software nations. Costa Rica’s size, population and institutional setting does not provide the quantity and quality of human resource to follow the Indian early growth trajectory of low spectrum, low price and high quantity. Instead, the early Costa Rican strategy efforts focussed on developing the high spectrum which presented several paradoxes and dilemmas. The country lacks focussed R&D and with
no military to provide technology transfer there are problems in following Israel’s trajectory. Ireland’s multinational led strategy is hampered by amongst other issues a private organisation (known as “CINDE”) responsible for foreign direct investment (FDI) that is not focussed on software cluster development meaning a scattergun approach to FDI undirected by policy.

Policymakers in Costa Rica and other DTEs are forced to consider the exogenous environment in terms of market trends of buyers and suppliers in different countries. With regard to the endogenous setting, the analysis shows some aspects of how the formal and informal internal institutions (North 1990) may enable and constrain the development of routes to growth. In democratic Costa Rica, the policymaking process is attempting to take into account and coordinate the multiple institutions and organisations involved in software exports. Further work will focus on the continuing process of software industry development which will provide further insights into software industry development in small DTEs.

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REFERENCES


Figure 1 The Software Export Success Model

International Market Demand for Software

International Linkages

National Software Industry

Clusters (Competition) Collaboration

National Software-Related Infrastructure

People Technology Finance R&D

National Software Vision/Strategy

Government Industry
Table 1: Relation between skills emphasized and human resources strategies

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<th>Kinds of Skills</th>
<th>Examples of Educational Focus</th>
<th>Human Resource Policy</th>
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<td>High spectrum</td>
<td>Project manager</td>
<td>University-R&amp;D Linkages</td>
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<td>Business analyst</td>
<td>University–private sector linkages</td>
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<td>Low spectrum</td>
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<td>Data processing</td>
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<td>Increasing number of colleges and programs</td>
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<td>Attracting graduates from non-computer science backgrounds.</td>
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Table 2: Summary of data collection sources

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<th>Data collection mechanism</th>
<th>Number of meetings</th>
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<td>Interviews</td>
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<td>Focus Groups</td>
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<td>Workshops</td>
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