

Technology for Learning and Culture in the APEC Region to 2010

Vol. I Summary Report



Asia-Pacific Economic Cooperation
APEC Industrial Science and Technology
Working Group



The APEC Center for Technology Foresight
National Science and Technology Development Agency
Bangkok, Thailand
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This summary report was prepared for the APEC Center for Technology Foresight by *Professor Ron Johnston*, Executive Director of Australian Centre for Innovation and Industrial Competitiveness, University of Sydney and *Professor Greg Tegart*, Formerly Director and now Executive Advisor of the APEC Center for Technology Foresight.

Published for the APEC Secretariat by:
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Website: <http://www.apecsec.org.sg>

APEC # 00-IT-01.2

ISBN 974-7579-81-2

Printed and bound by Jirawat Express Co., Ltd, Bangkok, Thailand

Designed by
The Public Information Department
Thailand's National Science and Technology Development Agency
www.nstda.or.th
Bangkok, Thailand.
March, 2000

Foreword

The APEC Center for Technology Foresight was launched in Bangkok on 3 February 1998. The objectives of the Center are:

- Promote the adoption of technology foresight across APEC member economies.
- Provide a means for comparison of technology foresight exercises and implementation in APEC member economies and across the world, with a view to stimulation of Best Practice in appropriate methodologies for Foresight in APEC economies.
- Conduct technology foresight exercises on an APEC-wide basis, and between relevant member economies.
- Improve the quality and effectiveness of technology-related planning and development and priority-setting for research, across APEC member economies.
- Develop a technology foresight research and application capability available to APEC member economies and International agencies.

Definition of foresight:

“Foresight involves systematic attempts to look into the longer-term future of science, technology, the economy, the environment and society, with a view to identifying emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic, social and environmental benefit.”

As its second major project, the Center chose the topic of ‘Technology for Learning and Culture’, with a time horizon of 2010. The project was initiated with a large public seminar in Bangkok in November 1998, at which Mr Jacques Lyrette, Vice-President (Technology and Industry Support) of the National Research Council, Canada, presented an analysis of the issues associated with technology for learning and culture from a Canadian perspective.

This paper formed the basis of a subsequent Issues Paper. Experts were drawn together from a wide range of APEC member economies at a workshop in Vancouver hosted by the National Research Council Canada. The roles of the Experts were to examine the various aspects raised in the Issues Paper, to represent their own national perspectives, and to develop possible scenarios of the future impacts of, and interactions between, technology, and learning and culture. On the basis of these scenarios, a series of priority actions were identified.

In addition, based on these scenarios, and the discussion of the Issues Paper, the Experts developed a set of topic statements for a Delphi survey. These questions were subsequently refined to make them appropriate to all APEC member economies. This questionnaire was distributed widely to identified experts across the APEC member economies in a two-stage Delphi survey.

This Volume provides a summary of the findings and policy implications designed for policy-makers and the interested public. A more detailed Volume 2 contains the Issues Paper, the process and outcomes of the Experts’ Workshop held in Vancouver on 3-6 May 1999, the results of the Delphi survey, and a list of participants of the Experts’ Workshop in Vancouver.

We are grateful for the roles played by the various consultants and facilitators:

Key Facilitator:

Professor Ron Johnston

Executive Director, Australian Centre for Innovation Limited (ACIIC), University of Sydney, Australia

Co-Facilitator:

Ms. Lucille Pacey Private Consultant, Canada

Delphi Facilitator:

Dr. Taeyoung Shin Senior Fellow, Science and Technology Policy Institute (STEPI), Korea

Honorary Consultants:

Mr. Jacques Lyrette Vice President-Technology and Industry Support of the National Research Council Canada

Mr. Terutaka Kuwahara Director, Fourth Policy-oriented Research Group, National Institute of Science and Technology Policy, Japan

Others who deserve special mention include:

Dr. Arthur Carty, President of the National Research Council Canada

Dr. Sadiq Hasnain, Senior Strategy and Policy Advisor (International Relations) of the National Research Council Canada

Mr. Desmond Mullan, Director of the NRC Innovation Centre (Vancouver)

Dr. Ann Levi-Lloyd, Facilitator (Advanced Skills Training) of the NRC Innovation Centre (Vancouver)

Ms. Marian Jones, Supervisor (Administrative Services) of the NRC Innovation Centre.

We would like to thank Dr. Taeyoung Shin who supervised and analyzed the Delphi survey. We are most grateful to all experts participating in the Vancouver workshop as well as those experts who responded our Delphi survey. In addition, particular thanks should go to Dr. Sadiq Hasnain, Dr. Filma De Guzman Brawner, Dr. Craig George Blurton, Mr. Abdul Hamid Abdul Rahman and Dr. Jeffrey R day for their assistance in the Delphi process.

The APEC Center for Technology Foresight would like to acknowledge the financial support from the APEC Central Fund, the National Research Council Canada, Thailand's National Science and Technology Development Agency, and other relevant institutions and organizations in other APEC member economies that supported the participation of their Experts.

Finally, we are indebted to Monthida Sitathani, for her dedicated support and international coordination throughout the project. We also grateful for the support of Tamsin Jewell, Mayuree Vathanakuljarus and Wandee Senglam

Greg Tegart
*Formerly Director, now
Executive Advisor*

Chatri Sripaipan
Co-Director

Executive Summary

Technology is systematically transforming the basis of education and culture, while at the same time, rendering them even more crucial to the economic and social futures of nations. The capabilities of information and communication technology, in an era marked by globalization and the emergence of the knowledge economy, and the reach and access of the Internet, require a fundamental re-examination of the roles and effectiveness of existing institutions and systems to support learning and culture.

While there is great pressure towards internationalization, learning and culture remain at the heart of the economic and social fabric of each nation. Therefore, each nation must arrive at solutions which are appropriate to its own historical and cultural antecedents, and to its preferred future. At the same time, there is much to be gained by learning from and cooperating with other countries in developing the most appropriate responses to these challenges.

The major issues in using technology to support learning and culture identified in this project are:

- democratization of access through flexible, universal service infrastructures linked with a commitment to equity in access;
- the need for continuing study of the impact of the information highway on economic activity, trade, the workplace, the community and society at large;
- ensuring cultural enrichment for all citizens through strong commitment to diversity of cultural and linguistic content;
- encouraging the private sector to develop information networks and offer new information services, thereby encouraging international cooperation in developing a global information infrastructure;
- the need to improve, and exchange experience of, new developments in learning, training and skill upgrading, both in the school and higher education systems and through adult learning distance programs;
- the need to improve the understanding of social change, through initiatives that demonstrate the possibility of improving and increasing the flexibility of working conditions, opportunities for leisure-time education, urban life-styles, and the greater participation of disadvantaged in society.

The Foresight approach taken in the study using both scenario planning and a Delphi survey, identified a range of important issues that need to be taken into account.

Perhaps the principal one of these was the vulnerabilities inherent in converting learning and culture systems so that they become entirely dependent on electronic communication. Appropriate risk management strategies are needed to preclude, or at least protect against, catastrophic failure and/or loss of traditional knowledge and skills.

This also led to an emphasis on:

- the need for systematic capture and preservation of codified knowledge;
- increased understanding and valuing of tacit knowledge and those individuals and institutions that are important repositories;
- the development of international protocols and standards to protect and facilitate learning and transmission of culture;
- increased recognition of the central role of learning, and of the professions that are directly responsible for, or involved in facilitating, learning;
- the need for learning to be redefined in common culture as an essential life-long process;

- the need for substantial investment in continuous retraining of all those involved in assisting learning, whether formally as 'teachers' or informally through their community roles and expertise.

The project again revealed the challenges of multi-economy foresight studies. The scenario technique worked very well in a small group context with excellent interaction among participants and significant outcomes. The use of the Delphi technique to involve wider participation of APEC experts and stakeholders reinforced the outcomes of the scenario workshop but the demands on resources were considerable with an intensive follow-up to the questionnaire yielding a response rate of only 28 percent in the first round and 45 percent in the second round.

1. Introduction

The APEC Center for Technology Foresight was established with the objective of serving and involving all APEC member economies in developing and diffusing technology foresight expertise across the APEC region. This was to be achieved not only by providing training and assisting member economies with their own foresight studies, but also through conducting foresight studies at a multi-country level, focussed on issues which cross national boundaries.

Five criteria were established to identify foresight issues appropriate to the Center:

- they must be of concern to most member economies, with at least four agreeing to take part in the study;
- they must transcend national boundaries;
- there must be potential for sharing the results with all APEC members;
- they should be of general public concern or benefit; and
- they should have significant technology (though not exclusively high-technology) components or implications.

The subject of 'Technology for Culture and Learning' emerged from an extensive consultative process, based on a survey of APEC members, followed by prioritization of 50 candidate issues at an APEC Technology Foresight Symposium in Chiang Mai in June 1997, attended by representatives from 16 APEC member economies. This issue not only met the five criteria; it also was a matter of considerable concern in many countries and for many commentators, and was itself evolving rapidly. In addition, advances in technology, particularly information technology (IT), when applied to learning and culture, carried considerable threats to minority languages and cultures across the APEC region.

It was argued:

The convergence of telecommunications, computer technology and software is having a profound effect on the way we work, entertain ourselves and educate our present and future generations. The new wave of technology impacts on all economies and it is essential to ensure that technology is properly used as a tool for development and promotion of individual values and cultures. This is particularly true in the APEC member economies which vary widely not only in terms of physical information infrastructure but also in terms of culture and language. This project seeks to assess the situation in the APEC economies and to draw out the critical issues to be addressed by policy-makers, educators and the information industry. (APEC Center for Technology Foresight, 1999).

The Experts' Workshop in Vancouver in May 1999 brought together thirty-seven representatives from twelve APEC member economies. The overall approach of the project, and the processes of the foresight workshop, were designed to address the many challenges already identified by the APEC Center in the conduct of multi-country foresight. These include:

- familiarization of the participants with the processes and anticipated outcomes of foresight;
- establishment of the necessary legitimacy and credibility for the project and its findings;
- the commitment of national experts to a project whose genesis lies outside their own systems, structures, and communities;
- the use of English as the only language of the project;
- determination of an 'APEC perspective'; and
- transformation of generic findings into country-specific outcomes.

2. Key Issues in Technology for Learning and Culture

Learning is a process, a part of human development, that begins at birth and, in principle, never ends; it occurs in formal and, more importantly, informal ways. Through the application of IT we should be able to reduce and eliminate barriers to learning while at the same time increasing the quality and style of learning overall. Information technology is not about accessing and processing data so much as it is about communication. While technology acquisition is very important, the most difficult and important issues involve people. Investments in technology should be accompanied by substantial investments in human resources. (OECD, 1997)

The world is in the midst of fundamental economic and social transformation. This transformation is being driven by:

- an interplay of social and technological dynamics including, in particular, developments in information processing and telecommunications and the increasing links between those technologies;
- the emergence of an educated and informed population with associated changes in value;
- the increasing role of mass media;
- higher degrees of specialization in a more knowledge-based economy and consequent changes in the structure of work; and
- a much richer infrastructure of public and private organizations with a stronger degree of interaction among those organizations.

The impact of Information and Communication Technology (ICT) on the economy, trade, learning and culture has been in the forefront of many people's thinking for years. The question of the implications of the rate and penetration of ICT has been transformed to the question of the management and organization of the effective use of the emerging technologies to promote and sustain our cultures, our sense of community and the individual. At the same time there is an interest in promoting and sustaining economic growth on a global scene, and increasing the quality of learning in our societies.

Learning and skill development are acknowledged to be the core of a nation's economic engine. This implies a commitment to learning continuously, a new model of learning where collaboration is at the root of the model, and relies on ICT to provide the tools and drivers needed for this transformation. Most importantly, it begs the question of how do we develop new educators and retrain the existing teaching population to ensure their work supports and reinforces this systemic change.

For most countries the education system can be described as one which is institutionally oriented and geographically bounded. It is typically supply-driven, based on an industrial production model. The focus is primarily internal, on the health of the organization and on information management processes with internal measures of success.

The future that we are facing is one in which the scope is global, with a relationship orientation, requiring new forms of partnerships and willingness for collaboration. The system will be demand driven and the key driver of the economy will be knowledge with a focus on creating that knowledge. The learning systems will have to become learner/client focussed and the measures of success will be external to the institution. Digitization and the convergence of technologies will allow for integrated technological applications with 'smart' adaptive capacities.

As convergence in the technologies emerges we are also witnessing convergence in the way learning and training are provided (see Box 1). The distinction between

distance education and conventional education is quickly disappearing. Many institutions are providing services in a multiplicity of alternative forms, combining face-to-face classroom delivery with distributed learning, distance learning and many forms in between.

Box 1

Internet for All

It seems these days that everyone is getting onto the Internet—everyone, that is, except people living in the developing world. One man trying to do something about that is Suryatin Setiawan, head of research and development for Telkom Indonesia. He has developed a “voice Internet,” called the Rural Voice-rich Information Community (RVIC) which he hopes will help bring poor and scattered rural communities into the information age.

Suryatin has combined existing technologies to create an interactive device that converts text from the Internet into digital speech. This is transmitted to users through a device similar to a normal payphone. Instead of numbers, the keys have symbols that, when punched, provide data on everything from health problems to plant-cultivation tips to commodity prices. Users also can pose questions, which subsequently are answered by a team of local officials.

RVIC is potentially very useful for areas where literacy is low, and for languages where a keyboard is not very useful, such as Chinese or Japanese, (Far Eastern Economic Review, November 18, 1999)

The concept of a ‘home’ institution may be less of a concern for learners, as they access their learning needs from the best sources in the world. We cannot and should not try to restrict or curb this phenomenon but we do need to ensure that the learner is protected. There is no more important agenda item than to establish standards for service in the educational field—the “buyer beware” attitude of the western societies will not suffice.

The move to wired learning is proving a strain on the way access to this learning is provided. A transition to a ‘knowledge society’ is taking place, in which ICT is playing roles as both driver and facilitator. A knowledge society heightens the necessity for lifelong learning, which in turn implies new rhythms of working life.

If the vision of lifelong learning is to be realized, it must be understood that it requires a system of learning that is available on demand from any place, at any time and in a form that is useful to the learner. This will require a basic competency in computer utilization and the ability to synthesize and analyze information and to demonstrate the ability to critically evaluate these data to build knowledge. The application of the knowledge in ways that are in keeping with the culture and values of society are the paths to wisdom.

The learner of the future will by nature be more independent of the teacher. In return they will require access to pre-produced materials (in any number of forms/media), information and data, tools for the selection, storage, restructuring, and creation of information and the ability to access, combine, create and transmit audio, video text, and data as necessary.

The highly networked, global, learner-centered institution of the future will be forced to re-think many of its roles. As institutions become more decentralized, and learners more independent, the institutions will want to provide the most timely and relevant information on learning and training opportunities. They will need to manage the provision of credit through independent assessment of learning, brokering and validating learning opportunities regardless of whether they were whole courses and programs or portions/modules/granules of the same. Institutions will have to enable learners to transport credits and demonstrated learning easily and in such a way that the learner is not losing ground by being a

self-directed learner. This interconnected, global registry will challenge even the most creative institution in the world.

This agenda will not succeed without the active involvement of the private sector; public/private partnerships are key to moving forward. The agenda for change requires a multi-faceted solution; therefore it warrants partnerships and collaborations with multiple solution providers. This is the first time that one hears of cable companies working with book publishers and software developers to broker quality educational products to provide a rich array of approved curriculum-matched materials that can be accessed from the home and/or the school.

With regard to **culture**, there is much speculation about the potential of technologies to “bring down borders” between nations (see Box 2). This has to be tempered by the potentially negative effects of such eventualities. Bringing down borders can lead to a blurring of national identities. It can enable large population masses to dominate smaller cultures and define the emerging ‘global culture’ by sheer economic force. It can also rekindle old ethnic, regional or religious divisions that national cultures now transcend.

Box 2

Gift of Tongues

You're lost while driving on the book roads of a foreign country. It's getting dark as the sun sets. And you don't speak the language. What do you do? Relax and ask for directions at the nearest petrol station: All you need is a portable device such as an electronic notebook with a built-in microphone and some nearly flawless translation software.

That scenario is likely in the not-so-distant future, thanks to research being done in Japan. Digital dictionaries already exist, but most of these are limited to reciting simple stock phrases such as “I don't eat pork” or “Where's the bathroom?” Now, new Japanese technology is turning mobile phones, personal digital assistant and even laptop computers into simultaneous interpreters that can render colloquial conversations understandable in the local language.

This communications magic is being developed by a team of engineers working at the Advanced Telecom Research Interpreting Telecommunication Research Labs. The team is fine-tuning technology capable of translating about 80% of a conversation from Japanese into English and vice versa.

Developed over a period of six years, the program so far recognizes some 27,000 Japanese words and 8,000 English terms. It also has a more limited vocabulary for interpretation between Japanese and Chinese, German and Korean.

(Far Eastern Economic Review, November 18, 1999)

Respect for cultural differences is an essential component of civilized life. At the G7 Conference on the Information Society in February 1995, all participants supported the principle of encouraging cultural and linguistic diversity. In international terms, the recognition and protection of cultural differences is an expression of goodwill. It is not about creating barriers; it is about tolerance.

But culture is not simply a product on the global market. It is also a process, an ongoing dialogue capable of focusing a spectrum of diverse perspectives into a shared vision. In contrast to the robust existence of exportable products, the cultural dialogue within our borders is fragile.

There is a widespread view that cultural products must be promoted, not protected. Individuals must have access to all content, including a strong component of local products and services. We must recognize the value of the diversity of cultural and linguistic content and the opportunities that arise from a diversity of content.

In order to support culture through technology, it can be argued that priority should be given to:

- supporting the creation and dissemination of content;
- perfecting tools for content creation; and
- promoting dissemination.

The Issues Paper summarized six major issues that will need to be addressed with regard to technology for learning and culture. These are:

1. **Democratization of access.** Establishing flexible universal service infrastructures will ensure that citizens have access to new information services and are able to take advantage of the resulting opportunities that arise. By using existing organizational resources, the impacts of information services and technologies on society can be assessed. Strategies to prevent the marginalization or isolation of certain sectors of society must be formulated.

2. **Continue to study the impact of the information highway**

OECD should be encouraged to complete its research on the effect of information technologies on employment. The university community and public and private sectors must step up their efforts to assess the impact of the information highway on the economy, trade, the workplace and society at large. The results of research on employment can then be used in formulating policy.

3. **Ensure cultural enrichment for all citizens through the diversity of content**

People must have access to a wide range of content, including a strong component of local products and services. Diversity of cultural and linguistic content must be guaranteed.

4. **Encourage the private sector to develop information networks and offer new information services**

This encourages international co-operation in developing a global information infrastructure. This will promote the creation of a very high capacity infrastructure, with room for diversity and different mixtures of content.

5. **Improve education and training**

Countries must exchange information on new learning, training and skill upgrading methods. The use of information technology in teaching should be integrated into the school system. Developing adult distance learning programs using information technologies will help workers adapt to structural and organizational changes.

6. **Improve the understanding of social change**

Countries should promote joint projects and initiatives that demonstrate the possibility of improving and increasing the flexibility of working conditions, opportunities for leisure-time education, urban development and the greater participation of the handicapped in society.

This transformation and the more richly interconnected, complex and turbulent world, the vast increase in information availability, and the compression of both time and space can only be fully exploited through:

- people - education, training, retraining, lifelong learning and quality education;
- research - long-term research, short-term targeted research, consortia and partnerships;
- markets - competitiveness, globalization and free trade; and
- time scales - the time scale of investments and return on investments, the market place, strategic and corporate plans and capital markets have all dramatically shortened.

3. The Future of Technology for Learning and Culture

3.1 Scenario-based Futures

The Experts' Workshop identified a wide range of issues. These were subsequently clustered into eleven key issues, which were accepted as providing a suitable focus for further consideration and guiding the Workshop. There was some overlap, and uncertainty about where some boundaries should be drawn. In addition, policy issues were not distinguished, but rather treated as aspects of each issue. The eleven key issues were:

1. **Economic** aspects of learning and culture - human capital development and deployment, cost-benefit assessment of new technologies and methods, human resource development, globalized competitive education industry.
2. **Learning** - changing theories of learning, drive towards life-long and/or continuous learning, importance of un-learning, learning models, collaboration/sharing in learning development.
3. **Technology** - infra- (or 'info-') structure, capacity, standards, bandwidth availability, means of delivery and access.
4. **Access** - controlled (by government or private sector) versus free availability with little or no restrictions, information rich versus information poor.
5. **Culture** - values, sovereignty (as opposed to domination/imperialism), ethical issues.
6. **Language** - of the medium and technology - mono-lingual (English) or multi-lingual, content dominance.
7. **Institutions** - patterns of organization, corporatization, management.
8. **Diversity** - age, demography, gender.
9. **Social and cultural impacts/changes**.
10. **IT for education** - training, content, equipment, networking.
11. **Accreditation** - including consumer protection, quality control.

Four distinct scenarios were developed which were designed to address each of these issues, but with very different 'uncertainties' having eventuated. They are presented in full in Volume 2.

Water, Water Everywhere described a situation in which a major environmental disruption had occurred as a result of a significant increase in global warming impacts, leading to substantial rises in sea-level. Under these circumstances, engineers, health workers, and teachers have the skills that are most in demand. Teachers, in particular, are seen as crucial carriers of heritage and culture, and providers of education for the new future. Their position as an elite is reinforced by the need for the community to preserve and re-capture cultural heritage. This increases the importance of the network of teachers for archiving since a functioning material culture has been essentially destroyed. Schooling is now largely home-based, drawing from a centralized APEC education bank, accessed through wireless Internet. Common concepts and learning artefacts are shared.

Learning through Adversity dealt with a world in which global economic depression and collapse of trade and finance regulating organizations had occurred. Under these circumstances, there is a great emphasis on sustainable subsistence living and production. Children walk each day to the Community Center and look over the weekly schedule of learning activities. Knowledge transfer is largely

experiential plus that taken from the books in the archives. Internet sources are difficult and expensive to access. Culture is valued in a new way. Family life seems to move at a slower pace, commercial competition has become greatly reduced, and the extended family provides a comforting social support system.

Helpless and Hopeless describes a world in which there has been a major loss of technological capacity, resulting from a huge electro-magnetic pulse from outer-space that has destroyed much computer capacity. While economies and stockmarkets collapsed, pedagogy survived. Good teachers were still good teachers, albeit having to make do with less available resources to support their work. The learning theories still prevailed. A more reflective learning environment re-emerged. There was a revamp of the curriculum so that basic literacy and the 3Rs became important again. Teaching was revived as an important profession. Community-based instruction became a trend.. Libraries and museums became centers of knowledge. The scenario at tertiary institutions was less positive with the research community being very badly hit.

The Polkes Next Door described a world that had been transformed through a dramatic increase in technological capacity resulting from an entirely new electronic chip. Under these conditions, schools that had been changing from knowledge transfer stations to higher learning centers in 2003, now took on the role of socialization and knowledge integration centers. With the youngest children already possessing good computer skills, the most amazing potential was being seen from the best students who now spent almost no time in drudgery learning. Good pedagogy of 2001 had been transferred to the 'infinite bandwidth' net and true multi-sensory stimulation, already developing in the VR games centers of 1999, had become a learning tool.

In developed societies, all historical & cultural artefacts had been placed within electronic reach of all. Special research programs, mindful of eco-disasters, had begun to ensure that cultural heritage of the less developed world was protected at least by e-storage as those countries were encouraged by the new technology to develop to late 20th century first world economic standards.

With the experience of these scenarios, five 'actions' were identified as crucial for the future development of technology for learning and culture:

- Investment in new concept computers
- Development of wireless/satellite technology
- Capture and preservation of information
- Common international protocol and standards for learning and culture
- Investment in teachers upgrading/retraining.

One interesting outcome of the scenario-based process appears to have been a recognition among participants of potential drawbacks and vulnerabilities associated with the drive to a much higher level of technology dependence in learning and cultural formation and transmission.

3.2 Delphi-based Futures

In order to obtain a greater participation in the study, Experts and stakeholders across the APEC member economies were surveyed using the Delphi technique for their views on the importance, year of realization across APEC and in their own economy, and probability of 51 topic statements. In the first round 134 responses were obtained from 14 member economies. This represents a 28 percent response from those originally contacted and compares with a 19 percent response from an earlier Delphi study on Water Supply and Management. These topics were categorized as technologies, management, contents and learning resources, government policies, human resource development/training, and culture. Full details are provided in Volume 2.

Table 1 Key Delphi Results

Topic	Degree of Importance	Median Year of Realization across the APEC Economies	Industrialized Median Year of i) APEC ii) Own Economy Realization	Industrializing Median Year of i) APEC ii) Own Economy Realization
Information Technology literacy is integrated throughout the curricula of schools.	9.561	2005	2005/2002	2005/2005
Cheap computers for education and interactive learning are in widespread use.	9.474	2005	2005/2002	2005/2005
Use of the Internet by primary and secondary school students is widespread.	9.211	2006	2005/2001	2006/2007
All teachers in schools are trained in Information Technology-enabled teaching and learning.	9.140	2007	2008/2003	2007/2009
90% of the students in all grades have access to computer-aided learning environments.	9.138	2008	2008/2003	2008/2010
Information and communications technologies are accessible by 90% of the population.	8.964	2009	2010/2004	2009/2010
Best practices in Information Technology-based learning and teaching are identified on a continuing basis by national and international bodies.	8.889	2005	2007/2004	2005/2006
Computer Input / Output devices which have user friendly interface are in widespread use.	8.836	2005	2005/2004	2005/2006
Global wireless networks to allow global communications at a thousand times current speeds are in widespread use.	8.796	2008	2009/2005	2008/2009
Websites designed to assist people to reskill themselves are freely available.	8.649	2007	2009/2004	2005/2006
International cyber-laws to cover digital signature, electronic evidence, electronic transaction and documents are developed.	8.508	2007	2007/2004	2007/2007
Community access to school Information and Communication Technologies learning resources is freely available.	8.414	2008	2009/2004	2008/2008
A network of digital libraries and museums is in place.	8.397	2007	2009/2005	2007/2009

Note: 1) Index for the degree of importance was obtained by $I=10*(\% \text{ of } H)+5*(\% \text{ of } M)+1*(\% \text{ of } L)+0*(5 \text{ of } UN)$

2) Industrialized economies are responses from Australia, Canada, Chinese Taipei, Hong Kong, Japan, Korea and Singapore.

3) Industrializing economies are response from Indonesia, Malaysia, Philippines and Thailand. (There are no responses in the second round from China, USA and Vietnam).

Table 1 presents the key results for the 25% of topic statements, (in order of descending importance) that were rated as of the highest importance. Based on the responses, almost two-thirds, or more, of respondents identified these topics as of high importance.

Of these thirteen topics, four were in the category of technology. The predominant theme is the widespread availability, cheapness, and easy use of information and communication technologies. The ease of use is facilitated by user-friendly interfaces and knowledge management systems. The only other specific technology rated highly was global wireless networks supporting global communications at a thousand times current speeds.

Four of the highly important topics dealt with contents and learning resources. These largely addressed access to and skills, (on the part of both student and teacher) for a computer-aided learning environment. In particular IT literacy is integrated throughout curricula. An additional resource that was rated important was a network of digital libraries and museums.

Another three of the highly important topics were concerned with government policies, though closely related to the themes in the previous two categories: ready access to the Internet in schools, and availability of this ITC resource to the wider community. The distinct topic addressed international laws to regulate and protect electronic transactions and exchange.

Under training, freely available websites to support reskilling were also rated as highly important. One highly important topic was concerned with management issue: best practices in information technology-based learning and teaching on a continuing basis by national and international bodies.

More than half of the topics were rated by less than half of respondents as highly important. Those rated as least important were the emergence of robots capable of acting as opponents to humans in sports and other activities (5.3% high importance), Chinese characters on 50% of www pages (5.6%) and widely available subsidised programs for promoting computer literacy in elderly retirees (15.5%).

As Table 1 shows, the mean year of expected realisation of topics across the APEC economies were tightly bunched in just a four-year time period between 2005 and 2008. The most distant mean year for any topic was 2013. The spread of responses was also quite uniform, with upper and lower quartile estimates, in the great majority of responses, being four years from the mean. This concentration of expected year of realisation allows little useful analysis of time differences between the various topics.

Perhaps of greater interest is the breakdown of the estimates of the years of realisation across the APEC economies versus 'within your own economy'. Responses are insufficient to permit meaningful analysis at the country level. However when responses were grouped into industrialised and industrialising member economies (based on simple GDP per head of population), some interesting findings emerged.

First, and perhaps surprisingly, the responses from the industrialising countries indicated an earlier date of realisation across APEC than those from the industrialised nations. Across the 13 high importance topics, the mean year of realisation for the former was 2005.3, compared with 2007.5 for the latter. However, across all 13 topics, realisation in the industrialised countries was seen as occurring earlier than across APEC, by an average of 3.4 years. In contrast, realisation in the industrialising countries was seen as occurring after APEC realisation, by a mean of 2.1 years.

There were 60 second round responses from 11 APEC member economies (a 45% response rate). Second round responses essentially confirmed the first round outcome, with a marked exception. Thus Topic 19 (Best practices in Information Technology based learning and teaching are identified on a continuing basis by national and international bodies) rose dramatically from an 'Importance Rating' of 14th to 7th. Apparently in the second round, respondents saw the role of national and international bodies in diffusing learning as more important.

4. Implications for Technology for Learning and Culture in the APEC Region

4.1 Challenges to Multi-Economy Foresight

The first study by the APEC Center for Technology Foresight on 'Water Supply and Management in the APEC Region' brought out some of the difficulties in operating an effective multi-economy foresight study. As stated there:

'The relatively simple issue of engaging a range of national experts and stakeholders in a project whose genesis lies entirely outside their own structures and systems, and of conducting a challenging exercise in a single language presents many practical obstacles.'

In the present study the scenarios workshop was very successful with excellent interaction among participants and a strong commitment to outcomes. The computer literacy of the overall group was high and it was possible to rapidly diffuse results among the four working groups and to come to a consensus. The details of the Workshop were set out in a Report of the Workshop produced within a short time and placed on the APEC Center website for wider diffusion.

The Workshop produced a draft set of Delphi questions and these were subsequently refined by interaction with experts and stakeholders. However, as in the Water Supply and Management Delphi, there was considerable difficulty in ensuring that the Delphi statements were unambiguous, clear and understandable by respondents whose first language is not English. The feedback from respondents highlighted a number of difficulties which may have contributed to the low response rate. This was higher than Water Supply and Management but still lower than most national Delphi studies which have averaged over 30 cent. The details are set out in Volume 2. The time and effort involved in these two Delphi studies for a less than optimal outcome suggests that the use of this Foresight technique in a multi-economy study has limited value.

4.2 The Scientific and Technological Base for Addressing the Future of Technology for Learning and Culture

A number of technological issues were raised during the study as playing an important role in addressing the future of technology for learning and culture in the APEC region. The technologies that were identified at the Experts' Workshop were:

- Wireless community using satellite technology
- Data storage for digital libraries and museums
- Virus-immune software
- Language translation and teaching systems
- New concept, more user-friendly computers.

The were reinforced by the needs identified in the Delphi survey as:

- Cheaper computers for education and interactive learning
- Computer input / output devices with user-friendly interface
- Global wireless networks operating at 1000x current speeds.

Given the massive R&D efforts in the ICT industry there is no doubt that these needs will be met in the next decade. Boxes 1 and 2 give some indication of potential developments within the APEC region.

An area which was mentioned but not explored in the study is cognitive science which is exploding with new findings about the plasticity of the brain and how learning takes place at different ages, Computer firms are trying to capitalize on this research but there is yet no evidence for increased learning based on cognitive science. Nevertheless this is an area that needs to be closely followed by experts in APEC economies.