INTERNATIONAL JOURNAL OF COMPUTERS
Issue 4, Volume 2, 2008

Implementation of The Infinity Project© in Ireland to Make Mathematics and Science Relevant and to Interest Students in Careers in Science, Engineering and Technology

Michael Tully

Abstract— The Infinity Project is a programme, created in the late nineties by Southern Methodist University (SMU) in Dallas, Texas. It is presently taught in high schools in 37 states throughout the United States to interest students in engineering and technology as a career and in universities to help retention. The programme was designed to answer the perennial student question "why do I need to learn this" by connecting the relevance of science and mathematics to everyday digital devices such as: cell phones, MP3 players, the Internet etc.

The School of Electronic and Communications Engineering (SECE) at the Dublin Institute of Technology (DIT), is the first third level School outside the US to facilitate the teaching of The Infinity Project. The Project's curriculum is included in the first year of all SECE's programmes. SECE is also supporting the implementation of The Infinity Project in a number of secondary schools in Ireland. Some parts of the Project's subject material are ideally suited to students in transition year from age 15 years upwards. To date over 80 secondary school teachers of mathematics and science have attended SECE for training in The Project. This is the first instance of a collaborative initiave between the US and Ireland in second level education. A modified version of The Infinity Project now forms a part of the Pre-Apprenticeship/ Youthreach programmes which are designed for early school leavers and funded by the State Training Authority (FAS). The content of this modified programme is significantly different. It is designed to be more hands on and the computer laboratory exercises account for 80 % of total tuition time. Future plans are to teach this programme on science, computer skills and business courses within FAS.

***Keywords*—**engineering education, retention, infinity project, recruitment, science, mathematics, relevant, Ireland

I. Introduction

Over the past number of years the government and state agencies have made several attempts to promote Ireland internationally as a knowledge based and innovation-driven economy. However, the development of a knowledge economy is dependant on a strong supply of scientists, engineers and technologists. One of the most important economic and educational challenges we face in Ireland is the shortage of young students pursuing careers in engineering and technology [1].

Today, our students continue to see little relevance in the traditional mathematics and science curriculum and this sadly suggests that the unfortunate trend will continue into the foreseeable future.

Recent studies have shown that every engineering job generates five additional jobs, but that the gap between supply and demand for engineers and technicians is growing far too quickly [2]. Latest figures released in August 2008 show that, despite the current economic downturn, there are 10,000 vacancies in the computing and IT sector, and 5,000 jobs available in engineering [3].

One of the reasons for the shortage of graduates in engineering and technology is student's poor performance in mathematics in the Leaving Certificate, the State final school examination, and the falling number of students choosing higher level mathematics.

"The failure to fill all available places on honours engineering courses is a constant cause of concern, and is linked to the issue of the numbers achieving at least a grade C3 in Higher Level Maths. This provokes considerable debate each year, with calls for greater emphasis on maths all the way through primary and secondary school. Engineers Ireland, the representative body of all engineers in Ireland, reiterated its call for the introduction of bonus points for higher level maths as an incentive for more students to take higher level maths." [4].

In an Irish Times interview on 'the drop-off in interest in the sciences', Dr. Danny O'Hare, (Dublin City University) stated "*The State now finds itself confronted by a marked fall-off in interest in the sciences in the educational system. The development has nothing to do with job opportunities for science and engineering graduates. It is to do with what is taught in our schools and how it is taught. There is too much talk and chalk involved in the teaching of science in secondary schools"* [5].

A programme, called The Infinity Project [6], created in the late nineties by Southern Methodist University (SMU) in

Manuscript received May 28, 2008: Revised version received September 3, 2008.

M. Tully, Professor of the School of Electronic and Communications Engineering (Dublin Institute of Technology), Kevin Street Dublin 8 (Ireland) (phone: +353 1 402 4790; e-mail: michael.tully@dit.ie, http://www.electronics.dit.ie/infinity/).

Dallas, Texas is used currently in 37 states throughout the United States to help high schools incorporate state-of-the-art engineering and advanced technology into the curriculum. The programme was designed to help students understand the real-world relevance of science and mathematics and thus attract them to high-tech careers. A number of US based universities have adopted The Infinity Project in an attempt to improve student retention in engineering programmes.

Michael Tully of the School of Electronic & Communications Engineering (SECE) in DIT [7] obtained the support of SMU to use The Infinity Project in SECE programmes and to facilitate and support its implementation in secondary schools in Ireland. Ireland is the first country outside the US to be permitted to do this.

II. Student Examination Performance in the Leaving Certificate

A recent Forfas National Skills Strategy Report [8] showed that the total Central Applications Office (CAO) [9] level 6/7 acceptances for engineering courses fell from 14.5% to 12.1% of applicants between 2000 and 2005. Level 6 is Higher Certificate (two year full-time) and level 7 is Ordinary Bachelor Degree level (three year full-time). For level 8 (Honours Bachelor Degree) acceptances fell from 8% to 4.8% over the same period. Acceptances in computing fell even more dramatically. For level 6/7, courses acceptances fell from 13.7% to 6.3% and for level 8 from 8.7% to 4%.

Figures from the CAO show that applications for level 8 programmes in engineering and technology for 2007 were down 23% on 2006.

Students who wish to pursue a career in engineering and computing must have a strong foundation in mathematics. Generally, a C (55%) grade in higher-level mathematics is a minimum prerequisite for most level 8 engineering programmes and C grade in ordinary level mathematics is required for most level 6/7 programmes. The results from the 2006 Leaving Certificate give cause for alarm; out of a 54,110 students, only 14% obtained an honours grade (grade C3 or higher) in higher level mathematics. This contrasts with 43% of students achieving a similar grade in English language [10].

Taking all students who achieved below grade D in mathematics at either higher level or ordinary level, those who took mathematics at foundation level paper, those on vocational programmes and those who took the Leaving Certificate Applied Programme, 26.5% of those sitting the Leaving Certificate in 2006 were excluded from taking any engineering or technology programmes solely on the basis of their results in mathematics.

Results published in August 2008, show that 5000 of the 50,000 students who sat the Leaving Certificate examination in June 2008 failed to gain a pass grade in any of the mathematics programmes offered. As mathematics is a prerequisite for most third level programmes this means that 10% of the students who sat the Leaving Certificate examination in 2008 are excluded from further education of any kind.

Poor performance in mathematics, however, is not just an educational concern. It also has potentially severe economic consequences, given Ireland's desire to develop a knowledge-based economy.

The low numbers of female students taking higher level papers in mathematics and science subjects in the Leaving Certificate further compounds this problem.

In general, more females take higher level Leaving Certificate papers and they achieve higher grades in the examinations than their male counterparts. An analysis of 2005 Leaving Certificate results shows that 60% of honours grades on higher level English were awarded to females. However, more than twice as many males as females took the higher level paper in physics. This is a major cause for concern in view of the importance of physics as a subject area in engineering. The number of female students pursuing degrees in engineering and technology is less than 10% and as low as 2% in some disciplines.

As well as the problem of falling numbers of students opting for engineering and technology programmes there is also the problem concerning the ability and skills level of the students choosing these programmes. Most engineering and technology programmes are not attracting enough students in the top-scoring CAO cohort.

Students are awarded CAO points depending on their performance in the Leaving Certificate examination. The maximum number of points which a student can achieve through this examination process is 600. The number of points required by a third level institution for entry depends on the demand for a particular programme.

In 2007, the points required for programmes in engineering ranged from 520 (Civil & Environmental) to 335 (Electrical & Electronic) in the same institution. In other institutions the points required for entry to programmes in Electronic Engineering are as low as 250. Civil Engineering is one of the few disciplines which continues to attract large numbers of students. Over the past ten years Ireland has undergone a dramatic increase in construction in all areas, public and private as a result of its thriving economy.

However, government figures for 2008 show a substantial slow down in the construction industry which already has resulted in a decrease in the number of students wishing to pursue careers in this area.

In 2007, the Irish government committed itself to spending €8.2 billion on research in science and technology over five years. The government's objective is to transform Ireland into a world class research base in these areas. However, such aspirations will be difficult to achieve in the light of the declining number of students capable of carrying out this important task [11].

If Ireland is to achieve its goal it will need a strong supply of high quality researchers in engineering and computing. In 2004, Ireland had the equivalent of 5.7 researchers per 1,000 of total employment, compared to the OECD average of 6.6 with peaks of 17.7 in Finland and 10.6 in Sweden [12].

III. Student Progression (Retention) at Third Level

There are no agreed definitions of retention in Ireland (and the US). Ireland differentiates between students who graduate on time and those who graduate late.

Progression continues to be a major problem in engineering and technology programmes. In some disciplines, half the college engineering students do not progress to their second year and the overall graduation rate is often less than 40%. This problem is largely due to the lack of preparedness of students entering engineering and technology programmes after secondary school. In particular it has been attributed to the lack of a strong foundation in mathematics which results in few students having the skills required to succeed in college engineering programmes.

Another important contributory factor, is poor initial choice of programme which results in students having no clear motivation for attending.

In Ireland, under-graduate third level education in institutions supported by the government is free. Unlike in the US, for example, few students fail to complete their chosen programme due to the financial burden of tuition fees [13].

IV. The Infinity Project©

In the mid 1990s, the United States also experienced falling student numbers entering engineering and computing programmes. A key solution was found by The Institute for Engineering Education at Southern Methodist University (SMU), Dallas, Texas. Helped by substantial industrial and federal funding Dr. Geoffrey Orsak, Dean of Engineering headed the creation of a programme aimed at increasing the quantity, quality and diversity of students entering college engineering programmes.

The programme, called The Infinity Project, began in 1998, and is the first in the US to help high schools incorporate state-of-the-art engineering and advanced technology into the curriculum. The programme was designed to help students understand the real-world relevance of science and mathematics and attract them to high-tech careers. The goal of The Project is to make sure that every high school student has access to an exciting engineering curriculum at a time when it can influence their choices about advanced courses in mathematics and science and about potential careers in technology. However, The Project is a very useful introduction to technology that will benefit all students irrespective of their choice of future career. It teaches a systematic and logical approach to problem solving which is a very necessary skill to develop in our future labour force.

In its first two years more than 2,000 students in nine states participated in the programme, and 65% of them enrolled to pursue engineering in college. Young women formed 55% of these students of which nearly 50% came from minority and disadvantaged backgrounds [14]. At present the programme is taught in thirty seven states. A significant new development in The Project is currently taking place. The Project curriculum has been extended to enable it to be taught to younger students, aged fourteen years and upwards. The new programme is titled "The Infinity Project for Computer Applications".

The curriculum of The Infinity Project focuses on the mathematics and science fundamentals of the information revolution and teaches students how engineers create and design the technology around them. Hands-on laboratory exercises utilise advanced digital signal processors (DSPs), the technology that powers electronic devices ranging from cell phones to dishwashers. DSP is the fastest-growing segment of the semiconductor industry.

The Infinity Project is unique and innovative. Not only in content but also because it is taught through specially designed laboratory-based exercises that encourage interactive and collaborative learning. The laboratory programme uses National Instrument's LabVIEW software. The Infinity Project kit is shown in Fig. 1.

Fig.1 The Infinity Project Kit

The Infinity Project curriculum encourages students to be curious about mathematics and science by connecting their relevance to modern technologies such as: MP3, CD and DVD players; cell phones; portable video players; digital cameras etc. The Project curriculum sharpens mathematical and science based problem-solving skills and encourages students to be innovative and to develop a logical thinking process.

V. The Infinity Project in DIT

The School of Electronic and Communications Engineering (SECE), Dublin Institute of Technology, has equipped a special purpose laboratory with the necessary hardware and software to enables it to teach The Infinity Project. Two stand-alone modules have been developed based on The Project and are included in the first year of all SECE's programmes.

A. Module Content

Module 1:

Introduction to modern Technology: integrated circuits, Moore's law, binary numbers, exponential functions. Creation of Digital Music: making music from sines and cosines, MIDI format, simulation of different instruments. Digital Imaging technologies: capturing and storing images, image manipulation, matrices, improving image quality, extraction of

information. These operations are defined in terms of simple matrix manipulations.

Module 2:

Digitisation of information: analogue to digital conversion, using bits to store information, aliasing and quantization. Information coding and storage: compression, error detection and correction, MP3 format, human hearing and CD audio, rotational coding, encryption. History of digital communication. Simple communications system, causes of error in communications links, using tones to communicate. Computer Networks: network basics, relays, switching and routing. The Internet, simple transfer protocols, servers, domain names. Engineering the big picture: feats that changed the world.

B. Programme Delivery

Programme delivery is over two thirteen week semesters of four hours per week. Implementation is fifty percent laboratory/lecture time. The laboratory work consists of hands-on exercises that are carefully integrated with the course materials. The maximum number of students in the laboratory is sixteen and they work in groups of two. The laboratory exercises are implemented using a cutting-edge signal processor and graphical programming software LabVIEW both of which are produced by National Instruments. These exercises permit the students to build complex systems using simple functional blocks. As an example of a "learning outcome" to make mathematics and physics relevant, the interactive laboratory worksheet shown in Figs. 2 & 3 explains the concept of quantization.

Fig.2 LabVIEW Front Panel

Quantization is the process of selecting the number of gray levels which are used to represent an image. The exercise treats a digital image as an example of a matrix where each picture element (pixel) stores a binary number. The value of the number represents a shade of gray. A pixel storing an 8 bit binary number can have 256 gray levels, a 4 bit binary number 16 gray levels etc. In the example shown in Fig.2 each pixel stores a 2 bit binary number which corresponds to black, white and two intermediate gray shades (four levels). The original image which consisted of 524,288 bits is now reduced in size to 131,072 bits.

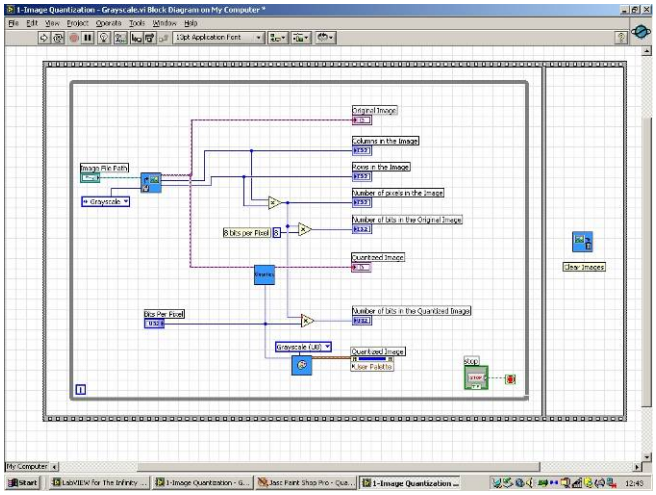

Fig.3 LabVIEW Block Diagram

The student learns that higher quality images require more memory storage that those of lower definition and that a number of considerations must be taken into account when processing digital images such as: image quality, application and the memory space required.

Figure 4 is the LabVIEW block diagram of some of the parts required to build a MIDI player.

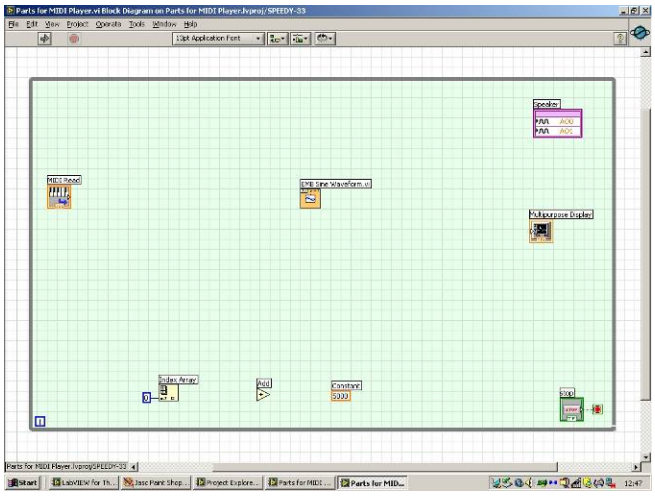

Fig.4 Parts for MIDI Player

In chapter two students learn that sound is produced by generating sine/cosine waves and that trigonometry is if fact interesting and relevant. The exercise in question is an example of how students use the knowledge gained in the

chapter to construct a MIDI player which can play any one of five tones.

The block diagram of the resulting MIDI player is shown in Fig. 5 below.

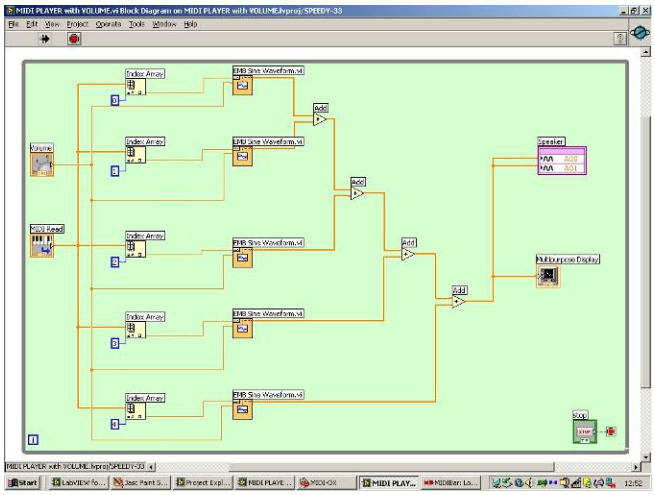

Fig.5 Block Diagram of Completed MIDI Player

The tones (or sinewaves) generated by each EMB (Embedded) Sine Waveform block are controlled by the MIDI block. Students learn that music is generated through the addition of sinusoids.

C. *Teaching Resources*

In addition to the textbook, the comprehensive resources comprise lesson plans, PowerPoint slides, a student (and instructor) laboratory manual and extensive homework and assessment material. A special purpose DIT WebCT web site contains additional laboratory exercises.

D. *Student Grades*

The Infinity Project is in its third year of implementation in DIT. It commenced in 2005. The overall assessment mark comprises two components, the formal end of semester examination which accounts for 70% and the continuous laboratory which contributes 30%. In the academic year 2005/2006, students achieved an overall assessment mark of 70% in The Infinity Project. The standard deviation was 11. In other subject areas the overall mark was in the range 50% to 55% and the standard deviation 20 to 25. Attendance in the Infinity Project laboratory was almost 100%. The progression rate of students was 80%. These results are in line with some universities in the US [15][16].

In the academic year 2006/2007, results were less positive but still indicated a considerable improvement over other subject areas. The overall assessment mark for The infinity Project was 62% compared with 45-50% in the other topics. The standard deviation was 12 compared to 25 in the other areas. Attendance in the Infinity Project laboratory was again nearly 100%. Progression of students was 68% which is still a considerable improvement over previous years.

This year 2007/2008 the results are in line with expectations and lie somewhere between results for the two previous years. The assessment mark for The Infinity Project was 67% and standard deviation 11. Other subjects average assessment mark was 54% and standard deviation 24. Progression is 74% [17][18].

In general students are very positive about the Project. When asked to comment on their level of interest virtually all found the Project "interesting" or "very interesting".

Student's comments on the strengths of the Project included:

- *"Some very interesting topics and easy to understand",*
- *"A lot more interesting than other subjects",*
- *"One of our most practical subjects",*
- *"The hand on approach to the subject was great"*
- *"Laboratory exercises are very cool".*

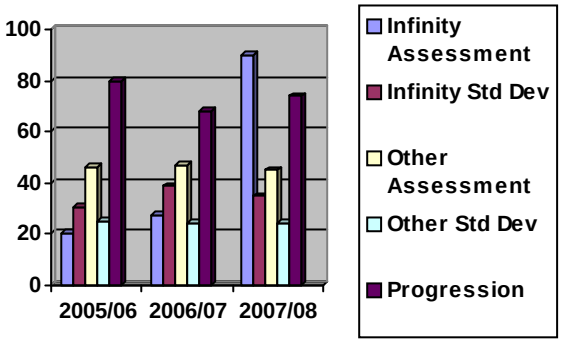

Fig. 6. Chart of results

VI. The Infinity Project in Secondary Schools in Ireland

One of the key recommendations of a report in 2005 titled "Educating the Engineer of 2020" from the National Academy of Sciences in the US, stated that engineering schools should lend their energies to national efforts to improve mathematics, science and engineering education at 2nd level [19].

The School of Electronic and Communications Engineering (SECE) is supporting a pilot of The Infinity Project in a number of secondary schools in Ireland. As a first step The Project is taught as part of the curriculum in transition year. The purpose of transition year is to promote maturity in studies by making students more self-directed learners. Also to develop maturity in relation to work and careers by developing work-related skills.

The schools chosen for the pilot are:

- Oatlands College, Mount Merrion, County Dublin (male only)
- Clonkeen College, Blackrock, County Dublin (male only)
- Loreto Abbey Dalkey, County Dublin (female only) (Fig.8.)
- Castlecomer Community College, Castlecomer, County Kilkenny (male & female)

- Colaiste Raithin (Irish language only school), Bray, County Wicklow, (male & female)

An official launch of The Infinity Project was held in Oatlands College in November 2006. The launch was attended by teachers, principals, DIT representatives and Government Ministers [20]. Fig. 7 below.

Fig.7 Minister Tom Kitt, Ms. Vivienne O'Rorke (Project Administrator) and Prof. Brian Norton (President DIT) at the official Launch in Oatlands College (Nov. 2006).

Although designed for older students, some parts of The Project's subject material are ideally suited to students in transition year (aged 15/16) as they incorporate mathematical concepts covered at Junior Certificate level. Also the curricula of the Leaving Certificate Applied (LCA) and the Leaving Certificate Vocational Programme (LCVP) would be enhanced greatly by the introduction of the Project. SECE is following the same process of implementation as in the US. To date over 80 secondary school teachers of mathematics and science have attended SECE for training. The teachers attended in their own time and at their own expense, which is undoubtedly a true testimony to their dedication and the strength of The Project.

Fig.8 Students of Loreto Abbey School demonstrate The Infinity Project to US Ambassador Thomas C Foley (May 2007) [21]

A second, purpose built *DIT* Infinity *WebCT* site has been constructed to support the teachers. It contains all the support material that the teachers require to teach and assess The Project. In addition there is a secure email and discussion environment where teachers can request backup, ask about problems they are experiencing or simply communicate ideas amongst each other.

A proposal to run a pilot of The Infinity Project in a greater number of secondary schools has been submitted to the Department of Education and Science.

Mr Michael O Leary, National Coordinator, Transition Year said *" The Infinity Project is a very exciting and innovative programme. The aim of transition year is to be educational, vocational and to help students in their personal development. The implementatoin of this Project in transition year has my full support and I can give it my highest recommendation."*

A. Teacher Feedback

Mr. Brian Mooney, educational correspondent for The Irish Times wrote in a special report on Science, Engineering and Technology in May 2007 titled "New Project Makes the Right Connections":

"Recently, teachers involved with The Infinity Project, and working with students on their selection of subjects for the Leaving Cert, have reported a dramatic improvement in interest in higher level maths, chemistry and physics along with a strong interest in the new Leaving Cert Technology subject being offered to students for the first time in September 2007. For these schools it has been claimed that this increase in interest can be attributed to a combination of factors including the new junior cert science curriculum, improved facilities and links to the real world of science and technology which they can explore through The Infinity Project" [22].

The teachers who attended training in DIT commended the Infinity Project on the following points:

- *"The Infinity Project is a wonderful opportunity for Irish students to get involved with crucial areas of technology".*
- *"Children learn without knowing or regarding it as a chore"*
- *"Has huge potential for secondary schools"*
- *"The teaching materials provided are of the highest quality".*
- *"The equipment is easy to set up (two minutes) and would not cut into available class time".*
- *"The learning/teaching process is extremely interactive and collaborative".*

VII. The Infinity Project in the State Training Agency (FAS)

A pilot of a modified form of The Infinity Project was undertaken in five Community Training Centres (CTCs) [23] which are funded by the Irish State Training and Employment Authority (FAS). It is called The Infinity Project for CTCs (IPCTC) programme and concluded in July 2008 [24][25].

The learners are early school leavers, aged 16 to 20 years, who have not completed any formal State educational programme. The FAS programmes in which The IPCTC has been included are Pre-Apprenticeship (PPA) and Youthreach which are government initiatives to promote second chance education.

The target group of the Pre-Apprenticeship programme is early school leavers (3.2%) who have decided to avail of second chance education to enable them to pursue a formal apprenticeship. The PPA programme is designed to bring the learners to the level of the State intermediate examination, the Junior Certificate and has a formal structure. Learners are taught mathematics, physics, English language along with other traditional subject areas. The programme is also designed to give the learner experience in some of the craft areas such as: mechanical workshop and carpentry. It is hoped that the learners will continue a formal apprenticeship programme on successful completion of their Pre-Apprenticeship training.

The Youthreach programme has a different emphasis. It is also designed for unemployed early school leavers but its emphasis is to provide participants with the opportunity to identify and pursue viable options within adult life and provides them with opportunities to acquire certification.

The unemployment rate is 47.5% for those with no qualifications compared to 9.6% for those with Leaving Certificate. The programme focus is on the holistic development of the individual and provides a learning environment which is safe, structured and challenging.

A. Details of the Pilot

The Community Training Centres chosen were:

CTC , Dun Laoghaire, Co Dublin (Pre- Apprentice),
Kylemore, Dublin (Pre-Apprentice),
Liberties, Dublin (Youthreach/Engineering),
Wexford, Co Wexford (Youthreach),
Newbridge, Co Kildare (Youthreach).

The pilot began end of January 2008, with a two day training event for instructors and ran until the end of July 2008. The instructors received eight days training over this period. Learner time is four hours per week comprising two, 2 hour periods. Each CTC was equipped with five Infinity Project kits and text books.

The Infinity Project for CTCs (IPCTC) is broadly based on the curriculum of the Infinity Project but employs teaching materials of a more visual nature. In addition to modern digital technology, the curriculum includes the use of a diverse range of software packages such as Computer Aided Design and Web Page Design. As a result the learners are provided with the opportunity to acquire a wide range of computer skills.

The curriculum material is presented through a series of PowerPoint slides in the computer laboratory. Conventional classrooms are not used. The object of the programme is to stimulate the learners back into more traditional education. Some learners may have learning difficulties, such as dyslexia and textual content is minimised where possible.

The laboratory activity of the programme is the predominant element and accounts for 75-80% of the total teaching time. A series of step-by-step laboratory exercises beginning with the creation of very simple systems as block diagrams allow the learners to become relaxed and confident in the use of National Instruments LabVIEW software. A simple example is shown in Figs. 8

As a first step learners build a simple switch and light (LED) system. The learners proficiency in the use of the software increases rapidly to a stage where they can build complex Virtual Instruments such as the vending machine illustrated in Figures 9 & 10 below.

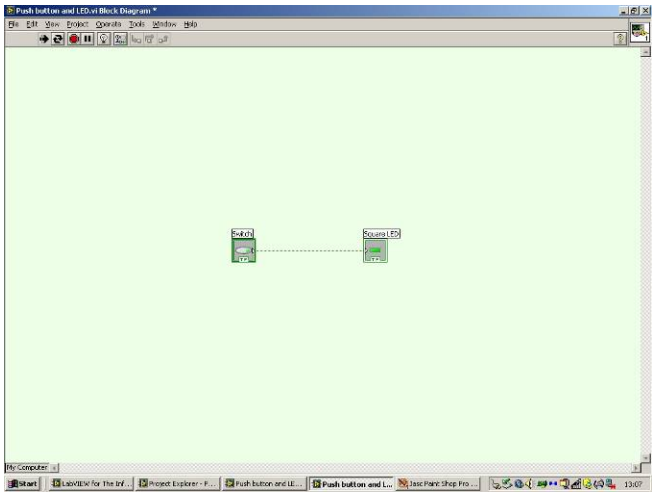

Fig.8 Block Diagram of Switch and LED

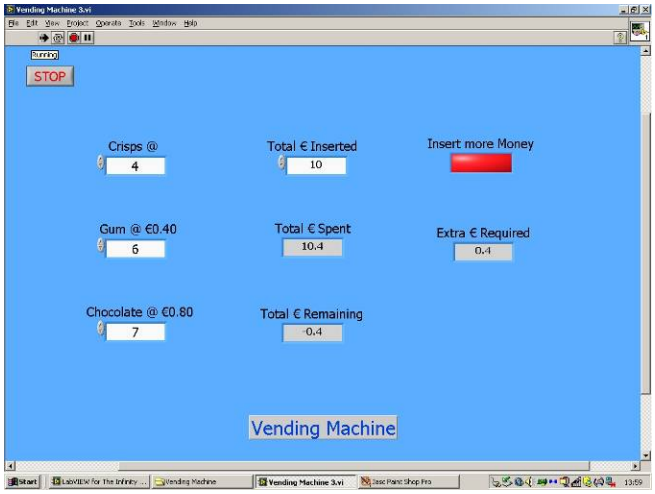

Fig.9 Front Panel of Vending Machine

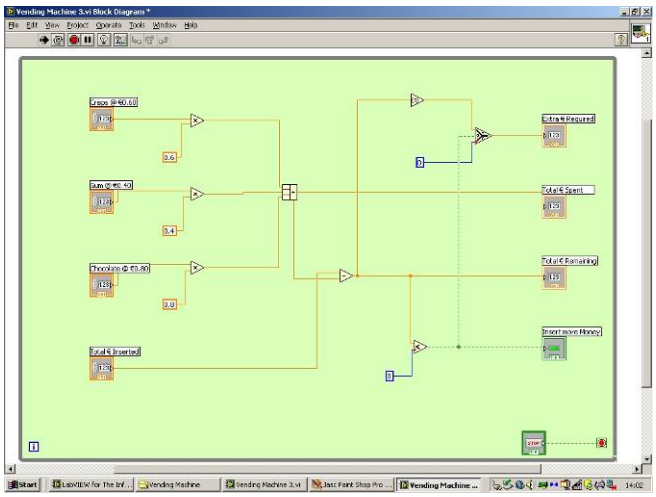

Fig.10 Block Diagram of Vending Machine

B. External Assessors Findings

The IPCTC was evaluated under several objectives most important of which was to evaluate the effectiveness of the pilot in developing learner conceptual skills.

The salient points are listed below:

- The majority of CTC staff view access to The Infinity Project as a "*God-given right*" as it has "*tremendous riches*" for all students.

- The reception of The IPCTC was overwhelmingly positive among CTC staff and allows students to get some appreciation of "the technology under the hood".

- Several instructors commented that a great strength of The Project is its contribution to fundamental learning and offers transferable skills e.g. conceptual skills, logical reasoning, planning skills and problem solving skills.

- A great virtue of The IPCTC is that it can help the learners come to terms with this technology and that it is not something to be frightened of.

- Both The Infinity Project Director and the CTC instructors were amazed at the "phenomenal pace" at which students progressed through the laboratory material.

- The pilot of The IPCTC has stimulated clear enthusiasm. It is evident that this energy is being communicated in the classroom and is proving to be very significant in retaining the attention of students.

- All CTCs found that The IPCTC developed a tremendous class spirit. Students took huge pride in their achievement. The also found that "*The Project improved teamwork. Learners helped each other and reached the norming phase of performance rapidly*".

- Some tutors go so far as to claim that the soft skills of confidence and communication skills engendered by participation in The IPCTC were the real value of the programme and should be recognised for the "progression" that they represent. The IPCTC is an excellent vehicle to facilitate a class in quickly reaching the "norming phase" essential before real performance can commence.

C. Future plans

The assessors preferred option that a preview of The IPCTC should be offered to all CTC's is educationally very progressive and far-seeing but to equip all CTC's and train sufficient instructor staff would present a formidable task to all involved at this stage.

The remaining two options are combined into a single strategy as outlined below commencing September 2008:

- Support of the present pilot to be continued until its completion and to maintain this support through the next implementation of the programme.

- Greater overlap of The IPCTC curriculum and the PPA science and technology curricula to be designed. This involves the Infinity Project Team working in close harmony and cooperation with the PPA curriculum review process.

- Learners on other CTC programmes which have science and technology elements to be offered a pilot of The IPCTC as future developments in these areas will become more and more dependent on modern digital technology.

- In addition, the non-science/technology CTC programmes such as Computer Science and Business Studies

to be considered for inclusion on a slightly modified version of the Infinity Project programme.

- The certification process to begin. All programmes run by FAS are certified by FETAC/HETAC [27].

The selection of the CTC's to be carried out by the Infinity Project Team and the FAS Project co-ordinator. Choosing CTC's other than the current selection adds to the number of CTC's equipped and trained which would be a positive step towards TMA's preferred option of the taster in all CTC's.

The pilot concluded with a graduation ceremony in DIT during which trainees demonstrated a tone communications system to Prof Brian Norton, President DIT. (Fig. 11).

Fig.11 Prof. Brian Norton, President DIT and CTC trainees at the close of the Pilot (July 2008).

VIII. Benefits of The Infinity Project

A. *Short-Term Benefits*

- Student numbers (especially female) to increase on mathematics, science, technology and engineering programmes.
- Improve retention within third level institutes.
- Allows secondary school teachers to become teachers of modern digital technology.
- Introduce a modern technology curriculum to schools which were previously unable to provide this programme of study to students.
- Project content very suitable for inclusion in training and re-training programmes.

B. *Long-Term Benefits*

- Increased number of qualified engineers, scientists and technologists in Ireland.
- Increase the problem solving skills in our student population.
- Ireland will continue to attract industry by having a fully skilled workforce available.
- Increased awareness of technology among secondary school students and teachers.
- Increase the number of high calibre students for post graduate and research studies.
- Raise the awareness of technology in the Irish workforce of the future.

IX. Conclusion

Ireland, like so many other countries is facing a crisis due to the poor take-up of programmes in science, engineering and technology at third level. Latest figures released in August 2008 show that, despite the current economic downturn, there are 10,000 vacancies in the computing and IT sector, and 5,000 jobs available in engineering.[3]

The problem is that students see mathematics and science as boring and irrelevant.

The Infinity Project is innovative and allows students to see the application of mathematics and science to modern digital technology at first hand. The Project material can be included early enough in their studies to encourage them to pursue advanced mathematics and science courses at a level which will allow them access to future careers in technology and engineering.

This is a great opportunity to make a real and substantial addition to the second level curriculum and to promote technology. A real danger exists that if we as a nation fall behind in our production of engineers and technicians it has the potential to have a serious negative impact on our economic growth.

The inclusion of The Infinity Project on engineering programmes at third level has a very positive effect on student retention.

The FAS pilot programme, based on a modified version of The Infinity Project (IPCTC) being taught to early school leavers as part of the Pre-Apprenticeship/Youthreach programmes was very successful. Learners are coming to terms with mathematical and science concepts which would previously have been considered beyond the scope of these programmes.

The learners are acquiring new computer and problem solving skills and a genuine insight into modern digital technology which would have been inconceivable before the adoption of The Infinity Project.

Fig.12 Deputy US Ambassador Robert Foucher presents CTC trainee Tanya Conroy with an award for her participation in the FAS pilot (July 2008) [26].

REFERENCES

[1] Review of International Assessments of Ireland's Competitiveness, Forfas, 2007.
[2] www.entemp.ie/science/technology/
[3] The Irish Independent, August 2008.
[4] "*Engineering a Knowledge Island"*, Engineers Ireland, Irish Academy of Engineering, 2005.
[5] The Irish Times Newspaper, March 12th, 2006.
[6] http://www.infinity-project.org/
[7] http://www.electronics.dit.ie
[8] Report of the Task Force on the Physical Sciences, Forfas, 2006
[9] http://www.cao.ie
[10] http://www2.cao.ie/handbook/handbook/index.php[11] "*Transforming Ireland – A Better Quality of Life for All"*, National Development Plan, Government Publications Office, 2007.
[12] "*Building Irelands Knowledge Economy*", The Irish Action Plan for Promoting Investment in R&D to 2010, Forfas.
[13] "*Student Retention in Higher Education Courses*", National Audit Office, RAND Corporation, 2007.
[14] John O. Attia, *"Increasing Electrical and Engineering Enrollment: A Multi-Faceted Approach"*, 37th ASEE/IEEE
[15] http://www.thecb.texas.gov/reports/HTM/0607/ TWD2002_summaries/ UT-Arlington_EE_infinity.html
[16] http://www.thecb.state.tx.us/reports/HTM/0607/ TWD2002_summaries/Prairie_View_EE_infinity.html
[17] Tully M. F. and Clarke D. P., "*Implementation of The Infinity Project in DIT*," INTED 2008, Valencia, 2008.
[18] Tully Michael, "*Use of The Infinity Project to Improve Student Recruitment and Retention on University Engineering Programmes and Apprenticeship Training in Ireland*", International Conference on Engineering Education 2008, ICEE Hungary 2008.
[19] The National Academy of Sciences, "*Educating the Engineer of 2020: Engineering Education to the New Century*", 2005.
[20] http://update.dit.ie/20-11-06/04news-briefs10.php
[21] http://dublin.usembassy.gov/index/embassy-news/ambassador/ambassadors-outreach.html
[22] The Irish Times Newspaper. May 9th, 2008
[23] http://www.fas.ie/en/Communities/Community+Training+Centres/ default.htm.
[24] http://www.dit.ie/DIT/news/2008/infinity- project.html
[25] Tully Michael, "*Use of The Infinity Project in Ireland"*, 2008 International Conference on Engineering and Mathematics, Bilbao 2008.
[26]http://www.dit.ie/news/archivecurrentyear/infinityprojectcelebratoryeveni ng/
[27] http://www.fetac.ie/
[28] Al-Bahadly, I., *Integrating Assessment and Learning into Engineering Education*, WSEAS Transactions on Advances in Engineering Education, 3, vol. 3, pp. 209-216, 2006.
[29] Staiou, E., *Implementing Total Quality Management in Higher Education Institutions*, WSEAS Transactions on Advances in Engineering Education, 6, vol. 3, pp. 525-532, 2006.
[30] Durand, G., Martel, C., An Improved Result Model for Scenarized Learning Activities, WSEAS Transactions on Advances in Engineering Education, 6, vol. 3, pp. 499-505, 2006.