AC 2010-1217: CHALLENGES FACING CONTINUOUS PROFESSIONAL DEVELOPMENT FOR TECHNOLOGY EDUCATION IN THE IRISH SECOND LEVEL SYSTEM

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Challenges facing continuous professional development for technology education in Irish second level education

As the demand for graduates of Science, Technology, Engineering and Mathematics increases, fewer second level students are choosing to pursue a third level qualification within the STEM disciplines. This dichotomous relationship is compounded by the recent trend showing a decline in the uptake of technological based subjects at second level.

Over the past 4 years, in an attempt to stimulate technological education, the Department of Education and Science has modernised the entire suite of traditional craft based syllabi to foster a design and creative culture. This brought with it an unprecedented amount of new material, the need for philosophical change and a dynamic learning approach.

The challenges facing contemporary teaching and learning centres on interpreting, realising and delivering the philosophical changes that accompanies educational reform. The focus of traditional subjects centred on prescribed project based outcomes that enabled practitioners form the role of a didactic director, the new contemporaneous suite of subject's call for a mentoring model of facilitation.

The role of the Technology Education Research group at the University of Limerick as the sole provider of pre service technology teachers is to inform the direction of a sustainable approach to a fluid dynamic technological education. Therefore this paper explores the approach taken to continue professional development of second level technology teachers in Ireland and analyses the CPD model utilised, the focus of training events, and the operation of a national in-service strategy.

The study highlights the response of practicing technology educators to the demands of the new syllabi and illustrates a significant level of engagement in in-service activities. The establishment of the self directed, peer driven Teacher Professional Network (TPN) is evidence of their intrinsic motivation to meet the challenges and requirements facing the STEM disciplines. This paper further investigates contemporary pedagogical strategies and innovative approaches to teaching and learning. In conclusion the study presents principle recommendations to complimenting the current in-service model and significantly outlines a sustainable paradigm of CPD that promotes the progression of technological literacy and competency.

Introduction- Current Trends

Since the time when man first realised that he could improve the condition of his existence, design and technology have enabled progression. Today technological innovation is core to the development of contemporary products and services that meet societal needs [1]. As Ireland endeavours to be a "*Top 5 global economy by 2020"* a joint task force of the *Irish Academy of Engineering* and *Engineers Ireland* propose a vision for a knowledge-based economy which would place the island of Ireland to the forefront of global economics. Achieving a growth rate of 4.5% annually is predicated by close collaboration between government and relevant educational and professional institutions to foster innovation[2].

The response by this task force also highlights that the entire island (both north and south) has fallen behind leading economies in terms of research and development expenditure and personnel in both industry and higher education. Higher education expenditure on research and development (HERD) in the Republic of Ireland in 2002 amounted to €322m or 0.31% of GNP, this was well below the European average of 0.41%GNP (Figure 1) [2].

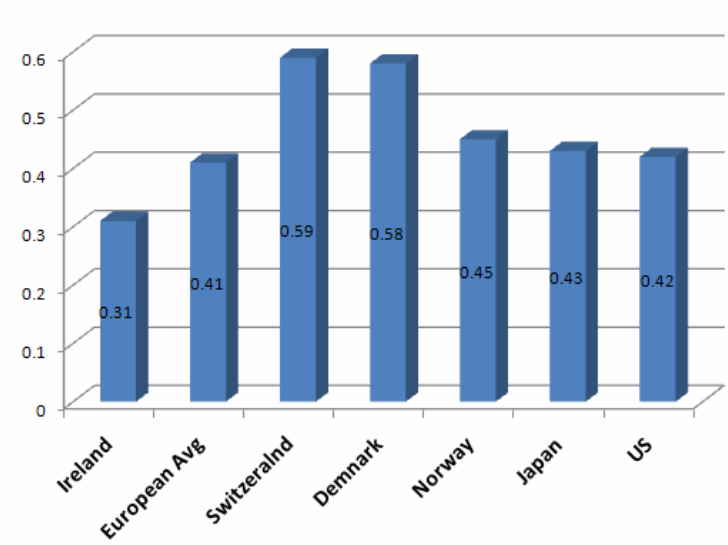

Figure 1

As part of the "Lisbon Agenda" in 2004 the Irish government adopted a target spend of 2.5% GNP by 2010 on Gross Expenditure on Research and Development (GERD- the medium through which overall spending on research and development by an economy is measured). At that time Ireland was well below the EU 2010 target of 3% GDP, having a figure of just 1.8%.

The demand for graduates of Science, Technology, Engineering and Mathematics is set to rise steadily in the coming years as the Irish economy replenishes and develops its workforce to meet the demands and expectations of a "*Knowledge Island*" [2]. A robust annual increase of qualified engineers (7%), IT workers (6%) and PhD graduates (13%) is critical to offering a competitive indigenous workforce. Targeting high end foreign direct investment is not sustainable in an economy where the higher the level of qualification held by a person in Ireland, the more likely he/she is to be non-Irish (Figure 2) [2].

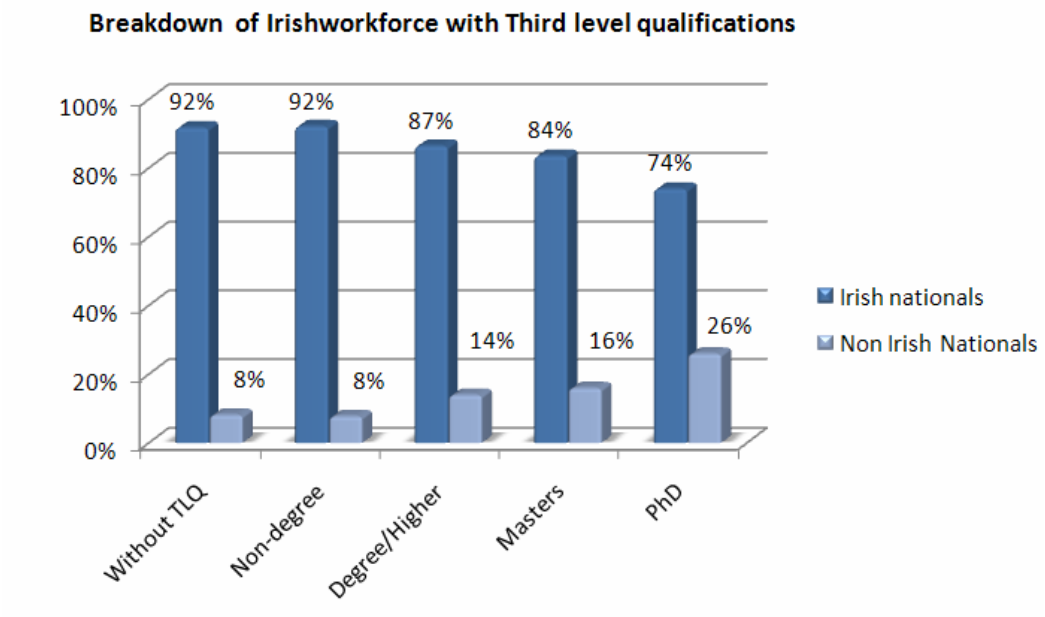

Figure 2

The *American Chamber of Commerce Ireland* (ACCI) recently voiced its concerns about the Irish Education System in a submission to the *Review Body for Higher Education* established by the Irish Minister for Education. In a damning indictment of the education system, the ACCI criticised the Department of Education's reluctance to make the necessary change to the curriculum to adapt to the changing needs, with a new focus on creativity and innovative thinking [13.] American investment is responsible for 200,000 Irish jobs and is critical to the success of the Irish Economy. The ACCI who is the main voice for US companies in Ireland also expressed concern about the supply of graduates in STEM disciplines for the economy of the future. Furthermore, it echoed the IEI report on the growing importance of research capability and says there is a need "*to inherently nurture creativity and innovation from an early stage to excite and engage our second-level students towards the pursuing of these disciplines*" [2,13].

The report "*Monitoring Irelands Skills Supply: Trends in Education/Training Outputs 2008"* was commissioned to provide an indication of the supply of skills to the Irish labour market from the formal education and training systems [3]. Contrary to the desires of both the IEI and ACCI for a rise in graduates, there is a significant drop in the number of second level students choosing to pursue a career within the STEM disciplines, despite the growing number of students entering the third level system. Science, Engineering and Technology (SET) courses accounted for 20.6% of all course acceptances in 2007, representing an overall decline of 13% since 2000 [3]. The breakdown of these SET courses paints a bleaker picture with a more worrying decline in acceptance to engineering and computing programmes. The rise in construction courses due the success of the building boom helps to mask the serious decline in the uptake of STEM courses. This has lead to a 10 % decline in Engineering and Technology graduates between 2005 and 2006 [3].

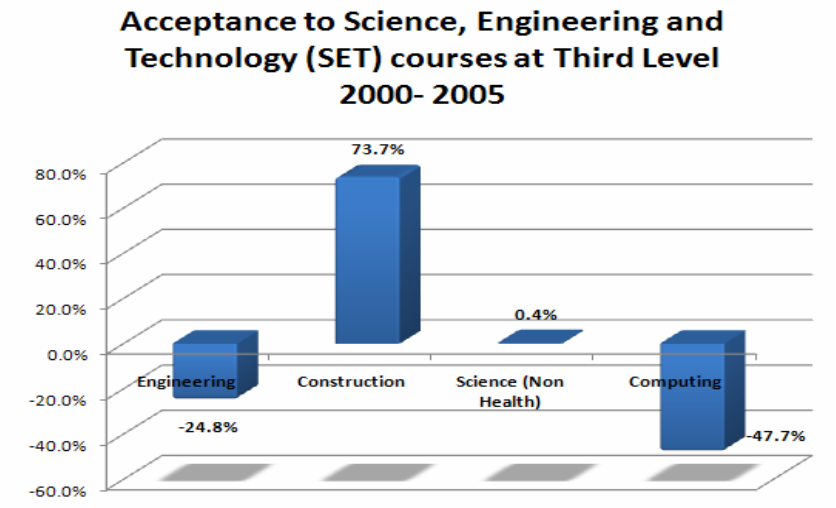

Figure 3

History of Technology education

Technology was introduced into the second-level curriculum at Junior Cycle (12-15yrs – pre leaving Certificate) as a standalone subject in 1989 to equip students with sufficient knowledge and understanding of science and technology so as to be able to function in a modern society [4]. Its launch was seen as being an attractive option for those schools that had not been in a position to provide a practical/technical subject previously and as a viable practical option to encourage female participation.

A report commissioned in 1997 by the Department of Education and Science which examined the implementation, resources, uptake and general roll out of the subject [4] highlights the importance of meaningful professional development. Its findings provided an insight into future curriculum reform in the areas of capital investment, introductory in-service, teacher ownership and the need for a sustainable model of continual professional development.

A diverse range of schools introduce Technology at Junior Cycle, receiving a once off grant of €6,200. This grant was awarded to assist in the cost of providing a technology room, necessary resources, and essential equipment. Conditional to the grant approval was that the subject must be delivered within existing resources. Schools that already offered technical subjects were at liberty to use existing practical workshops such as woodwork and metalwork rooms. Those schools previously without technology subjects and practical resource rooms (ironically the schools that this new subject targeted), reported having to refurbish existing rooms.

Provision of technology proved expensive, with 53% of schools reported spending between €12,000 and €70,000 [4]. Schools that incurred high refurbishment costs also had to invest more heavily in equipment, since they had not previously offered a practical subject. The report found that 27.5% of schools had invested between €12,000 and €50,000 on equipment essential to teaching fundamental areas of the syllabus and that the once off resource grant of €6,200 was inadequate, placing unjust expense on schools without previous technology subjects.

In relation to teacher professional development, a one-week introductory in-service course was offered for technology teachers; however only 64% of teachers surveyed attended. Of those that attended 66% felt that this course though positive did not sufficiently prepare them for the teaching of the subject, with inadequate treatment of teaching methodology, practical work, lesson preparation, care of equipment, and essential ICT skill development. This training deficit left teachers lacking confidence in the subject with 75% stating they would be interested in attending further courses [4].

A number of recommendations were made in a bid to improve technology education. The report called for

- A fundamental re-appraisal of the technology subjects with a more coherent rationale
- Standard specifications for the design of a technology room and the basic equipment required
- In-service courses to match the needs of the teachers
- The extension of technology to Senior Cycle, with criteria for the approval of schools to teach the subject at this level.
- Review of practical subjects by the Department of Education & Science, to integrate them into one coherent area of study. Every school should be enabled to offer these subjects and resources targeted so as to provide adequate funding for this purpose
- Initial teacher education courses to be revised so as to provide an integrated programme designed to meet requirements in the area of technology education [4].

Irish Educational Response

In an attempt to stimulate the STEM subjects at second level the Department of Education and Science has modernised the entire suite of traditional craft based subjects, revitalised science programs, and endorsed a new hands-on math curriculum. In November 2009 the "*Smart Schools= Smart Economy*" initiative was also launched, which will provide €150 million over the next three years for the provision of ICT resources to every school in the country [5]. This announcement indicates the government's commitment to investment in the area STEM education and also the importance of providing funding to support the integration of information communications technology (ICT) in teaching and learning [5]. Integrated professional development focusing on helping schools to integrate eLearning is also a target aim to ensure a high level of ICT literacy among teachers.

Project Maths was piloted from September 2008 in 24 schools nationally, with full roll out in 2010. This major curricular reform will:

- Promote greater mathematical literacy across the school population
- Bring a changed emphasis in the mathematics learned and, in particular, a strong focus on context, application and problem solving
- Move towards a strengthened emphasis on real life mathematics education
- Encourage greater up-take at higher level

- Provide a solid foundation for careers in science, technology, engineering, business and the humanities as we build the knowledge economy and society [6].

The government investment of €40 million in the new suite of Technology subjects at Leaving Certificate (High School) represents a significant commitment to technological education. These new subjects bring unprecedented contemporary material, a change in philosophical values and a dynamic learning approach. A distinct redefining of the traditional craft based subjects to centre on valuing design and creativity is welcomed [7]. The general aim of this new approach is to value the experience that comes from the utilisation of a wide variety of competencies and abilities, leading to a sense of competence and empowerment [8].

Technological literacy is essential for contemporary living and working, where a rapidly changing environment requires students:

- Understand appropriate concepts and processes
- Value design and realisation
- To apply knowledge and skills by thinking and acting confidently, imaginatively, creatively and with sensitivity [8].

Many subject areas can contribute to the development of technological capability, the new technology subjects in Irish second level education, which incorporate the principles of design and realisation in a creative manner, are central to this development.

The introduction of the two new subjects has taken place on a phased basis, beginning with *Technology* and *Design and Communication Graphics* (DCG). Both subjects are constructed around a core area of study and a choice of two options from a possible range of five. Technology by virtue of its broad treatment of topics aims to help students respond confidently to a world that is characterised by rapid changes in the society, the economy, work and leisure environment. D.C.G. makes a unique contribution to the student's cognitive and psychomotor skills development; it is designed and structured to take cognisance of important developments in the modes of communicating design information. The intent of this subject is to develop the creative thinking and problem solving abilities of students [8].

Challenges facing Technology Education

Entry into teaching the practical subjects in the Irish second level system has been traditionally via level eight honours degree programs provided at the University of Limerick. The two initial teacher-training programmes focus on two disciplines; Material and Engineering Technology (B.tech Ed) and Materials and Construction Technology (B.tech Ed). In 2005 the University Course Design Team (Course Board) with the foresight of the philosophical changes, unprecedented inclusion of new material, dynamic learning approach and greater student autonomy, responded to this need with new and revised teacher education degree programmes. The first graduates of these programmes entered the teaching profession in September 2009. Although these new graduates are a welcome addition, the focus of professional development must centre on practicing teachers.

The introduction of *Technology* and *D.C.G* at Leaving Certificate level into the Irish education system created an immediate need for extensive in-service for practicing technology teachers. Introducing new subjects to a curriculum is complex activity, and presents many challenges as opportunities [4].

Formation of the Technology Support Service

The Subject Support Service (t4) was established following the unveiling of four new technology syllabi at senior cycle in December 2005, two of which were approved for implementation (Technology and Design and Communication Graphics). t4 the full time support service under the auspices of the Teacher Education section within the Department of Education and Science was charge with the roll out of these new syllabi. An investment of €40m enabled the support service address the unprecedented need for technology teacher in-service. The primary function of t4 was to prepare and support teachers in the implementation of the new syllabi at Leaving Certificate Level [9]. At the intensive phase of in-service the support service had 12 fulltime team members, all of which were practicing technology teachers seconded from their schools; figure 4 illustrates the structure of the support service. In addition a team of Associated Trainers delivered the in-service at numerous education centres nationwide.

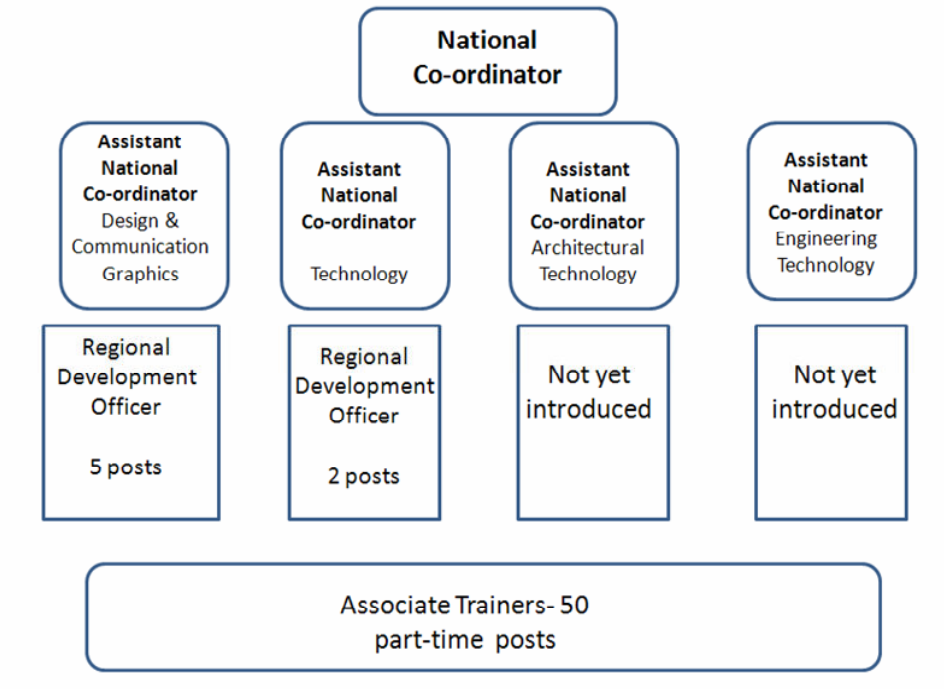

Figure 4 – Structure of national support service (t4)

The responsibility of the effective implementation of these two subjects lay with the support service. An initial allocation of nine days (with an average of three rounds annually) in-service training per subject was agreed between the Teachers Unions, the Department of Education and the t4, taking place during school hours. Funding was provided to cover classroom supervision, travel and subsistence costs, with training taking place in local education centres. In-service began in September 2006, one year before the national roll out of both subjects into schools.

The unparalleled volume of material, philosophical change and a new constructivist learning approach associated with the new syllabi called for a two-pronged *Pro-active* and *Re-active* in-service design. Trainers designed the in-service days based around aspects of both syllabi that were new to teachers and also on the information collected from practising teachers on their proficiency level in different areas of the new syllabus. Teachers were constantly monitored and questioned during each round of in-service for their subjective evaluation of the training event. This proactive approach gave teachers a voice and a sense of ownership of these new syllabi [10]. The response by teachers to the changing face of technical education was palpable and invigorating, which fostered a bottom up approach to change. The level of engagement and attendance nationally was exceptional, a significant improvement from the poor attendance during the role out of Junior Cycle Technology twenty years earlier.

Findings/ Observations

Technology was introduced in a phased basis nationwide with 66 schools implementing the new syllabus in 2007. 100% of technology teachers within these schools attended in-service on a number of key content areas. Despite the small number of schools currently offering the subject, attendance at in-service clearly illustrated the desire of other schools/teachers to embrace this subject. Round 9 of the in-service saw the t4 inviting 210 teachers to technology in-service, with a final attendance of 160 [11].

Design and Communication Graphics is taken by 12% of students at senior cycle level and therefore a far larger cohort of teachers were involved at in-service[3]. The initial survey of teachers indicated a need to addressing ICT literacy among teachers. With 73% of teachers lacking the necessary competence in using ICT in the classroom and 88% of those surveyed were inexperienced in the use of CAD (figure 5). The support service addressed these deficiencies from the outset, by organising separate in-service for those who had expressed concern over their ICT skills. Attendance at the DCG in-service rounds was consistent, with an average attendance of invited teachers 87% (1077 teachers).

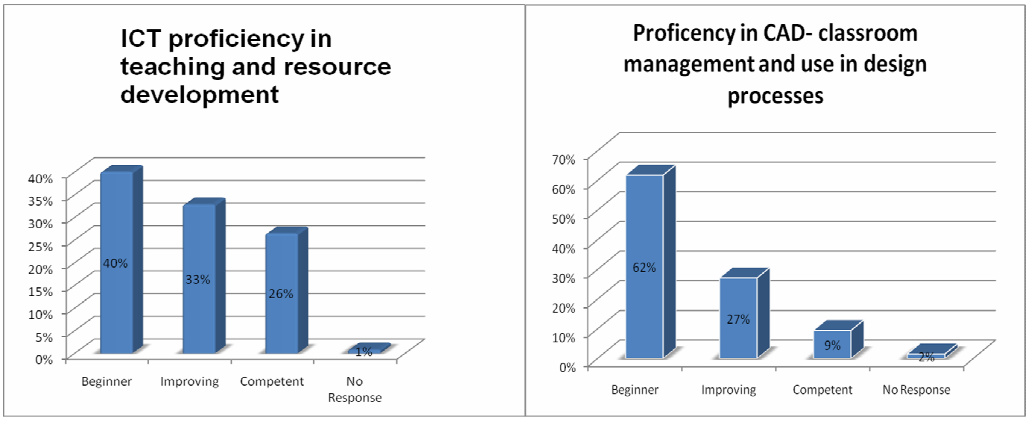

Figure 5

The addition of two more in-service days in each subject shows a continued commitment from all sides to develop the technology subjects. The level of teacher satisfaction with the in-service to date is positive, a survey of 951 teachers post Round 10 were asked to rate the in-service session using the 5 point Likert scale. Where the 5 represented excellent and 1 poor, an average rate of 4.79 for the session (Figure 6) [11] indicated the success of the session.

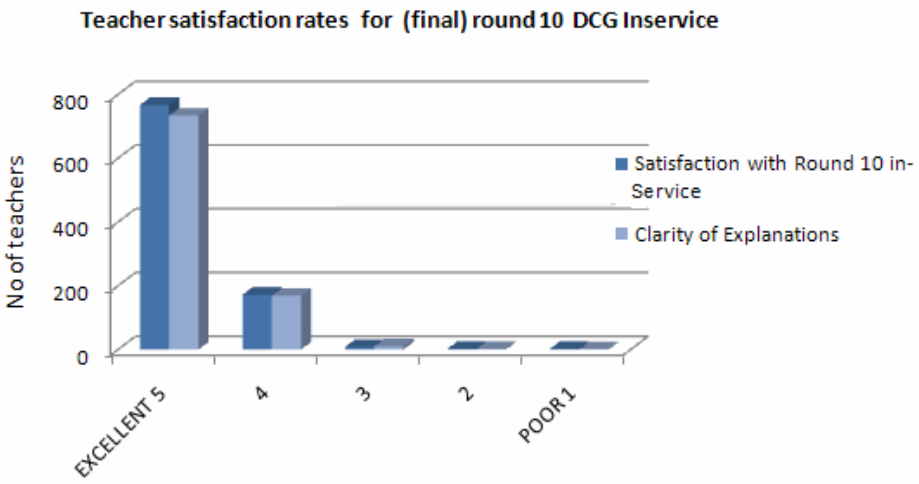

Figure 6

This survey also questioned teachers about their need for further support in the subject. The vast majority (87%) expressed a wish for support in a number of different areas of the DCG syllabus (figure 7).

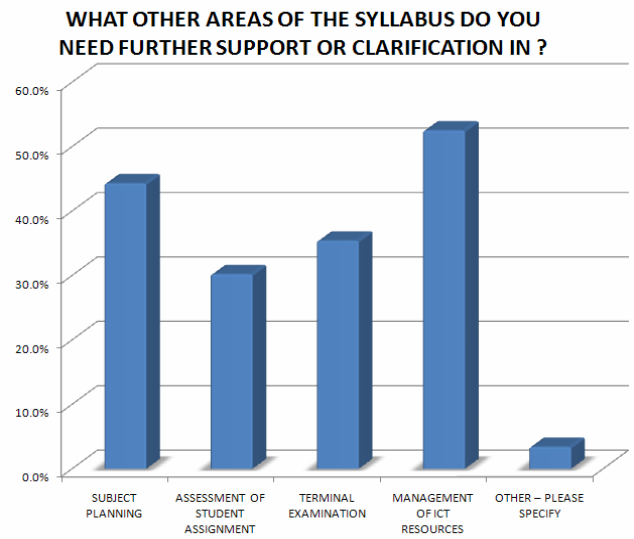

Figure 7

Teachers' establishment of the Teacher Professional Network (TPN) in response to the demand for further training is an indication of their level of commitment and intrinsic motivation. There are currently 1,000 teachers attending evening courses nationwide co-ordinated by the TPN and assisted by t4 and the National Centre for Technology in Education (NCTE)[10].

Discussion

The level of in-service engagement in by Irish technology teachers is a testament to their commitment to an education system that places pupil learning at the fore. Technology saw 100% attendance by those teachers who were actively teaching exam classes, the in-service also saw a large attendance by teachers who did not have technology within their schools. The introduction of Technology on a phased basis saw 66 schools involved in the initial implementation. The large attendance by teachers indicated the desire for more schools to embrace this new subject, and a sign of its nationwide success.

The rebirth of technological educational has given teachers a sense of renewed vigour and hope, in-service not only provides subject specific content but assists in the personal development of its teachers. Many teachers as the sole technology teacher within their schools work in faculty isolation. In-service days help teachers "*eliminate the subjective reality of the classroom press"*[12] they give teachers the opportunity to mix with their professional peers, to discuss, evaluate and express their views on their subject area.
The consistently high level of attendance at DCG in-service of 87% strengthens this argument further. Large schools with a number of technology teachers tend to have one specific teacher that consistently teaches DCG classes. This would suggest that all technology teachers invited to DCG in-service would not be representative of practicing DCG teachers, therefore presenting a skewed participation rate, however the attendance records highlighted the a significant engagement by non-practicing teachers. Initial surveys by the t4 showed a large number of teachers lacked competence in ICT and CAD skills. It can be hypothesised that the high attendance rate came from the realisation that proficiency in ICT and CAD were transferable skills and valuable additions to their repertoire.

The Proactive and Reactive model of in-service adopted by the t4 is commendable. Teachers positively engaged with the support service, who provided a fulfilling in-service consisting of subject content, philosophical changes and contemporary pedagogy. The quality of CPD during the implementation phase has developed a demand among teachers, who are looking for further support and training. The initiation of the TPN to facilitate its members with further courses (held outside formal school time) has led to over 1,000 technology teachers engaging in professional development activities. The assistance of the t4 and the NCTE has made this possible; however the current economic climate may restrict future funding. The finical constraints must be challenged to avoid a mismatch between the requirements of the subjects and the needs of the teachers [1].

Critical to our success as an economy will be our ability to increase the number of graduates in STEM to take up positions within science and engineering disciplines. Technology Education at second level has been reformed through new syllabi and the in-depth up skilling of our technology teachers. Technology education is ready to assist in the national effort to attain this global economy.

We are living in exponential times and technological advances are apparent within every facet of life especially. As Ireland endeavours to become a top 5 global economy by 2020 [2] we need to embrace technological advances. Technology education cannot afford to become complacent; it needs to remain focused on maintaining a modern syllabus that reflects the technological world, with the need for a sustainable model of CPD that promotes the progression of technological literacy and competency.

Bibliography

1. OFSTED-UK, *Education for a technolgically advanced nation*. 2008: London. p. 51.
2. Irish-Academy-of-Engineering, E.-I., *Engineering a Knowledge Island 2020*. 2005, Irish Academy of Engineering: Dublin. p. 66.
3. Condon, N., McNaboe, J., *Trends in Education / Training outputs*, in *Monitoring Irelands Skill Supply*. 2008, Expert group on future skills needs Dublin. p. 85.
4. McGuinness, S., *An Evaluation of the Implementation of Technology in the Junior Cycle Curriculum*. 1997, Trinity College Dublin: Dublin. p. 124.
5. DES. *Taoiseach launches €150m plan for "smart schools".* 2009 [cited 2010 5th January].
6. DES. *Project Maths "breaks new ground" in approach to curricular reform* 2008 [cited 2010 5th January].
7. Lane, D., Seery, N., Gordon, S., *The Understated Value of Freehand Sketching in Technology Education.* Engineering Design Graphics Journal, 2009. **73**(3): p. 13-22.
8. DES, *Leaving Certificate Design and Communication Graphics Syllabus*. 2007, National Council for Curriculum and Assessment: Dublin.
9. t4. *About t4*. 2006 [cited 2010 January 5].
10. Keays, P., *National Co-ordinator t4*. 2010: Galway.
11. t4, *In-service attendance database* Des, Editor. 2009: Galway.
12. Gleeson, J., *Curriculum Development*. 2007, University of Limerick: Limerick.
13. Donnelly, K. (2010). US firms call for overhaul of Irish education. Irish Independent. Dublin, Independent Newspapers