Tuning

India

Reference Points for the Design and Delivery of Degree Programmes in Information and Communication Technologies

Rituparna Chaki,
Preetham Kumar (eds.)

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Reference Points for the Design and Delivery of Degree Programmes in Information and Communications Technology
Reference Points are non-prescriptive indicators and general recommendations that aim to support the design, delivery and articulation of degree programmes in Information and Communication Technologies. Subject area group including experts from India and Europe has developed this document in consultation with different stakeholders (academics, employers, students and graduates).

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Content

Preface

India moves towards becoming a true knowledge society and because of the imminent fourth industrial revolution, the Higher Education System in India faces several challenges.

The three biggest challenges identified for Indian Higher Education for the upcoming years are those of expansion, excellence and equity. To make sure all the students who enrol in Higher Education institutions across the country benefit from comparable high-quality educational experience, Indian Higher Education needs to develop comparable and compatible degree programmes (curriculum development) and build the capacity of university teachers (enhancing the quality of education and teaching).

The National Education Policy-2020 (NEP-2020) is grounded on the principles of Access, Equity, Quality, Affordability and Accountability. The NEP-2020 provides a "new" and "forward-looking" vision for India's HES and its quality. The policy emphasizes, among other, on:

- Enabling faculty and institutional autonomy;
- Revamping of curriculum, pedagogy, assessment and student support;
- Enabling increased access, equity, and inclusion through a range of measures, including greater opportunities for outstanding public education;
- Moving towards a more multidisciplinary undergraduate education.

In this backdrop, the NEP-2020 proposes to revise and revamp all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st-century education. The NEP-2020 recommends that all undergraduate and graduate programmes be developed on an underlying foundation of holistic education, which enhances the intellectual, social, ethical, analytical, and aesthetic capacities of all students.

According to the NEP-2020, teachers are at the heart of the learning process–their recruitment, continuous professional development, positive working environments and service conditions are an important aspect of quality and excellence in higher education. The policy further states that it is critical to empower the faculty with high competence and deep commitment to energize them for excellence in teaching and research. It recognizes that the most crucial factor for the success of higher education institutions is the quality and engagement of its faculty. Hence, the NEP-2020 makes critical interventions in reforming the current state-of-affairs to energize and engage faculty members towards excellence in teaching and research.

Modernisation of Indian Higher Education is also seen through equipping Indian Higher Education Institutions with procedures, tools, human resources and continuous professional development mechanisms necessary for Curriculum Internationalisation and creating institution-wide thriving cultures of internationalisation for all.

The motivation behind the Tuning India project comes from 2013, when the European Commission offered the University of Deusto the possibility to undertake a "Feasibility study into the relevance of a Tuning approach for Higher Education in India" within the broad cooperative relationship between India and the European Union. The Tuning India project builds on the recommendations formulated as an outcome of that 9-month study, which combined a policy documents analysis with interviewing key actors of Indian Higher Education: University Grants Commission, Indian Government Planning Commission, Association of Indian Universities, All India Council of Technical Education, Federation of Indian Chambers of Commerce and Industry (FICCI), National Assessment and Accreditation Council, as well as more than 25 of the most relevant universities from the five sub-regions of India. The target groups of the study were the policymakers, higher education authorities, university staff and students in India.

"Expansion", "excellence" and "equity" is what Indian higher education strives for – every university student should have a high-quality educational experience, while every person dreaming of higher education should have the right to enter a university. The Tuning India project brings together 15 Indian universities, along with 5 European Union (EU) partners, to try and make this dream come true. Academics, students, graduates, employers and other relevant stakeholders from the five sub-regions of the country have been involved in the process of (re)designing degrees to make them learner-centred, comparable and compatible, as well as relevant for the society and the labour market.

The Tuning India project uses the "Tuning Methodology", which has been successfully implemented in 130 countries since 2000. It is a university-driven project which aims to offer higher education institutions and subject areas a concrete approach to implementing competency-based and student-oriented approaches. Most importantly, Tuning has served as a forum for developing reference points at subject area level. These are relevant for making programmes of studies comparable, compatible and transparent.

According to Tuning, the change from a staff-centred approach to a student-oriented approach emphasises the fact that it is the students who have to be prepared to the greatest extent possible for their future roles in society. At this moment in the global process of reforms in higher education, it is experientially clear that it is not enough just to desire change, or even to programme it at the general level, but rather it is necessary to consider processes and tools at the institutional and degree programme level.

Tuning India has brought together a group of experts, highly qualified in their fields, from Indian reputed higher education institutions. It has provided a structured way for them to work together, both on issues regarding 4 subject areas (ICT, Law, Medicine and Teacher Education) and on aspects relevant to the entire area of higher education. Much of Tuning's work focuses on the role of subject areas. This aspect of Tuning reflects the conviction that only those who have actual knowledge and experience in teaching, learning processes and research at an advanced level can create the framework for developing new programmes and guarantee their quality, in design and delivery, in the new global context.

Tuning India has provided a platform for developing understanding and insight into how this can be best accomplished. In a carefully

organised process of dialogue and debate, all the universities involved have reached deeper levels of understanding regarding the elements which constitute the essence of degree programmes in a national and international setting. Both common and diverse elements have been identified and formulated in wording which is commonly understood. For the last twenty years, Tuning has proved to be an effective way of reaching international consensus while respecting – and indeed positively implementing – the rich diversity of educational traditions and the specific experience and insight of different subject areas.

In the course of its operation, the Tuning India project has developed a common language and conceptual framework. Thus, it favours dialogue between different academic traditions and facilitates mutual understanding and transparency between universities and the broader community of stakeholders – i.e. ultimately society at large. It has stimulated a process of reflection, development and innovation in higher education programmes. All of this has constituted an intense and demanding, but ultimately useful and rewarding, learning process for all those involved. The Tuning India project empowered those who are directly responsible for the design and implementation of curricula. The hands-on experience gave them the know-how and confidence to roll it out to their colleagues in other degree programmes.

The four subject area groups in Tuning India (ICT, Law, Medicine and Teacher Education), developed final documents following a similar procedure to obtain their results. Through discussion, creation of reciprocal knowledge and mapping the ways the discipline is learned and taught in the various countries, insight was gained and consensus built on what constitutes the vital core of each subject area.

This book reflects the outcomes of the work done by Information and Communications Technology in the Tuning India project and shows in synthesis the consensus reached after intense, prolonged and lively discussions. The outcomes are presented in the standard Tuning format, introducing the methodology developed to design and to deliver degree programmes on the basis of well identified profiles and how this can be expressed in competencies and translated into learning outcomes. In general terms, we may consider that Tuning India developed reference points for the design and implementation of degree programmes in India.

In the carrying out of the Tuning India project, the collaboration of numerous academics and administrative staff from India and EU

Member States has been essential. A remarkable degree of talent, expertise, generosity, loyalty and commitment has distinguished the Tuning India project. We owe great gratitude to all the academics involved directly and indirectly in the elaboration process. They have shown tremendous commitment and imagination, finding new solutions and ways forward in an open and constructive dialogue. They have shown that Indian academics have the calibre and the vision necessary to tackle vital issues at an international level. Today's global society requires this kind of vision and commitment.

This project would never have been possible without the dedication and wisdom of the Subject Area Coordinators. They have been the pillars of the project, not only carrying great responsibility but also channelling discussions and debate in a constructive and stimulating manner. They have shown their ability to build consensus and reach outcomes which will prove useful for Indian Higher Education institutions in general.

We express our sincere gratitude to all participating universities who through their academic and administrative staff have offered us their time, energy and support to help meet our goals, piloting a concrete Tuning experience.

We would like to thank the European Commission, which through its Erasmus+ Programme has offered us the support that has made this project possible.

We also thank the European colleagues, who have greatly enriched the project, both with their wealth of knowledge and insight, and new questions and ideas.

This project means dreaming – imagining ways in which current practices can be transformed and improved. But it means not only dreaming of this future, but of getting down to the work of making it a reality. The consortium as a whole has demonstrated admirable integrity through its involvement and commitment working with determination in a disadvantaged situation during a historical moment of suffering at the international level, proving to be an example not only for the world of higher education but also for the entire society.

We would also like to highlight the important contribution made at each Policy Forum and plenary session by the people who spoke about their experiences enriching the discussions.

Finally, we would like to acknowledge the work of the project management team and the steering committee, whose devotion contributed to keep alive the activity, allowing the project to be completed on time and within budget. Whose enthusiasm kept teams motivated and on track, and whose dedication ensured that the project obtained the best possible result.

We hope and believe that the material contained in this publication will be very useful for all higher education institutions wishing to implement a competence-based and student-oriented approach, and that it will help them find and use the most suitable tools for adapting or creating higher education programmes to respond to the needs of today's society.

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1

Introduction

1.1. About the Program

The development of technology has changed business operations and functions. It results in a need for IT professionals across the globe, who are expert in cutting edge technologies. The program is designed to produce qualified IT professionals who are experts in providing solutions to business requirements. Technology is changing day by day, and today's technology may be obsolete tomorrow. It results in a need for revising the courses in the program. The curriculum conclave is conducted every four years where the students present their dream syllabus, and the feedback is taken from the alumni and employers. Based on the feedback received, the final syllabus of the program is revised, which is approved by the board of studies and the Academic Council.

1.2. Tuning India Project

The main objective of the Tuning India project is to contribute to and support the internationalization process in India through building a framework of comparable, compatible and transparent degree programs. The TUNING methodology [4] is introduced to facilitate this effort to develop graduates with the desired attributes and competencies. TUNING also aspires to enhance the student's learning experience throughout their academic years. The project is aimed towards achieving the following specific objectives:

1. To apply the Tuning methodology in Indian universities in four subject areas – Law, ICT, Medicine and Teacher Education.
2. To develop Tuning Meta-Profiles in four subject areas.
3. To develop, implement, monitor and improve degree programs.
4. To promote sub regional and international cooperation between India and EU universities.

Much effort is taken to define the desired generic and specific competencies of the graduates in the TUNING methodology. The TUNING approach empowers academic program owners to define the list of generic and specific competencies that best suit the needs of the most relevant stakeholders. The term "META-PROFILING" is used to put all the competencies into a framework incorporating intangible attributes such as values and other generic, but critical outcomes. The design of the academic program will be based on the Meta-Profile. Designing in the TUNING approach involves TEN steps, which are shown in Table 1.1. Also student's survey is conducted to estimate adequately the workload required for students to achieve the learning outcomes specified in the curriculum.

Table 1.1
Ten steps in designing tuning approach

1	Name and level of the programme
2	The social need for the programme (in its revised version)
3	Future fields, sectors of employment / occupation of graduates
4	Description of the degree profile of the new programme or a revised programme in terms of generic and subject-specific competences. Definition of competences and formulation of learning outcomes at programme level.
5	Link of the competences with the agreed meta-profile
6	Structure of the programme: units / courses / modules with their learning outcomes and learning, teaching and assessment strategies
7	Length of the programme and student workload
8	Overall consistency of the programme
9	Internal Quality Control / Enhancement
10	Other relevant aspects

1.3. Participating Universities

Following are the six universities in India involved in SAG-ICT

Table 1.2
Participating Universities

Participating Members	University
Dr. Pradeesha Ashok	International Institute of Information Technology, Bangalore
Dr. Prashant Shukla	Jagran Lakecity University
Dr. Dileep Kumar Singh	
Dr. Ravikesh	Jawaharlal Nehru University
Dr. Girish Jha	
Dr. Arun Sidram Karat	
Dr. Subhashis Majumder	Kalyan Bharti Trust (Heritage Institute of Technology)
Dr. Preetham Kumar	Manipal Academy of Higher Education
Dr. Sanjay Singh Dr. Raghavendra Achar	
Dr. Rituparna Chaki	University of Calcutta

2

Definition of Generic Competences - A Thematic Perspective

2.1. Generic Competences

Identification and generation of Competencies areas is one of the first steps that Tuning India addressed in curriculum development. The Tuning project began by focusing on the generic competencies expected to be acquired by graduates trained regardless of their area of specialization. In the initial meeting, 30 generic competencies were defined, as shown in Table 2.1.

Table 2.1
Generic Competencies of Information Technology

G1	Ability to do research
G2	Adhere to ethical principles
G3	Be socially responsible and humane
G4	Ability to apply knowledge in practical situations
G5	Ability to plan and manage time efficiently
G6	Be a lifelong learner
G7	Acquire problem solving capacity
G8	Ability to make reasoned decisions

G9	Have good interpersonal skills
G10	Appreciate and respect diversity and multiculturism
G11	Ability to manage crisis effectively
G12	Act within the legal framework
G13	Demonstrate environmental and economic consciousness
G14	Ability to communicate effectively
G15	Ability to work as a team
G16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)
G17	Be a reflective practitioner
G18	Be innovative
G19	Ability to work independently in a responsible manner
G20	Possess self-confidence and entrepreneurial spirit
G21	Be adaptable to emerging trends.
G22	Practice professionalism
G23	Promote and ensure equal opportunities including gender issues
G24	Adhere to and enhance quality standards
G25	Demonstrate leadership qualities.
G26	Ability to use available resources optimally and efficiently
G27	Ability to manage stress and maintain emotional stability
G28	Have organizational and managerial skills
G29	Be motivated for self-learning.
G30	Be goal-oriented.

2.2. Revised Generic Competences

After the consultation with key stakeholders - employees, students, graduates, and academic staff, generic competencies are reduced. Table 2.2 shows the revised nine generic competencies.

Table 2.2
Revised Generic Competencies of Information Technology

G1	Ability to do research
G4	Ability to apply knowledge in practical situations
G6	Be a lifelong learner
G9	Have good interpersonal skills
G14	Ability to communicate effectively
G15	Ability to work as a team
G21	Be adaptable to emerging trends
G26	Ability to use available resources optimally and efficiently
G28	Have organizational and managerial skills

3

Identification of Specific Competences

3.1. Specific Competences

Similar to the generic competencies, in the initial meeting, specific competencies were also defined. Table 3.1 shows 15 specific competencies defined.

Table 3.1
Specific Competencies of Information Technology

S1	Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems.
S2	Identifying opportunities in order to remedy redundancy in organizations via the efficient and effective use of ICT solutions.
S3	Identify, formulate, analyse and resolve problems
S4	Stay committed to confidentiality and data safety.
S5	Design ICT systems, including modelling (formal description) of their structure and processes.
S6	Deploy, install, integrate, put into service and maintain ICT systems and their elements.
S7	Assimilating emerging ICT technology with societal developments.
S8	Develop ICT systems in compliance with industry specifications, standards and recommendations.

S9	Maintain the quality of ICT systems and substantiate it with research based methodologies.
S10	Understand and create the documentation of ICT solutions
S11	Identify security threats and provide effective methods for information security.
S12	Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and merge ICT projects
S13	Efficient utilization of resources.
S14	Train and support ICT users
S15	Knowledge of relative quantitative methods and tools and demonstrate their usage.

3.2. Revised Specific Competences

After the consultation with key stake holders – employee, students, graduates and academic staff, generic competencies are narrow downed. Table 3.2 shows revised nine generic competencies.

Table 3.2
Revised Specific Competencies of Information Technology

S1	Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems.
S5	Design ICT systems, including modelling (formal description) of their structure and processes.
S6	Deploy, install, integrate, put into service and maintain ICT systems and their elements.
S8	Develop ICT systems in compliance with industry specifications, standards and recommendations.
S11	Identify security threats and provide effective methods for information security.
S12	Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and merge ICT projects

4

Consultation on Competences

4.1. Description of process followed

The project foresees an exhaustive consultation process with key stakeholders – employers, students, graduates and academic staff, to identify the essential competencies that should be developed in a degree program [1]. Based on the TUNING methodology, the consultation process of the different stakeholders is meant to identify three critical variables: the "importance, achievement and ranking" of generic and subject-specific competencies. These three variables play an essential role as a foundation for the development of the Meta-Profile. "Importance" will indicate the level of urgency for any particular competency to be considered in the curriculum design process. Any competency labeled as "important" should be given a much higher priority and more coverage by courses during the curriculum design stage.

Meanwhile, the "achievement" variable will disclose how far the existing curriculum has covered the generic and subject-specific competencies, as proposed during the first general meeting. Based on the "ranking" variable, the hierarchy of the competencies can then be developed. Tables 4.1 and 4.2 show the number of respondents for generic and specific competencies from various stakeholders.

Table 4.1
Number of respondents for generic competencies

	Academics	Employers	Students	Graduates	Total
ICT	126	106	494	132	858

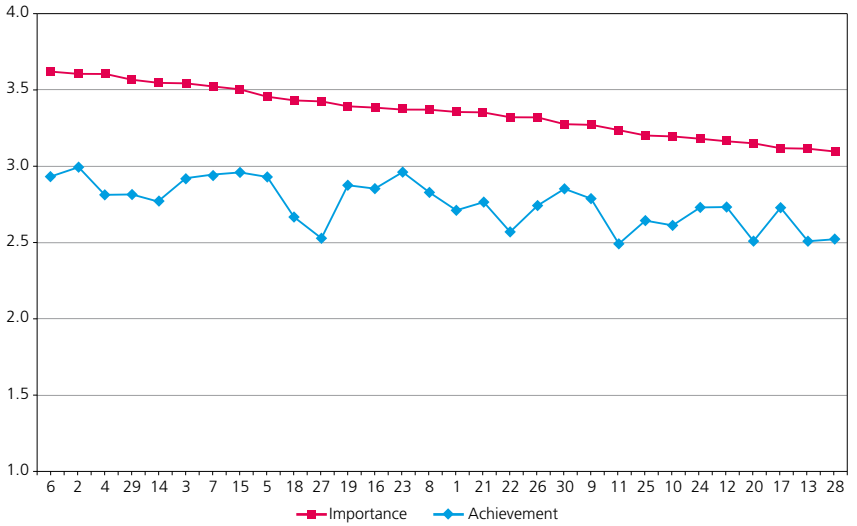
Table 4.2
Number of respondents for specific competencies

	Academics	Employers	Students	Graduates	Total
ICT	108	73	466	94	741

4.2. Analysis of the Results of Generic Competencies Survey

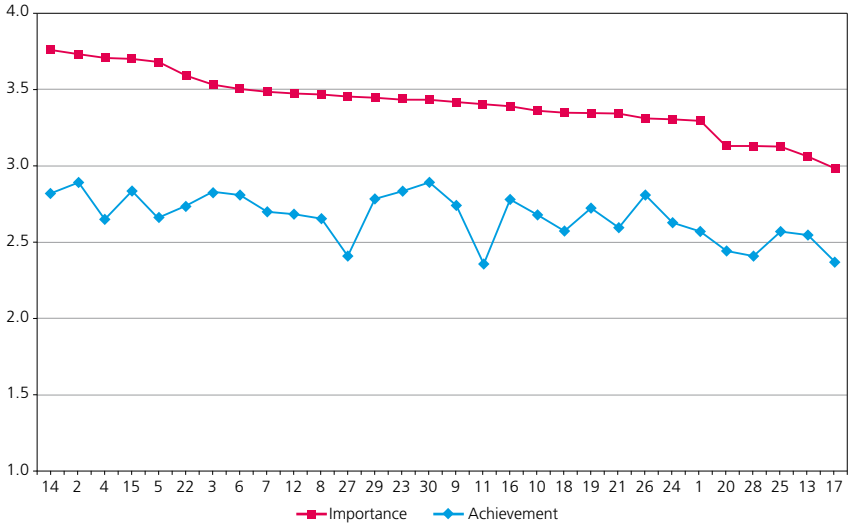
Ratings

It refers to the means for each competence on a scale of 1 to 4. Each competence was rated in terms of importance and achievement. The first graphic displays results ordered from the most important to the least important competence.



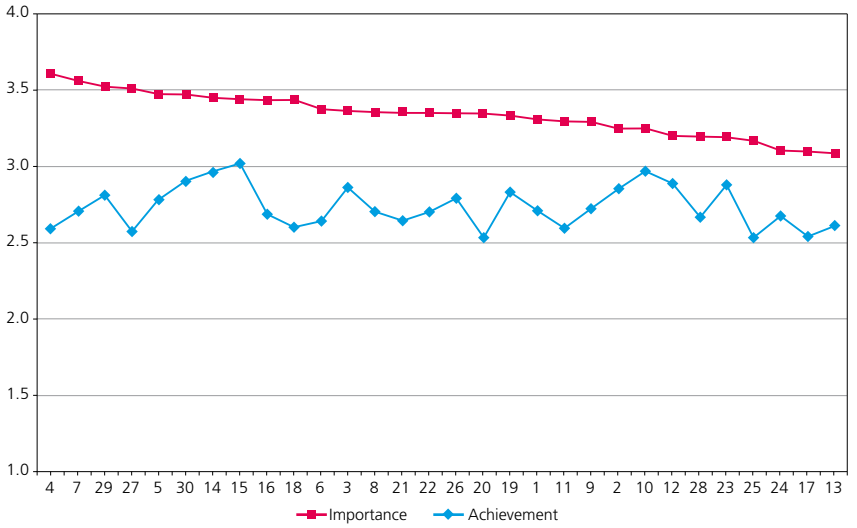
ICT Academics Ratings			
#	Description	Importance	Achievement
6	Be a life-long learner	3.62	2.93
2	Adhere to ethical principles	3.60	2.99
4	Ability to apply knowledge in practical situations	3.60	2.81
29	Be motivated for self-learning	3.56	2.81
14	Ability to communicate effectively	3.54	2.77
3	Be socially responsible and humane	3.54	2.91
7	Acquire problem solving capacity	3.52	2.94
15	Ability to work as a team	3.50	2.96
5	Ability to plan and manage time efficiently	3.45	2.93
18	Be innovative	3.43	2.66
27	Ability to manage stress and maintain emotional stability	3.42	2.52
19	Ability to work independently in a responsible manner	3.39	2.87
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	3.38	2.85
23	Promote and ensure equal opportunities including gender issues	3.37	2.96
8	Ability to make reasoned decisions	3.37	2.82
1	Ability to do research	3.35	2.71
21	Be adaptable to emerging trends	3.35	2.76
22	Practice professionalism	3.32	2.56
26	Ability to use available resources optimally and efficiently	3.32	2.74
30	Be goal-oriented	3.27	2.85
9	Have good interpersonal skills	3.27	2.78
11	Ability to manage crisis effectively	3.23	2.49
25	Demonstrate leadership qualities	3.20	2.64

ICT Academics Ratings			
#	Description	Importance	Achievement
10	Appreciate and respect diversity and multi-culturalism	3.19	2.60
24	Adhere to and enhance quality standards	3.18	2.72
12	Act within the legal framework	3.16	2.73
20	Possess self-confidence and entrepreneurial spirit	3.14	2.50
17	Be a reflective practitioner	3.12	2.72
13	Demonstrate environmental and economic consciousness	3.11	2.51
28	Have organizational and managerial skills	3.09	2.52



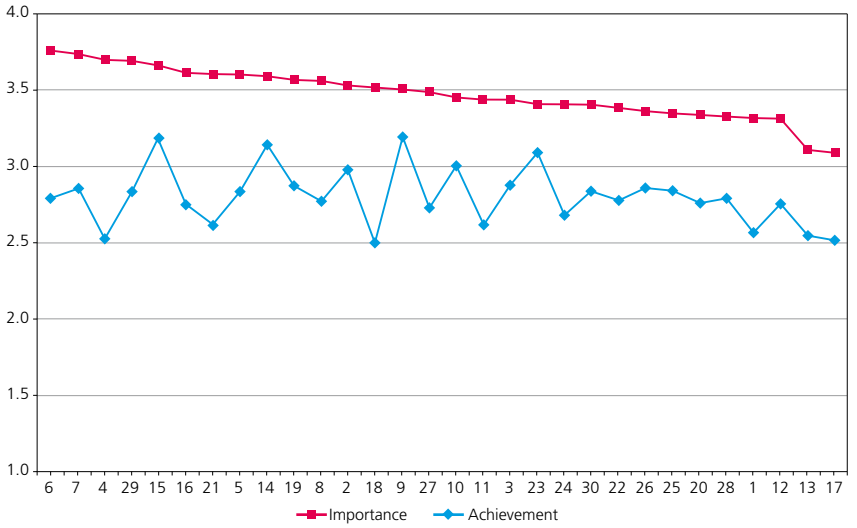
ICT Employers Ratings			
#	Description	Importance	Achievement
14	Ability to communicate effectively	3.75	2.82
2	Adhere to ethical principles	3.73	2.89
4	Ability to apply knowledge in practical situations	3.70	2.64
15	Ability to work as a team	3.70	2.83
5	Ability to plan and manage time efficiently	3.68	2.66
22	Practice professionalism	3.59	2.73
3	Be socially responsible and humane	3.53	2.82
6	Be a life-long learner	3.50	2.80
7	Acquire problem solving capacity	3.48	2.69
12	Act within the legal framework	3.47	2.68
8	Ability to make reasoned decisions	3.46	2.65
27	Ability to manage stress and maintain emotional stability	3.45	2.40
29	Be motivated for self-learning	3.45	2.78
23	Promote and ensure equal opportunities including gender issues	3.43	2.83
30	Be goal-oriented	3.43	2.89
9	Have good interpersonal skills	3.41	2.74
11	Ability to manage crisis effectively	3.40	2.35
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	3.39	2.78
10	Appreciate and respect diversity and multiculturalism	3.36	2.67
18	Be innovative	3.35	2.57
19	Ability to work independently in a responsible manner	3.34	2.72
21	Be adaptable to emerging trends	3.34	2.59

ICT Employers Ratings			
#	Description	Importance	Achievement
26	Ability to use available resources optimally and efficiently	3.31	2.80
24	Adhere to and enhance quality standards	3.30	2.63
1	Ability to do research	3.29	2.56
20	Possess self-confidence and entrepreneurial spirit	3.13	2.44
28	Have organizational and managerial skills	3.13	2.40
25	Demonstrate leadership qualities	3.12	2.56
13	Demonstrate environmental and economic consciousness	3.06	2.54
17	Be a reflective practitioner	2.98	2.36



ICT Students Ratings			
#	Description	Importance	Achievement
4	Ability to apply knowledge in practical situations	3.60	2.59
7	Acquire problem solving capacity	3.56	2.70
29	Be motivated for self-learning	3.52	2.81
27	Ability to manage stress and maintain emotional stability	3.51	2.57
5	Ability to plan and manage time efficiently	3.47	2.78
30	Be goal-oriented	3.46	2.90
14	Ability to communicate effectively	3.45	2.96
15	Ability to work as a team	3.44	3.02
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	3.43	2.67
18	Be innovative	3.43	2.60
6	Be a life-long learner	3.37	2.63
3	Be socially responsible and humane	3.36	2.86
8	Ability to make reasoned decisions	3.35	2.70
21	Be adaptable to emerging trends	3.35	2.64
22	Practice professionalism	3.35	2.70
26	Ability to use available resources optimally and efficiently	3.35	2.79
20	Possess self-confidence and entrepreneurial spirit	3.34	2.53
19	Ability to work independently in a responsible manner	3.33	2.83
1	Ability to do research	3.30	2.71
11	Ability to manage crisis effectively	3.29	2.59
9	Have good interpersonal skills	3.29	2.71
2	Adhere to ethical principles	3.24	2.85

ICT Students Ratings			
#	Description	Importance	Achievement
10	Appreciate and respect diversity and multi-culturalism	3.24	2.97
12	Act within the legal framework	3.20	2.89
28	Have organizational and managerial skills	3.19	2.66
23	Promote and ensure equal opportunities including gender issues	3.19	2.87
25	Demonstrate leadership qualities	3.17	2.53
24	Adhere to and enhance quality standards	3.10	2.67
17	Be a reflective practitioner	3.09	2.53
13	Demonstrate environmental and economic consciousness	3.08	2.61

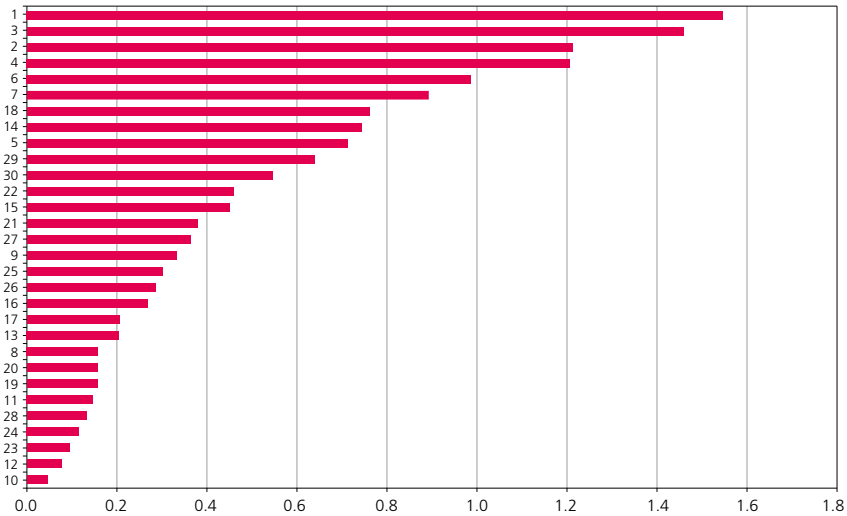


ICT Graduates Ratings			
#	Description	Importance	Achievement
6	Be a life-long learner	3.76	2.79
7	Acquire problem solving capacity	3.74	2.85
4	Ability to apply knowledge in practical situations	3.70	2.52
29	Be motivated for self-learning	3.69	2.83
15	Ability to work as a team	3.66	3.18
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	3.61	2.75
21	Be adaptable to emerging trends	3.60	2.61
5	Ability to plan and manage time efficiently	3.60	2.83
14	Ability to communicate effectively	3.59	3.13
19	Ability to work independently in a responsible manner	3.56	2.87
8	Ability to make reasoned decisions	3.56	2.77
2	Adhere to ethical principles	3.53	2.98
18	Be innovative	3.52	2.50
9	Have good interpersonal skills	3.50	3.19
27	Ability to manage stress and maintain emotional stability	3.48	2.73
10	Appreciate and respect diversity and multiculturalism	3.45	3.00
11	Ability to manage crisis effectively	3.43	2.61
3	Be socially responsible and humane	3.43	2.87
23	Promote and ensure equal opportunities including gender issues	3.41	3.09
24	Adhere to and enhance quality standards	3.41	2.67
30	Be goal-oriented	3.40	2.83
22	Practice professionalism	3.38	2.77

ICT Graduates Ratings			
#	Description	Importance	Achievement
26	Ability to use available resources optimally and efficiently	3.36	2.86
25	Demonstrate leadership qualities	3.34	2.84
20	Possess self-confidence and entrepreneurial spirit	3.34	2.76
28	Have organizational and managerial skills	3.33	2.79
1	Ability to do research	3.32	2.56
12	Act within the legal framework	3.31	2.75
13	Demonstrate environmental and economic consciousness	3.10	2.55
17	Be a reflective practitioner	3.09	2.52

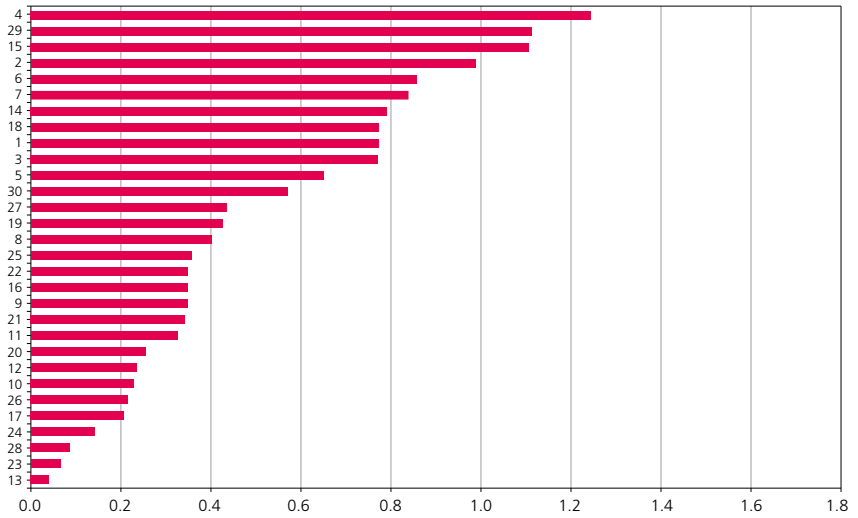
Ranking

In the questionnaire, respondents chose the five most essential competencies. To analyze the results, the first selected competence was assigned 5 points, the second one 4 points, the third one 3 points, the fourth 2 points, and 1 point to the fifth and last one. The competencies not chosen were assigned zero points. Therefore, if all respondents chose one given competence as the first one, the mean of this assigned score would yield a top 5 for the mean of this competence. Similarly, a given competence never chosen by any of the respondents among the top five would yield a mean of zero. The graphic shows the competencies in descending order using this score. After this graphic, the same results are given in the corresponding table, where competencies are ordered in ascending order.



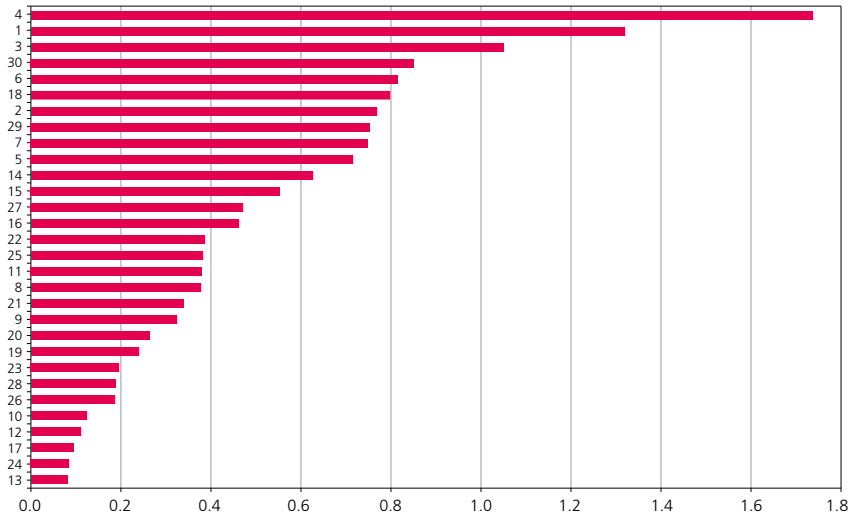
ICT Academics Rankings		
#	Description	Ranking
10	Appreciate and respect diversity and multiculturalism	0.05
12	Act within the legal framework	0.08
23	Promote and ensure equal opportunities including gender issues	0.10
24	Adhere to and enhance quality standards	0.12
28	Have organizational and managerial skills	0.13
11	Ability to manage crisis effectively	0.15
19	Ability to work independently in a responsible manner	0.16
20	Possess self-confidence and entrepreneurial spirit	0.16
8	Ability to make reasoned decisions	0.16
13	Demonstrate environmental and economic consciousness	0.21
17	Be a reflective practitioner	0.21
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	0.27
26	Ability to use available resources optimally and efficiently	0.29

ICT Academics Rankings		
#	Description	Ranking
25	Demonstrate leadership qualities	0.30
9	Have good interpersonal skills	0.33
27	Ability to manage stress and maintain emotional stability	0.36
21	Be adaptable to emerging trends	0.38
15	Ability to work as a team	0.45
22	Practice professionalism	0.46
30	Be goal-oriented	0.55
29	Be motivated for self-learning	0.64
5	Ability to plan and manage time efficiently	0.71
14	Ability to communicate effectively	0.74
18	Be innovative	0.76
7	Acquire problem solving capacity	0.89
6	Be a life-long learner	0.99
4	Ability to apply knowledge in practical situations	1.21
2	Adhere to ethical principles	1.21
3	Be socially responsible and humane	1.46
1	Ability to do research	1.55



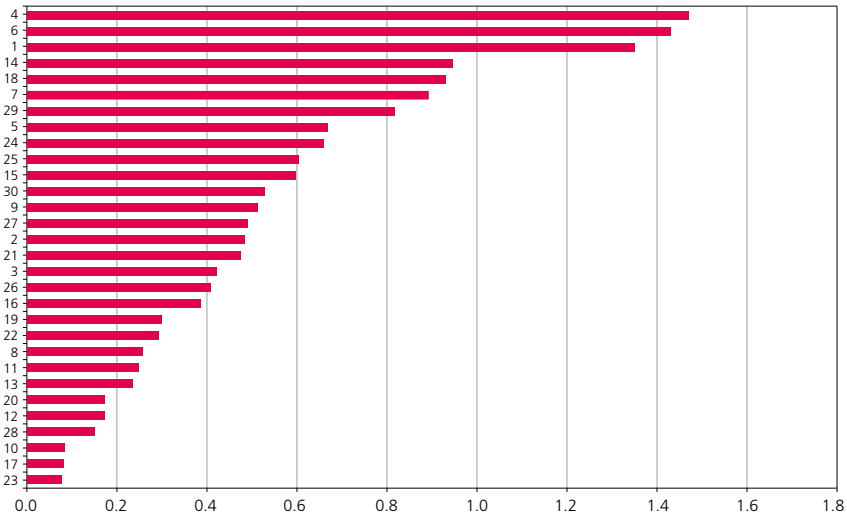
ICT Employers Rankings		
#	Description	Ranking
13	Demonstrate environmental and economic consciousness	0.04
23	Promote and ensure equal opportunities including gender issues	0.07
28	Have organizational and managerial skills	0.09
24	Adhere to and enhance quality standards	0.14
17	Be a reflective practitioner	0.21
26	Ability to use available resources optimally and efficiently	0.22
10	Appreciate and respect diversity and multiculturalism	0.23
12	Act within the legal framework	0.24
20	Possess self-confidence and entrepreneurial spirit	0.25
11	Ability to manage crisis effectively	0.33
21	Be adaptable to emerging trends	0.34
9	Have good interpersonal skills	0.35
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	0.35

ICT Employers Rankings		
#	Description	Ranking
22	Practice professionalism	0.35
25	Demonstrate leadership qualities	0.36
8	Ability to make reasoned decisions	0.40
19	Ability to work independently in a responsible manner	0.42
27	Ability to manage stress and maintain emotional stability	0.44
30	Be goal-oriented	0.57
5	Ability to plan and manage time efficiently	0.65
3	Be socially responsible and humane	0.77
1	Ability to do research	0.77
18	Be innovative	0.77
14	Ability to communicate effectively	0.79
7	Acquire problem solving capacity	0.84
6	Be a life-long learner	0.86
2	Adhere to ethical principles	0.99
15	Ability to work as a team	1.11
29	Be motivated for self-learning	1.11
4	Ability to apply knowledge in practical situations	1.25



ICT Students Rankings		
#	Description	Ranking
13	Demonstrate environmental and economic consciousness	0.08
24	Adhere to and enhance quality standards	0.09
17	Be a reflective practitioner	0.09
12	Act within the legal framework	0.11
10	Appreciate and respect diversity and multiculturalism	0.13
26	Ability to use available resources optimally and efficiently	0.19
28	Have organizational and managerial skills	0.19
23	Promote and ensure equal opportunities including gender issues	0.20
19	Ability to work independently in a responsible manner	0.24
20	Possess self-confidence and entrepreneurial spirit	0.27
9	Have good interpersonal skills	0.33
21	Be adaptable to emerging trends	0.34
8	Ability to make reasoned decisions	0.38

ICT Students Rankings		
#	Description	Ranking
11	Ability to manage crisis effectively	0.38
25	Demonstrate leadership qualities	0.38
22	Practice professionalism	0.39
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	0.46
27	Ability to manage stress and maintain emotional stability	0.47
15	Ability to work as a team	0.55
14	Ability to communicate effectively	0.63
5	Ability to plan and manage time efficiently	0.72
7	Acquire problem solving capacity	0.75
29	Be motivated for self-learning	0.76
2	Adhere to ethical principles	0.77
18	Be innovative	0.80
6	Be a life-long learner	0.82
30	Be goal-oriented	0.85
3	Be socially responsible and humane	1.05
1	Ability to do research	1.32
4	Ability to apply knowledge in practical situations	1.74



ICT Graduates Rankings		
#	Description	Ranking
23	Promote and ensure equal opportunities including gender issues	0.08
17	Be a reflective practitioner	0.08
10	Appreciate and respect diversity and multiculturalism	0.08
28	Have organizational and managerial skills	0.15
12	Act within the legal framework	0.17
20	Possess self-confidence and entrepreneurial spirit	0.17
13	Demonstrate environmental and economic consciousness	0.24
11	Ability to manage crisis effectively	0.25
8	Ability to make reasoned decisions	0.26
22	Practice professionalism	0.30
19	Ability to work independently in a responsible manner	0.30
16	Demonstrate higher order thinking skills (analytical, critical, abstract, creative)	0.39
26	Ability to use available resources optimally and efficiently	0.41

ICT Graduates Rankings		
#	Description	Ranking
3	Be socially responsible and humane	0.42
21	Be adaptable to emerging trends	0.48
2	Adhere to ethical principles	0.48
27	Ability to manage stress and maintain emotional stability	0.49
9	Have good interpersonal skills	0.52
30	Be goal-oriented	0.53
15	Ability to work as a team	0.60
25	Demonstrate leadership qualities	0.61
24	Adhere to and enhance quality standards	0.66
5	Ability to plan and manage time efficiently	0.67
29	Be motivated for self-learning	0.82
7	Acquire problem solving capacity	0.89
18	Be innovative	0.93
14	Ability to communicate effectively	0.95
1	Ability to do research	1.35
6	Be a life-long learner	1.43
4	Ability to apply knowledge in practical situations	1.47

Correlations

At the end of these results, correlations among the means given by groups have been calculated. This correlation coefficient measures the sign and intensity of the relationship between the means of the four groups considered in each result: importance, achievement and ranking. This most used coefficient has a minimum value of –1 (maximum possible negative relationship) and a maximum value of +1 (maximum possible positive relationship). A zero would indicate the absence of a relationship between the results of any pair of given groups. As one may observe, all correlations are positive, as expected. Note that a negative correlation would indicate that two given groups are behaving in an opposite manner. A correlation

close to 1 for two groups, let's say Academics and Students as an example, shows that the means obtained for the set of competencies behave in a very similar manner. If this correlation refers to importance, as an example again, it would mean that when Academics judge a competence as very important, Students have considered this competence as very important too (that does not imply that the means are equal in both groups, but both means will be high relatively in each group). In the same manner, if Academics judge a given competence among the least important ones, Students will consider this competence as the competence of least importance (once again, that does not imply that the means are equal in both groups, but both means will be relatively low in each group).

Comparing importance and achievement separately between groups

Two final slides are showing graphics for importance and achievement ratings separately with four groups altogether in each graphic. This graphics allows for comparison between different groups. The competences are ordered just as they were listed in the original questionnaire

Importance

	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.7830	1.0000		
Students	0.7153	0.6162	1.0000	
Graduates	0.8086	0.6972	0.7618	1.0000

Achievement

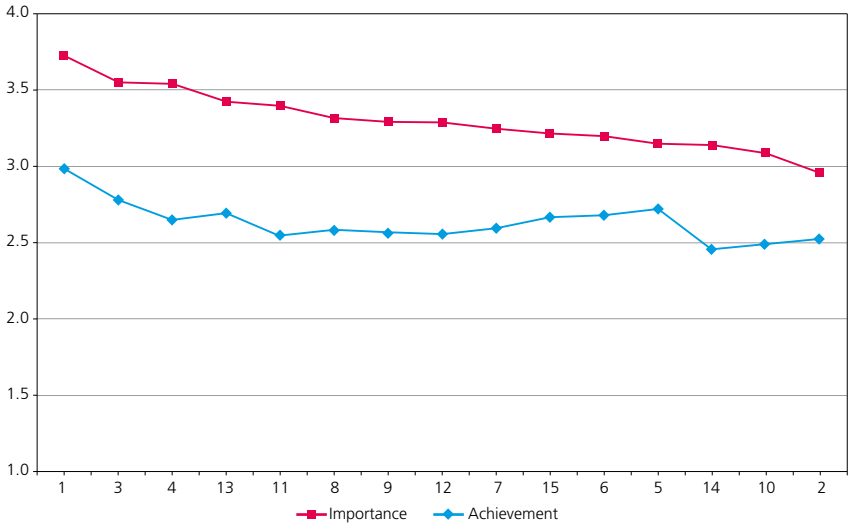
	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.7596	1.0000		
Students	0.5177	0.7340	1.0000	
Graduates	0.4378	0.6206	0.7134	1.0000

Ranking

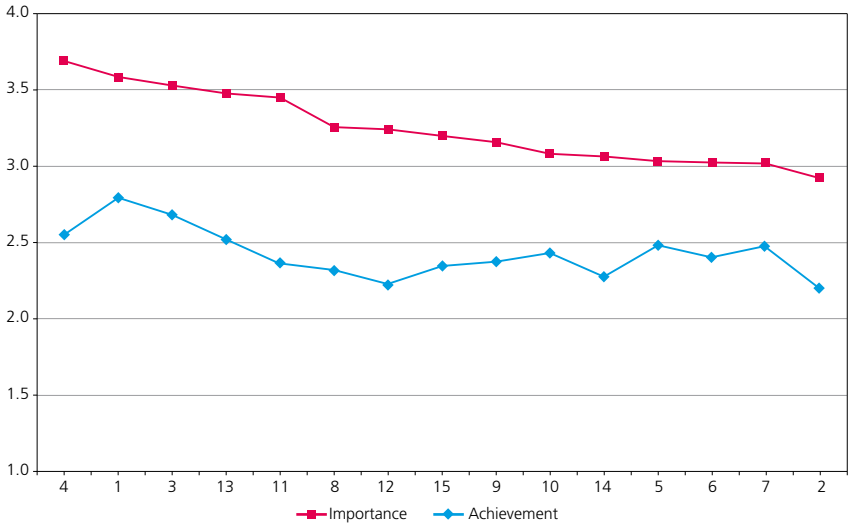
	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.7770	1.0000		
Students	0.8888	0.8334	1.0000	
Graduates	0.7376	0.7453	0.8002	1.0000

4.3. Analysis of the Results of Specific Competencies Survey

Ratings

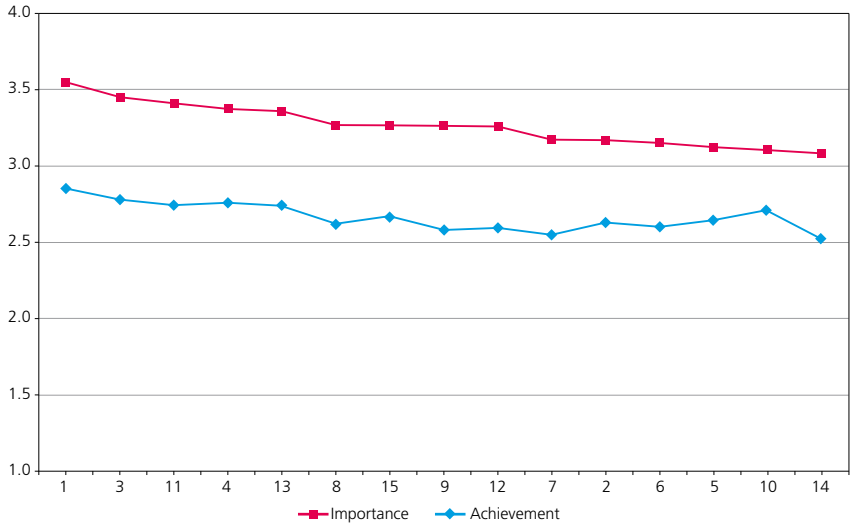


ICT Academics Ratings			
#	Description	Importance	Achievement
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.74	2.99
3	Identify, formulate, analyse and resolve problems	3.56	2.78
4	Stay committed to confidentiality and data safety	3.55	2.65
13	Efficient utilisation on resources	3.43	2.69
11	Identify security threats and provide effective methods for information security	3.40	2.55
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	3.32	2.58
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	3.30	2.57
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	3.29	2.57
7	Assimilating emerging ICT technology with societal developments	3.25	2.60
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	3.22	2.67
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	3.20	2.68
5	Design of ICT systems, including modelling (formal description) of their structure and processes	3.16	2.72
14	Train and support ICT Users	3.15	2.46
10	Understand and create the documentation of ICT solutions	3.10	2.50
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	2.96	2.52

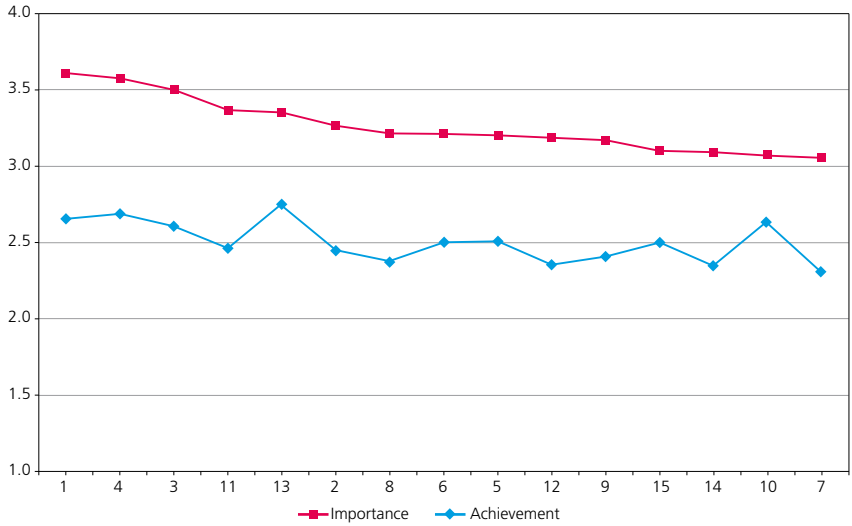


ICT Employers Ratings			
#	Description	Importance	Achievement
4	Stay committed to confidentiality and data safety	3.70	2.55
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.59	2.80
3	Identify, formulate, analyse and resolve problems	3.53	2.68
13	Efficient utilisation on resources	3.48	2.52
11	Identify security threats and provide effective methods for information security	3.46	2.37
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	3.26	2.33
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	3.25	2.22
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	3.21	2.35
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	3.16	2.38

ICT Employers Ratings			
#	Description	Importance	Achievement
10	Understand and create the documentation of ICT solutions	3.08	2.43
14	Train and support ICT Users	3.07	2.27
5	Design of ICT systems, including modelling (formal description) of their structure and processes	3.04	2.48
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	3.03	2.41
7	Assimilating emerging ICT technology with societal developments	3.03	2.48
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	2.93	2.20



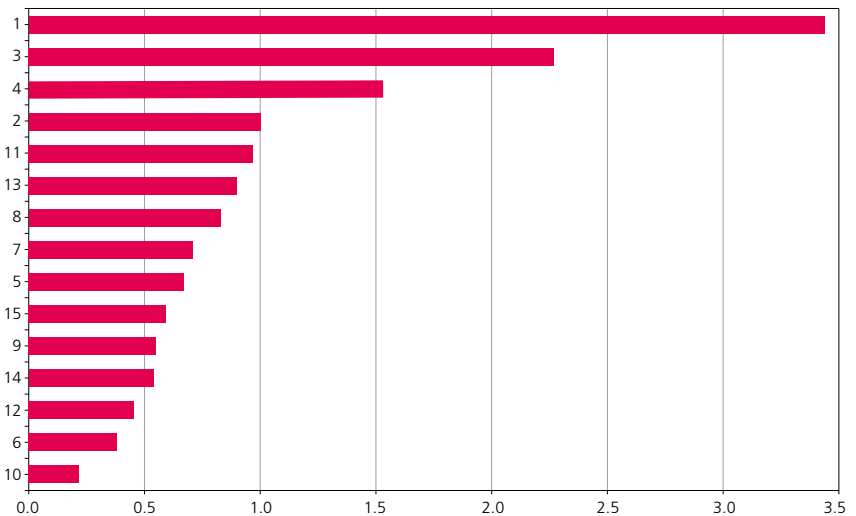
ICT Students Ratings			
#	Description	Importance	Achievement
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.56	2.86
3	Identify, formulate, analyse and resolve problems	3.46	2.78
11	Identify security threats and provide effective methods for information security	3.42	2.75
4	Stay committed to confidentiality and data safety	3.38	2.76
13	Efficient utilisation on resources	3.36	2.75
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	3.27	2.62
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	3.27	2.67
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	3.27	2.59
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	3.27	2.60
7	Assimilating emerging ICT technology with societal developments	3.18	2.55
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	3.18	2.63
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	3.16	2.61
5	Design of ICT systems, including modelling (formal description) of their structure and processes	3.12	2.65
10	Understand and create the documentation of ICT solutions	3.12	2.71
14	Train and support ICT Users	3.09	2.53



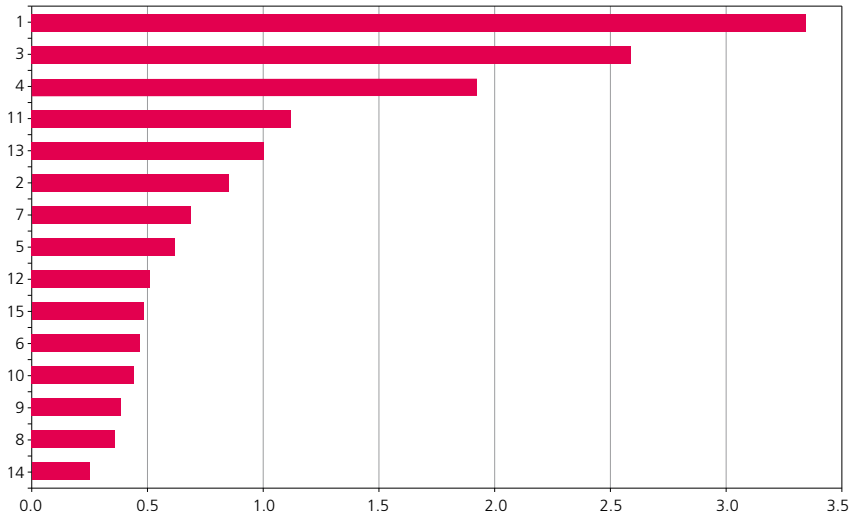
ICT Graduates Ratings			
#	Description	Importance	Achievement
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.62	2.66
4	Stay committed to confidentiality and data safety	3.59	2.69
3	Identify, formulate, analyse and resolve problems	3.51	2.61
11	Identify security threats and provide effective methods for information security	3.37	2.47
13	Efficient utilisation on resources	3.36	2.76
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	3.27	2.45
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	3.22	2.38
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	3.22	2.51

ICT Graduates Ratings			
#	Description	Importance	Achievement
5	Design of ICT systems, including modelling (formal description) of their structure and processes	3.21	2.51
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	3.19	2.36
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	3.18	2.41
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	3.11	2.51
14	Train and support ICT Users	3.10	2.35
10	Understand and create the documentation of ICT solutions	3.08	2.64
7	Assimilating emerging ICT technology with societal developments	3.06	2.31

Ranking

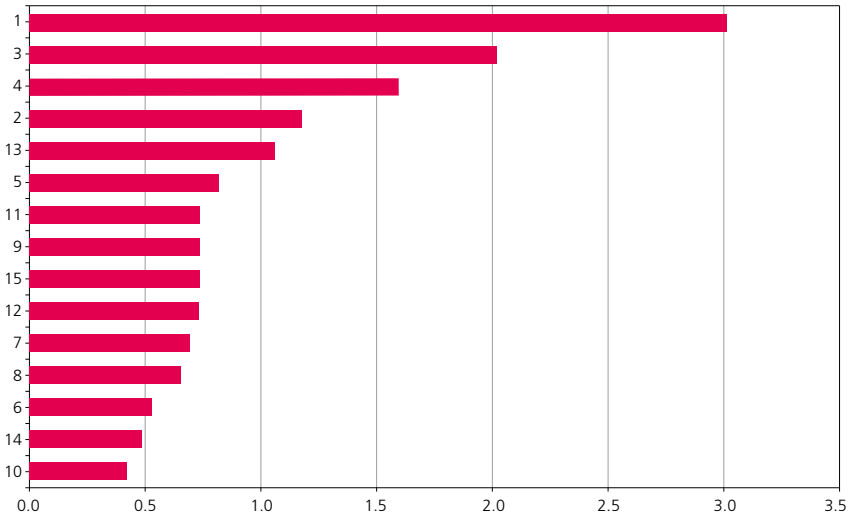


ICT Academics Ratings		
#	Description	Ranking
10	Understand and create the documentation of ICT solutions	0.21
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	0.38
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	0.45
14	Train and support ICT Users	0.54
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	0.55
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	0.59
5	Design of ICT systems, including modelling (formal description) of their structure and processes	0.67
7	Assimilating emerging ICT technology with societal developments	0.70
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	0.83
13	Efficient utilisation on resources	0.90
11	Identify security threats and provide effective methods for information security	0.97
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	1.00
4	Stay committed to confidentiality and data safety	1.53
3	Identify, formulate, analyse and resolve problems	2.27
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.44

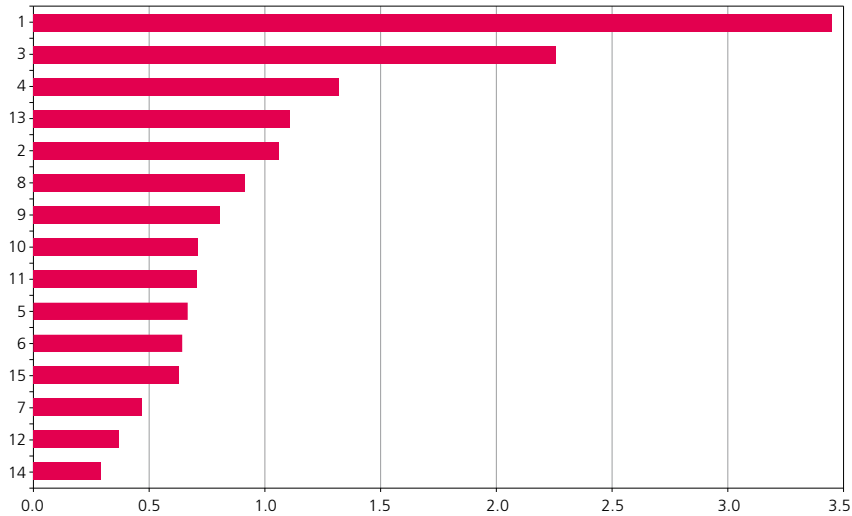


ICT Employers Ratings		
#	Description	Ranking
14	Train and support ICT Users	0.25
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	0.36
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	0.38
10	Understand and create the documentation of ICT solutions	0.44
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	0.47
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	0.48
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	0.51
5	Design of ICT systems, including modelling (formal description) of their structure and processes	0.62
7	Assimilating emerging ICT technology with societal developments	0.68

ICT Employers Ratings		
#	Description	Ranking
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	0.85
13	Efficient utilisation on resources	1.00
11	Identify security threats and provide effective methods for information security	1.12
4	Stay committed to confidentiality and data safety	1.92
3	Identify, formulate, analyse and resolve problems	2.59
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.34



ICT Students Rankings		
#	Description	Ranking
10	Understand and create the documentation of ICT solutions	0.42
14	Train and support ICT Users	0.48
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	0.53
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	0.65
7	Assimilating emerging ICT technology with societal developments	0.69
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	0.73
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	0.73
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	0.74
11	Identify security threats and provide effective methods for information security	0.74
5	Design of ICT systems, including modelling (formal description) of their structure and processes	0.82
13	Efficient utilisation on resources	1.06
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	1.18
4	Stay committed to confidentiality and data safety	1.59
3	Identify, formulate, analyse and resolve problems	2.02
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.01



ICT Graduates Rankings		
#	Description	Ranking
14	Train and support ICT Users	0.29
12	Undertanding and applying ethical, legal, economic and financial concepts (...)	0.37
7	Assimilating emerging ICT technology with societal developments	0.46
15	Knowledge of relevant quantitative methods and tools and demostrate their usage	0.63
6	Deploy, install, integrate, put into service and maintain ICT systems and their elements	0.64
5	Design of ICT systems, including modelling (formal description) of their structure and processes	0.67
11	Identify security threats and provide effective methods for information security	0.70
10	Understand and create the documentation of ICT solutions	0.71
9	Maintain the quality of ICT systems and substantiate it with research based methodologies	0.80

ICT Graduates Rankings		
#	Description	Ranking
8	Develop ICT systems in compliance with industry specifications, standards and recommendations	0.91
2	Identifying opportunities to remedy redundancy in organisations via the efficient and effective use of ICT solutions	1.06
13	Efficient utilisation on resources	1.11
4	Stay committed to confidentiality and data safety	1.32
3	Identify, formulate, analyse and resolve problems	2.26
1	Applying knowledge of mathematical principles, algorithms and computer sciences (...)	3.45

Correlations

Importance

	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.9184	1.0000		
Students	0.9147	0.8948	1.0000	
Graduates	0.8176	0.8511	0.8511	1.0000

Achievement

	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.8408	1.0000		
Students	0.6743	0.7455	1.0000	
Graduates	0.5385	0.6636	0.8357	1.0000

Ranking

	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.9689	1.0000		
Students	0.9814	0.9669	1.0000	
Graduates	0.9660	0.9394	0.9660	1.0000

5

Elaboration of Meta-Profiles

5.1. Meta-Profiles of ICT group

A meta-profile is the structure and combination of competencies that give identity to the subject area and is a mental construct that categorizes competencies into major recognized components and illustrates their interrelationship. Meta-profiles present an understanding of the core elements and their description and their identification and explanation in a readily understood and shared language. They offer the location, importance and weight of the different factors that make up the whole image. Figure 5.1 below shows the meta profile of the ICT group. Table 5.1 shows the meta profile description of the ICT group.

Table 5.2 shows the mapping of generic and specific competencies with meta profile clusters.

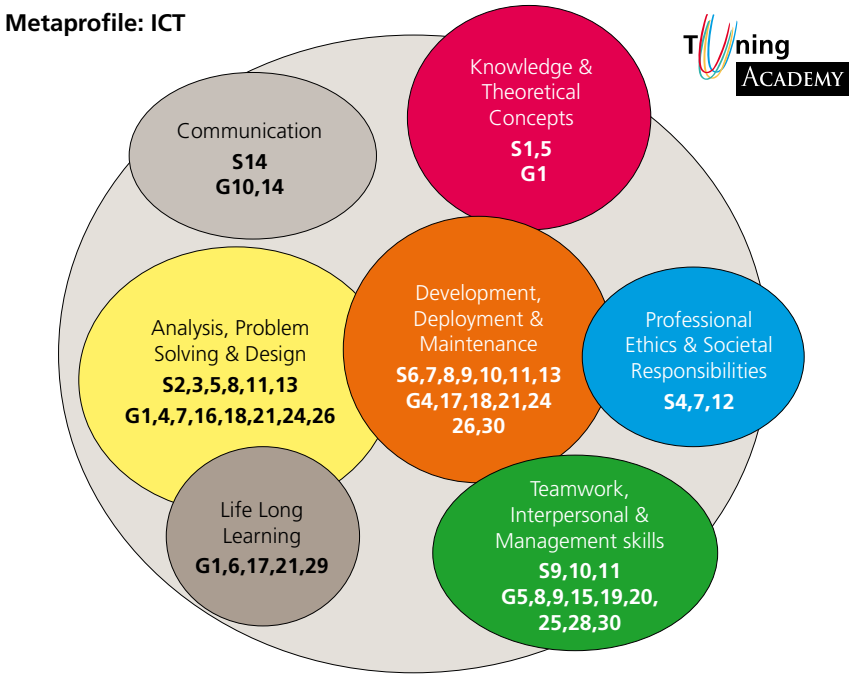


Figure 5.1
Metaprofile of ICT group

5.2. Meta-Profiles Descriptions of ICT group

Table 5.1
Metaprofile description for the ICT group

META PROFILE DESCRIPTION-ICT GROUP		
BASED ON SGM-II		
1	Knowledge & Theoretical Concepts	Acquisition of relevant principles, concepts & methods from mathematics, Computer Science, statistics and other allied disciplines and their applications to develop research capabilities.

META PROFILE DESCRIPTION-ICT GROUP		
BASED ON SGM-II		
2	Analysis, Problem Solving & Design	Developing the ability to apply the knowledge already acquired to formulate, analyze and model the solution for practical problems in an innovative manner. It should involve utilization of the available resources optimally so that the target is achieved in a secured manner, being also complaint with standards and specification.
3	Development, Deployment & Maintenance	Ability to develop ICT systems focused at satisfying customer requirement in an innovative manner so as to guarantee efficient resource utilization and information security, creating user manuals and deploying the system while maintaining the quality standards and providing training to the users besides upgrading the system with continuous research.
4	Communication	Acquire knowledge with an understanding of various tools of written and oral communication and demonstrate effective and unambiguous communication capabilities at different stages of ICT project including training and support for ICT users that simultaneously respects and appreciates diversity and multiculturalism.
5	Teamwork, Interpersonal & Management skills	Develop teamwork, interpersonal and managerial skills to optimize performance in various areas like quality assurance, documentation, security, decision making, self-help, confidence building, entrepreneurial spirit, leadership qualities, managerial skills, stress management, and goal oriented approach.
6	Professional Ethics & Societal Responsibilities	To learn and appreciate professional ethics and social responsibilities so that ICT solutions follow data safety and confidentiality norms, are assimilated to socio-cultural-environmental needs, apply ethical, legal, financial concepts to decision making, crisis management, self-help and provide equal opportunities and gender equality.
7	Lifelong learning	To continue education and training throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective

5.3. Mapping of Meta-Profiles with Generic and Specific Competences

The competencies whether general or specific has been mapped as per the recent ACM Computing Curriculum 2020 concept model, which is defined by

$$\text{Competency} = \text{Knowledge} + \text{Skills} + \text{Disposition}$$

where the Knowledge component answers "what", Skills is pertaining to "how", and Disposition refers to the "Why."

Table 5.2 shows mapping meta-profile with generic and specific competencies.

Table 5.2
Mapping meta-profiles with generic and specific competences

Clusters	Generic Competencies	Specific Competencies
Knowledge & Theoretical Concepts	G1: Ability to do research	S1: Applying knowledge of mathematical principles, algorithms and computer sciences to understand and solve problems
Analysis, Problem Solving & Design	G4: Ability to apply knowledge in practical situations G26: Ability to use available resources optimally and efficiently	S5: Design of ICT systems, including modelling (formal description) of their structure and processes S11: Identify security threats and provide effective methods for information security
Development, Deployment & Maintenance	G21: Be adaptable to emerging trends	S6: Deploy, install, integrate, put into service and maintain ICT systems and their elementes S8: Develop ICT systems in compliance with industry specifications, standards and recommendations
Communication	G14: Ability to communicate effectively	

Clusters	Generic Competencies	Specific Competencies
Teamwork, Interpersonal & Management skills	G9: Have good interpersonal skills G15: Ability to work as a team G28: Have organizational and managerial skills	
Professional Ethics & Societal Responsibilities		S12: Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage ICT projects
Lifelong learning	G6: Be a life-long learner	

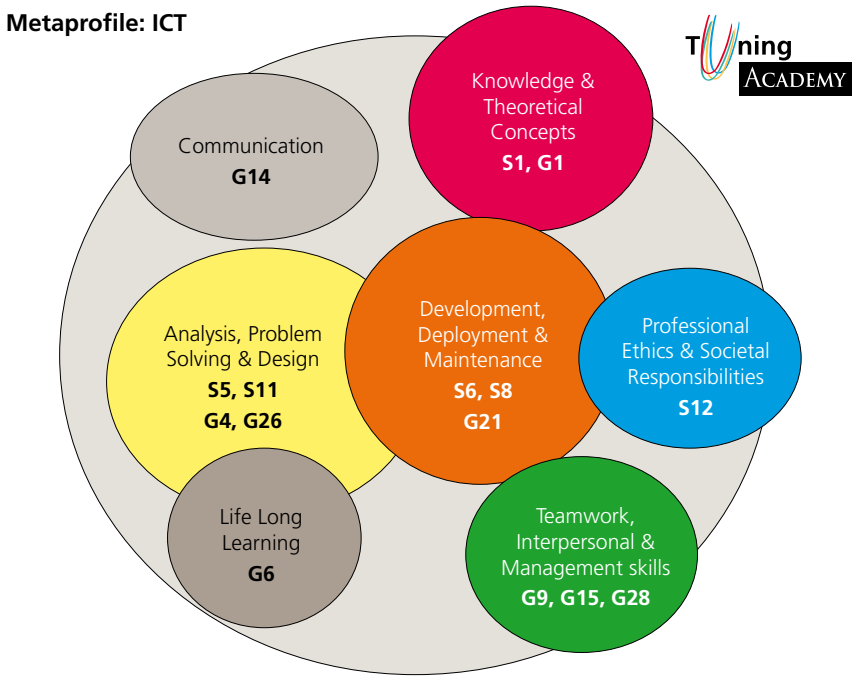


Figure 5.2
Metaprofile of ICT group with revised competences

6

Contrast of Meta-Profile at national level

The objective is to contrast the institutional current degree profile with the Meta-Profile agreed in Bilbao [2]. This process allows to reflect on the coincidences and differences and to start the institutional validation.

6.1. Description of the process followed

Table 1 shows the mapping of Program Outcomes (PO) and program specific outcomes (PSO) of Bachelor of Technology (Information Technology) with the Generic and Specific Competences of Meta Profile. This mapping is done in order to find similarities and differences between POs and PSOs with the Meta Profile. For this, first we have listed all courses and mapped it into Program Outcome and Program Specific Outcomes (PSO). Later, the mapping between Program Outcome and Program Specific Outcome (PSO) to the META Profile has been done.

Table 1
Mapping of POs and PSOs of Bachelor of Technology (Information Technology) with the Meta Profile

POs and PSOs of Bachelor of Technology (Information Technology)		Generic and Specific Competences
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	(S1) Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	(S15) Knowledge of relative quantitative methods and tools and demonstrate their usage.
		(G11) Ability to manage crisis effectively
PO3	Design / development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	(S3) Identify, formulate, analyse and resolve problems
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	(G4) Ability to apply knowledge in practical situations.
		(G7) Acquire problem solving capacity.
		(G18) Be innovative.

POs and PSOs of Bachelor of Technology (Information Technology)		Generic and Specific Competences
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	(S5)Design ICT systems, including modelling (formal description) of their structure and processes.
		(S8) Develop ICT systems in compliance with industry specifications, standards and recommendations.
		(G21) Be adaptable to emerging trends.
		(G16) Demonstrate higher order thinking skills (analytical, critical, abstract, creative)
		(G26)Ability to use available resources optimally and efficiently
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	(S7) Assimilating emerging ICT technology with societal developments.
		(G3) Be socially responsible and humane
		(G19) Ability to work independently in a responsible manner.
		(G23) Promote and ensure equal opportunities including gender issues.
		(G24) Adhere to and enhance quality standards
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	(S13) Efficient utilization of resources.

POs and PSOs of Bachelor of Technology (Information Technology)		Generic and Specific Competences
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	(S4) Stay committed to confidentiality and data safety.
		(S12) Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and merge ICT projects.
		(G2) Adhere to ethical principles
		(G12) Act within the legal framework
		(G13) Demonstrate environmental and economic consciousness.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	(G8) Ability to make reasoned decisions.
		(G10) Appreciate and respect diversity and multiculturism.
		(G15) Ability to work as a team.
		(G25) Demonstrate leadership qualities.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.	(S10) Understand and create the documentation of ICT solutions
		(G9) Have good interpersonal skills
		(G14) Ability to communicate effectively.
		(G22) Practice professionalism
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	(S2) Identifying opportunities in order to remedy redundancy in organizations via the efficient and effective use of ICT solutions.
		(G5) Ability to plan and manage time efficiently.
		(G28) Have organizational and managerial skills

POs and PSOs of Bachelor of Technology (Information Technology)		Generic and Specific Competences
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	(G1) Ability to do research
		(G6) Be a lifelong learner
		(G29) Be motivated for self-learning.
		(G30) Be goal-oriented.
PSO1	To identify, analyze and develop software systems using appropriate techniques and concepts related to information technology.	(S5) Design ICT systems, including modelling (formal description) of their structure and processes.
PSO2	To design an algorithm or process within realistic constraints to meet the desired needs through analytical, logical and problem-solving skills.	(S11) Identify security threats and provide effective methods for information security.
PSO3	To apply state of the art IT tools and technologies, IT infrastructure management abilities in treading innovative career path as a prospective IT engineer.	(S6) Deploy, install, integrate, put into service and maintain ICT systems and their elements.
		(S14) Train and support ICT users

6.2. Presentation of the degree profile of the University

Bachelor of Technology (Information Technology) degree program is of 4 years' duration comprising of 8 semesters. The courses of the program comprised of core and elective courses. The elective courses are offered during the 4th, 5th, 6th and 7th semesters. Students are assessed based on the 10-point grading system, which involves in-semester evaluation and end semester evaluation. During the final semester, i.e., the 8th semester, all students must go through 4 months' industry internship. During the internship period, they are evaluated twice: once after 2 months of internship to assess the progress made and secondly during end-semester evaluation after 4 months of internship. During the final assessment, a student submits a dissertation report, and a panel of experts conducts a viva-voce.

6.3. Coincidences with the meta-profile

Most of the competencies mentioned in the META-Profile (except G27-Ability to manage stress and maintain emotional stability) are mapped to program outcome and program-specific outcomes of Bachelor of Technology in Information Technology. It endorses that the academic program, Bachelor of Technology in Information Technology, offered at Manipal Institute of Technology, Manipal Academy of Higher Education (MAHE), Manipal, India, matches META-Profile requirements' requirement.

6.4. Differences with the meta-profile

One of the General Competency, G27 (Ability to manage stress and maintain emotional stability) does not precisely match with the Program Outcome and Program Specific Outcome of Bachelor of Technology in Information Technology.

6.5. People consulted and reflections

Members of the Department Curriculum Committee (DCC) were consulted for their inputs and reflection about mapping the department's current profile to the proposed META profile. They believe that the Department's existing profile matches most of the proposed META-profile requirements, except G27.

6.6. Profile adjustments / Profile suggested for the university

There is a mismatch in the current profile and the proposed META profile for one general competency, G27 (Ability to manage stress and maintain emotional stability). We have a counseling cell with a dedicated counselor who assists students in gaining confidence and managing stress, to become successful in their career.

6.7. Summary

With the mapping of proposed META-Profile to the program outcome, we conclude that the proposed META-Profile is in line with the current degree Bachelor of Technology (Information Technology).

7

Student Workload Reflection

7.1. Description of process followed

To estimate adequately, the workload required for students to achieve the learning outcomes specified in the curriculum, a special survey on students' workload at Indian universities has been conducted [3]. The process included the involvement of academics and students as the key groups of the study. The survey approximates the actual volume of work hours needed by a student to pass the unit / course / module from the teachers' planning and perception and students' opinion.

7.2. Data Editing, Cleaning & Checking and Consistency

The raw database went through the standard editing process of cleaning and checking for extreme, invalid or inconsistent values. Given the nature of the survey, where individuals were asked to give rough estimates referred to the number of hours devoted to different academic activities within different periods (semester, week), some inconsistencies and errors were to be expected. At the same time, and as it happens in many surveys, some questions were left unanswered sometimes or individuals assigned values that could be considered inconsistent. The process of data checking / cleaning was performed on each of the variables separately. Careful analysis was carried out observing the distribution of different variables to decide what could be considered inconsistent within each variable based on the analysis of outliers. As it could be expected, the number of outliers was higher among students than among academics.

7.3. Calculating Results

Results are displayed according to the four different areas divided into academics and students. The methodology implies that, to include a given academic institution in the final results, at least one value was requested for all courses constituting one given semester. Below are the survey results.

How many CONTACT HOURS* in total were you given to study this unit/course/module along the SEMESTER?

*Contact hours: the amount of time spent on training in contact with the teacher or other staff of the university in the study of a particular unit/course/module. It includes lectures, seminars, clinical practices, labs, project work and field work (supervised).

	How many CONTACT HOURS in total were you given to study above-mentioned unit/course/module along the SEMESTER? (in hours) (1)	
	Students	Academics
ICT	260.09	236.94

Academics

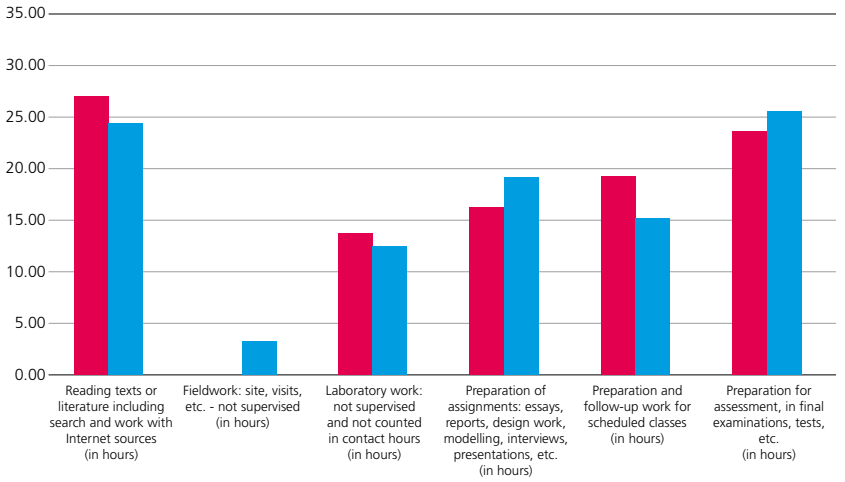
Specify the types of INDEPENDENT WORK you promote in the unit/course/module along the SEMESTER. Enter the estimated number of hours which in your opinion, should the student have in order to complete self-work on unit/course/module.

Students

Specify the types of INDEPENDENT WORK you use to learn the unit/course/module along the SEMESTER. Enter the estimated number of hours that you needed to complete self-work on unit/course/module.

	Reading texts or literature including search and work with Internet sources (in hours)		Fieldwork: site visits, etc. - not supervised (in hours)		Laboratory work: not supervised and not counted in contact hours (in hours)		Preparation of assignments: essays, reports, design work, modelling, interviews, presentations, etc. (in hours)		Preparation and follow-up work for scheduled classes (in hours)		Preparation for assessment, final examinations, tests, etc. (in hours)		Total independent work hours per semester (2)	
	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics
ICT	121.42	99.28	16.42	0.00	61.53	50.73	95.57	59.65	75.48	70.84	127.18	86.68	497.59	367.18

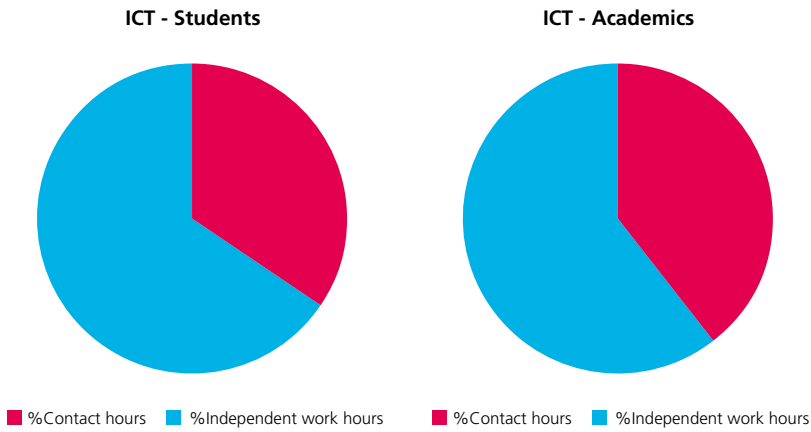
Total INDEPENDENT WORK to learn the unit/course/module along the SEMESTER (% distribution)



TOTAL NUMBER OF HOURS PER SEMESTER AS THE RESULT OF THE SUM OF THE PREVIOUS RESULTS

	How many CONTACT HOURS in total were you given to study above-mentioned unit/course/module along the SEMESTER? (in hours) (1)		Total indpendent work hours per semester (2)		Total = Contact (1) + Independent work (2)	
	Students	Academics	Students	Academics	Students	Academics
ICT	260.09	236.94	497.59	367.18	757.68	604.12

% Contact hours vs Independent Work



ICT

Academics

How many hours does an AVERAGE student need to complete all the requeriments of the unit/course/module in this SEMESTER (taking into account CONTACT HOURS and INDEPENDENT WORK)?

Students

How many hours did you spend in the SEMESTER to complete al the unit/course/module (taking into account CONTACT HOURS and INDEPENDENT WORK)?

	Students	Academics
ICT	523.23	524.05

Academics

How many hours per WEEK does an AVERAGE student study (both CONTACT HOURS and INDEPENDENT WORK) to complete all the requeriments of the unit/course/module?

Students

How many hours per WEEK did you spend (both CONTACT HOURS and INDEPENDENT WORK) to complete all the requeriments of the unit/course/module?

	Students	Academics
ICT	54.45	40.89

	%Academics saying YES to…		%Students saying YES to…	
	When planning the workload for your unit/course/module, do you consider necessary to include hours for independent work of students?	Do you take students' expectations and evaluation into consideration when planning the workload for the course?	Have you been aware of the number of hours planned for the students for independent work in the unit/course/module?	Has the professor guided you at the beginning of the unit/course/module on the necessary workload for each part of the independent work?
ICT	83.00	74.00	56.66	80.91

8

Some Examples of Revised / New Programmes

8.1. Brief University Profile

Manipal Academy of Higher Education (MAHE) is a private deemed university located in Manipal, India. The university also has campuses in Mangalore, Bangalore, Jamshedpur, Melaka and Dubai. MAHE traces its roots to Kasturba Medical College, the first self-funded medical college established in 1953. As of 2021, MAHE offers more than 350 programs across 30 disciplines.

8.2. Brief Program Profile

B.Tech in Information Technology is a four-year undergraduate program, which caters to the needs of the IT industry from across the world. The program is designed to produce qualified IT professionals who are experts in providing solutions to business requirements.

The entire program module comprises eight semesters where students learn introductory engineering courses like Basic Electronics, Basic Electrical Engineering and Programming Languages in the first two semesters; in the 3rd and 4th semesters, students learn core subjects like data structures, networking, database systems, etc., and elective courses are offered in 4th, 5th, 6th and 7th semesters

The Information Technology courses are delivered through classroom lectures and tutorials. The program adheres to the academic calendar

provided for each academic year by the institute. Laboratory courses very well support the theoretical studies. Industrial training is a mandatory course wherein the students undergo the real-time experience with complex engineering activities. Apart from all the said course delivery methods, the program also includes Project Work / Practice School courses, wherein the students' knowledge, skill and attitude are polished.

The theory-based courses are assessed generally through in-semester tests, assignments and end-semester examinations. Experience in solving open-ended problems is provided through the projects taken up by students in a few courses. The laboratory courses follow a continuous evaluation process. The students are evaluated based on the experiments conducted and the submitted report. The students are expected to demonstrate their experimentation skills, self-learning and achieve familiarity with appropriate tools in the laboratory courses.

The theory-based courses are assessed generally through in-semester tests, assignments, and end-semester examinations. Experience in solving open-ended problems is provided through the projects taken up by students in a few courses. The laboratory courses follow a continuous evaluation process. The students are evaluated based on the experiments conducted and the submitted report. The students are expected to demonstrate their experimentation skills, self-learning and achieve familiarity with appropriate tools in the laboratory courses. Different assessment tools are used to assess the Course Outcome. These are:

- Four surprise quizzes (5 marks each)
- Two sessional tests (15 marks each)
- End semester examination (50 marks)

Below is the sample template for evaluating the theory course.

Components	Quizzes	Sessional Tests	End Semester/ Make-up Examination
Duration	20 to 30 minutes	60 minutes	180 minutes
Weightage	20% (4* 5 Marks)	30% (2 *15 Marks)	50% (1*50 Marks)
Typology of Questions	Understanding / Comprehension; Application; Analysis; Synthesis; Evaluation	Knowledge/ Recall; Understanding/ Comprehension; Application	Understanding / Comprehension; Application; Analysis; Synthesis; Evaluation
Pattern	Answer one randomly selected question from the problem sheet. (Students can refer their class notes)	MCQ: 10 Questions (0.5 marks) Short Answers: 5 questions (2 marks)	Answer all 5 full questions of 10 marks each. Each question may have 2 to 3 parts of 3/4/5/6/7 marks.
Schedule	4, 7, 10, and 13th week of academic calendar.	Calendared activity	Calendared activity
Topics Covered	Assignment/Quiz 1 (L1-7 & T) (CO1,2)	Test 1 2 (L1-15 & T) (CO1,2)	Comprehensive examination covering full syllabus. Students are expected to answer all the questions.
	Assignment/Quiz 2 (L8-15 & T) (CO1,2)		
	Assignment/Quiz 3 (L16-24 & T) (CO1,2,3)	Test 2 (L16-27 & T) (CO1,2,3, 4)	
	Assignment/Quiz 4 (L25-34 & T) (CO1,2,4)		

9

Implementing Universities

9.1. Linking Degree Profile with Meta-Profile

The Information Technology program is NBA accredited and follows Outcome-Based Education (OBE). Table 8.2 shows program-level learning outcomes formulated with an action verb, content, and context. Program-level learning outcomes are measured using Course Outcomes (CO)s, where COs are calculated using different components like quizzes, sessional tests, and end semester examinations.

Table 9.1
Program Outcome (PO)s

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	To identify, analyze and develop software systems using appropriate techniques and concepts related to information technology.
PSO2	To design an algorithm or process within realistic constraints to meet the desired needs through analytical, logical and problem-solving skills.
PSO3	To apply state of the art IT tools and technologies, IT infrastructure management abilities in treading innovative career path as a prospective IT engineer

As a process of alignment, descriptions of Generic / Specific Competencies and Learning Outcomes at the program level are mapped and linked to the degree with the agreed meta-profile. Table 8.2 shows the mapping of Meta-profile with competencies and Program Level Learning outcomes.

Table 9.2
Mapping meta-profile, competancies and PLO's

Competence/ Dimensions of Meta-profile	Generic or Subject-Specifics	Definition of the competence – how is it understood in your programme	Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence)
1. **Knowledge & Theoretical Concepts** - Acquisition of relevant principles, concepts & methods from mathematics, Computer Science, statistics and other allied disciplines and their applications to develop research capabilities.	S1 G1	Apply knowledge of mathematical and computer science principles to solve complex engineering problems.	(PO1) Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Analysis, Problem Solving & Design** – Developing the ability to apply the knowledge already acquired to formulate, analyze and model the solution for practical problems in an innovative manner. It should involve utilization of the available resources optimally so that the target is achieved in a secured manner, being also complaint with standards and specification.	S5, S11 G4, G26	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	(PO2) Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (PO4) Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. (P05)Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (PSO2) To design an algorithm or process within realistic constraints to meet the desired needs through analytical, logical and problem-solving skills.

Competence/ Dimensions of Meta-profile	Generic or Subject-Specifics	Definition of the competence – how is it understood in your programme	Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence)
3. Development, Deployment & Maintenance – Acquire knowledge with an understanding of various tools of written and oral communication and demonstrate effective and unambiguous communication capabilities at different stages of ICT project including training and support for ICT users that simultaneously respects and appreciates diversity and multiculturalism.	S6, S8, G21	Design solutions for complex engineering problems in compliance with industry specifications, standards considering the public health and safety, and the cultural, societal, and environmental considerations.	**(PO3)** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (PSO1) To identify, analyze and develop software systems using appropriate techniques and concepts related to information technology. (PSO3) To apply state of the art IT tools and technologies, IT infrastructure management abilities in treading innovative career path as a prospective IT engineer.
4. Communication - Acquire knowledge with an understanding of various tools of written and oral communication and demonstrate effective and unambiguous communication capabilities at different stages of ICT project including training and support for ICT users that simultaneously respects and appreciates diversity and multiculturalism	G14	Communicate effectively on complex engineering activities to demonstrate unambiguous communication capabilities at different stages of ICT project	(**PO10)** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Competence/ Dimensions of Meta-profile	Generic or Subject-Specifics	Definition of the competence – how is it understood in your programme	Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence)
5. Interpersonal skills – Develop interpersonal skills to optimize performance in various areas like quality assurance, documentation, security, decision making, self-help, confidence building, entrepreneurial spirit, leadership qualities, managerial skills, stress management, and goal oriented approach.	G9, G15, G28	Function effectively in a team to take reasoned decisions and appreciate and respect diversity and multiculturism	(PO9) Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. (PO11) Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
6. Professional Ethics & Societal Responsibilities – To learn and appreciate professional ethics and social responsibilities so that ICT solutions follow data safety and confidentiality norms, are assimilated to socio-cultural-environmental needs, apply ethical, legal, financial concepts to decision making, crisis management, self-help and provide equal opportunities and gender equality.	S12	Apply ethical principles and commit to professional ethics and responsibilities so that ICT solutions follow data safety and confidentiality norms	(PO8) Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (PO6) Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. (PO7) Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Competence/ Dimensions of Meta-profile	Generic or Subject-Specifics	Definition of the competence – how is it understood in your programme	Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence)
7. Lifelong learning – To continue education and training throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective	G6	Be goal-oriented and recognize the need for, and have the preparation and ability to engage in life-long learning in the broadest context of technological change.	(PO12) Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Table 9.3

Mappig of courses with meta-profile clusters

		Cluster 1		Cluster 2				Cluster 3			Cluster 4				Cluster 5	Cluster 6
		G1	S1	G 4	G26	S5	S11	G21	S6	S8	G14	G9	G15	G28	S12	G6
MAT 2155	Mathematics - III		X													
ICT 2151	Data Structures			X	X	X										
ICT 2152	Digital Systems		X	X		X										
ICT 2155	Object Oriented Programming			X		X			X							
ICT 2156	Principles of Data Communication		X			X										
ICT 2161	Data Structures Lab					X			X							
		G1	S1	G4	G26	S5	S11		S6	S8	G14	G9	G15	G28	S12	G6
ICT 2162	Digital Systems Lab					X										
ICT 2163	Object Oriented Programming Lab					X			X							
MAT 2256	Mathematics - IV		X													
ICT 2251	Computer Network Protocols		X			X										

		Cluster 1		Cluster 2				Cluster 3			Cluster 4				Cluster 5	Cluster 6
		G1	S1	G4	G26	S5	S11		S6	S8	G14	G9	G15	G28	S12	G6
ICT 2252	Computer Organization and Microprocessor Systems		X			X										
ICT 2253	Design and Analysis of Algorithms		X	X		X										
ICT 2254	Operating Systems		X		X											
ICT 2261	Algorithms Lab					X										
ICT 2262	Microprocessor Systems Lab		X			X										
ICT 2263	Operating Systems Lab		X			X									X	
HUM 3052	Essentials of Management													X	X	
ICT 3151	Cyber Security	X	X				X									
		G1	S1	G4	G26	S5	S11		S6	S8		G9	G15	G28	S12	G6
ICT 3152	Database Systems		X			X										
ICT 3153	Embedded Systems		X			X										
ICT 3154	Software Engineering		X	X												
ICT 3161	Database Systems Lab					X				X						

		Cluster 1		Cluster 2				Cluster 3			Cluster 4				Cluster 5	Cluster 6
		G1	S1	G4	G26	S5	S11		S6	S8		G9	G15	G28	S12	G6
ICT 3162	Embedded Systems Lab		X			X										
ICT 3163	Network Programming and Simulation Lab					X			X							
HUM 3051	Engg. Economics and Financial Management				X							X		X		
ICT 3251	Data Warehousing and Data Mining		X			X										
ICT 3252	Distributed Systems		X													
ICT 3261	Advanced Technology Lab					X			X							
ICT 3262	Data Warehousing and Data Mining Lab					X										
ICT 3263	Internet Tools and Technology Lab								X	X						
ICT 4298	Industrial Training							X	X		X		X			
ICT 4299	Project work/Practice school					X		X			X					X

Table 9.4
Mapping meta profile with Course Outcomes

		Metaprofile						
Course (name and code)	**Course/paper learning outcomes**	**Custer 1**	**Custer 2**	**Custer 3**	**Custer 4**	**Custer 5**	**Custer 6**	**Custer 7**
Mathematics - III (MAT 2155)	CO1: Learn algebraic structures and their importance	X						
	CO2: Understand the combinatorial theory	X						
	CO3: Know the basic concept in graph theory vertices in a network.	X						
	CO4: Understand how to construct valid mathematical statements and arguments.	X						
Data Structures (ICT 2151)	CO1: Relate the concepts of arrays, dynamic memory management, class, searching, sorting		X					
	CO2: Illustrate the working of linear and non-linear data structure.		X					
	CO3: Apply the appropriate data structure to solve real world problems.		X					
Digital Systems (ICT 2152)	CO1: Identify the applications of various elements of digital system abstractions		X					
	CO2: Transform complex Boolean expressions using Boolean theorems, K-Map, tabulation methods.	X						
	CO3: Design combinational and sequential logic circuits.		X					
	CO4: Classify different memory devices of a computer		X					

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Object Oriented Programming (ICT 2153)	CO1: Develop simple applications using Java primitives		X					
	CO2: Implement OOP Concepts using JAVA		X					
	CO3: Use inbuilt library packages of JAVA		X					
	CO4: Develop Java application using object oriented concepts			X				
	CO5: Write simple concurrent programs using		X					
Principles of Data Communication (ICT 2154)	CO1: Outline the basics of data communication	X						
	CO2: Compute frame check sequence and error correction		X					
	CO3: Explain data link layer protocol	X						
	CO4: Compute the performance of media access	X						
Data Structures Lab (ICT 2161)	CO1: Identify suitable data structures for the given problem		X					
	CO2: Associate suitable searching and sorting techniques for the given data structure		X					
	CO3: Demonstrate the working of linear and non-linear data structure			X				
Digital Systems Lab (ICT 2162)	CO1: Interpret the working of a digital circuit		X					
	CO2: Design a digital logic circuit for a given problem by applying the principles of digital design		X					

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Object Oriented Programming Lab (ICT 2163)	CO1: Implement Object Oriented Programming Concepts		X					
	CO2: Use and create packages and interfaces, collections, implement exception handling			X				
	CO3: Implement string programs, use input/output streams, create		X					
Mathematics - IV (MAT 2256)	CO1: Discuss the relevance of probability in engineering problems.	X						
	CO2: Explain the concepts of random variable and probability distribution	X						
	CO3: Identify situation where different discrete probability distribution can be applied.	X						
	CO4: Use suitable continuous distributions to various situations.	X						
	CO5: Understand the measures of probability distributions, point estimations and interval estimations.	X						
Computer Network Protocols (ICT 2251)	CO1: Illustrate the proper usage of various protocols that has been used in the different layers of TCP/IP protocol suite	X						
	CO2: Interpolate the basic protocols of computer networks in network design and implementation	X						
	CO3: Apply various protocols to solve challenges in a given scenario		X					

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Computer Organization and Microprocessor Systems (ICT 2252)	CO1: Recall 8086 architecture	X						
	CO2: Write assembly language programs using development tools		X					
	CO3: Understand the interfacing of programmable devices to 8086 microprocessor	X						
	CO4: Understand the organization of various parts in computer system	X						
	CO5: Design building blocks of computer system	X						
Design and Analysis of Algorithms (ICT 2253)	CO1: Understand asymptotic notations to represent the complexities of algorithms	X						
	CO2: Understand the basic concepts of graph traversal methods	X						
	CO3: Apply various algorithm designing techniques for a given problem		X					
	CO4: Comprehend the basic concepts of trees and hashing techniques		X					
	CO5: Understand NP complete and NP hard problems	X						

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Operating Systems (ICT 2254)	CO1: Acquire detailed understanding of operating system functionalities	X						
	CO2: Apply the knowledge to solve issues in process as well as memory management		X					
	CO3: Able to understand the fundamental concepts of real time operating	X						
	CO4: Apply the knowledge to understand modern operating systems concepts	X						
Algorithms Lab (ICT 2261)	CO1: Implement an algorithm to find path between any two vertices in the given graph		X					
	CO2: Apply the knowledge of shortest path algorithms for real world problems.		X					
	CO3: Implement Greedy, Divide and Conquer, Dynamic Programming, Back tracking and Branch and Bound techniques to solve different problems.		X					
	CO4: Implement approximation algorithm for travelling sales person and vertex cover problem.		X					

		Metaprofile						
Course (name and code)	**Course/paper learning outcomes**	**Custer 1**	**Custer 2**	**Custer 3**	**Custer 4**	**Custer 5**	**Custer 6**	**Custer 7**
Microprocessor Systems Lab (ICT 2262)	CO1: Use assembly language development tool	X						
	CO2: Extend the knowledge of instruction set for writing efficient programs	X						
	CO3: Use subroutine concepts in programming		X					
	CO4: Write the programs using DOS interrupts		X					
	CO5: Apply the knowledge of advanced screen processing concepts		X					
Operating Systems Lab (ICT 2263)	CO1**:** Understand the working of UNIX based operating system	X						
	CO2**:** Illustrate the process management in operating systems.	X						
	CO3: Implement CPU scheduling as well as synchronization algorithms.		X					
	CO4: Implement algorithms used to understand the functionality of modern operating systems.		X					

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Essentials of Management (HUM 3052)	CO1: Make comparisons of project alternatives during the planning and implementation phases					X		
	CO2: Determine the future value of a payment made in the present						X	
	CO3: Distinguish the present value of a payment to be made in the future						X	
	CO4: Estimate the future value of periodic payments						X	
	CO5: Compare and contrast the interest rate required on an investment to achieve a future sum						X	
	CO6 : Compute the annual worth of proposed alternatives					X		
	CO7 : Describe the best time to replace an aging asset					X		
	CO8: Explain the best method of depreciation to minimize tax liability					X		
Cyber Security (ICT 3151)	CO1: Understand the basics of cyber security.	X						
	CO2: Evaluate attacks on operating system, network and web.		X					
	CO3: Analyze the existing vulnerabilities and propose solutions.		X					
	CO4: Examine real case studies of cyber security incidents and their mitigation.	X						

		Metaprofile						
Course (name and code)	**Course/paper learning outcomes**	**Custer 1**	**Custer 2**	**Custer 3**	**Custer 4**	**Custer 5**	**Custer 6**	**Custer 7**
Database Systems (ICT 3152)	CO1: Understand the database concepts.	X						
	CO2: Apply procedural and non-procedural language constructs to manage database system		X					
	CO3: Design database using data modelling tool and normalization concepts		X					
	CO4: Describe transaction management and concurrency control concepts	X						
	CO5: Interpret the unstructured databases	X						
Embedded Systems (ICT 3153)	CO1: Familiarise with the salient features of embedded systems	X						
	CO2: Illustrate the architecture of ARM Cortex-M microcontroller	X						
	CO3: Familiarise with the efficient software design for embedded systems		X					
	CO4: Outline software development for ARM Cortex-M microcontroller	X						
	CO5 : Design real world systems using ARM Cortex-M microcontroller		X					

		Metaprofile						
Course (name and code)	**Course/paper learning outcomes**	**Custer 1**	**Custer 2**	**Custer 3**	**Custer 4**	**Custer 5**	**Custer 6**	**Custer 7**
Software Engineering (ICT 3154)	CO1: Understand the basics of software development life cycle.	X						
	CO2: Understand the basic principles behind software configuration and risk management	X						
	CO3: Explore the importance of requirement analysis through scenario based exercise	X						
	CO4: Adapt software design strategies using object oriented concepts	X						
	CO5: Identify a suitable testing strategy to validate a given software application		X					
Database Systems Lab (ICT 3161)	CO1: Implement a graphical user interface (GUI) and access database through GUI using an integrated development environment.		X					
	CO2: Design, create and query the relational database using structured query language.		X					
	CO3: Demonstrate the working of procedural and non-procedural language.		X					
	CO4: Perform create, read, update and delete operations on MongoDB		X					
	CO5: Implement a mini project that provides solution to a real world problem.			X				

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Embedded Systems Lab (ICT 3162)	CO1: Recall the basics of an embedded system	X						
	CO2: Program an embedded system using ARM controller		X					
	CO3: Design, implement and test an embedded system.		X					
Network Programming and Simulation Lab (ICT 3163)	CO1: Implement client server socket programming			X				
	CO2: Simulate the network concepts using packet tracer.		X					
Engg. Economics and Financial Management (HUM 3051)	CO1: Understand the roles of mangers, principles of management, and managerial skills					X		
	CO2: Develop an organization structure and plan for manpower in a given business organization					X		
	CO3: Set objectives and propose strategies to accomplish them in a business					X		
	CO4: Apply leadership and motivational theories in the organizational context					X		
	CO5: Acquire budgetary skills		X					
	CO6: Understand the salient international business theories and practices					X		
	CO7: Prepare a business plan					X		

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Data Warehousing and Data Mining (ICT 3251)	CO1: Apply pre-processing techniques on datasets	X						
	CO2: Describe the data warehouse architecture for facilitating querying	X						
	CO3: Identify data mining techniques and apply on datasets		X					
	CO4: Identify web mining techniques		X					
Distributed Systems (ICT 3252)	CO1: Understand basic concepts of distributed systems	X						
	CO2: Understand various techniques used for communication between distributed systems	X						
	CO3: Analyze the requirements for designing distributed file system and shared memory	X						
	CO4: Understand the issues pertaining to coordination, consistency, fault tolerance for a distributed system	X						
	CO5: Identify the concepts of distributed system to design any distributed application	X						
Advanced Technology Lab (ICT 3261)	CO1: Recognize the emerging technology used in the software industry		X					
	CO2: Construct the database that interacts with the application		X					
	CO3: Develop the GUI for the application			X				
	CO4: Select the appropriate tools and techniques to implement application		X					

		Metaprofile						
Course (name and code)	Course/paper learning outcomes	Custer 1	Custer 2	Custer 3	Custer 4	Custer 5	Custer 6	Custer 7
Data Warehousing and Data Mining Lab (ICT 3262)	CO1: Identify suitable pre-processing techniques for various dataset		X					
	CO2: Develop data warehouse		X					
	CO3: Apply suitable data mining technique on pre-processed data		X					
Internet Tools and Technology Lab (ICT 3263)	CO1: Design and develop dynamic web pages with good aesthetic sense of designing and latest technical know-how's			X				
	CO2: Have a good understanding of Web Application Terminologies, Internet Tools other web services			X				
	CO3: Understand and implement the client and server side programming for a Web application using latest tools			X				
Industrial Training (ICT 4298)	CO1: Be acquainted with working environment at the Software Industries.				X	X		
	CO2: Be acquainted with processes that are in place at the Software Industries.			X				
	CO3: Familiarize the challenges as Software professionals.							X
	CO4: Effectively write a technical report.				X	X		

		Metaprofile						
Course (name and code)	**Course/paper learning outcomes**	**Custer 1**	**Custer 2**	**Custer 3**	**Custer 4**	**Custer 5**	**Custer 6**	**Custer 7**
Project Work / Practice School (ICT 4299)	CO1: Identify real world problems in the field of information and communication technology.							X
	CO2: Design methodologies with implementation.		X					
	CO3: Write technical report				X	X		
	CO4: Communicate effectively.				X	X		

10

Conclusion

Tuning India Project is introduced to contribute and support India's internationalization process by building a framework of comparable, compatible and transparent degree programs. This report gives the complete details of adapting Tuning Methodology to the Course Information Technology. Identification and generation of Competencies areas is one of the first steps in tuning methodology. Thirty generic and 15 specific competencies were defined in the initial stage. After the consultation with key stakeholders – employees, students, graduates and academic staff, generic competencies were narrowed downed to 9 and specific competencies were narrowed downed to 6. The term "META-PROFILING" is used to put all the competencies into a framework incorporating intangible attributes such as values and other generic, but critical outcomes.

With the mapping of the proposed META-Profile to the program outcome, we conclude that the proposed META-Profile aligns with the current degree of Bachelor of Technology (Information Technology).

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