



QQI

Quality and Qualifications Ireland
Dearbhú Cáilíochta agus Cáilíochtaí Éireann

AWARD STANDARDS - SCIENCE

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FOREWORD

The Qualifications (Education & Training) Act 1999 required the Higher Education and Training Awards Council to determine standards of knowledge, skill or competence to be acquired by learners “before a higher education and training award may be made”. These standards are based on the level indicators and award-type descriptors of the National Framework of Qualifications (NFQ, Appendix 2).

Standards for certain broad fields of learning were developed for awards at level 6 to level 9 on the NFQ. These standards represent an elaboration of the generic descriptors of the Framework. They should facilitate experts in particular fields of learning to create the link between their programmes’ intended learning outcomes and the NFQ. These standards are not programme specifications. It is through these, however, that the relationship between a programme, its component parts and the NFQ should be evident. The standards are a reference point and a point of comparison against which individual programmes may be justified.

They are intended to provide general guidance for articulating the learning outcomes associated with a particular field of learning. In designing programmes, providers must take cognisance of the standards for specific fields of learning where they generally relate to the programme being developed. It is, however, recognised that there is a significant growth in multi-disciplinary/inter-disciplinary programmes; there are emerging fields of learning; and in addition, within each field there is the vast spectrum of programmes possible, which range from highly practical to very theoretical.

In this context, it is not possible to have a standard, or multiple standards, that cater for the complete range of programmes possible. It is therefore expected that the standards for specific fields of learning will be used as reference points for the design of programmes.

In drafting the standards every effort has been made to ensure that they will provide for flexibility and variety in the design of programmes and therefore encourage innovation within an overall agreed framework. It is not expected that all programmes will include every learning outcome identified in a standard. It is, however, expected that many programmes will include learning outcomes that are not included in the relevant standard. When designing a programme, each learning outcome in the standard should be considered. Where departure from these is necessary, it should be justified in the context of the specific orientation of the programme and other facts pertaining to it. Each programme provider should be able to demonstrate how the design and content of its own programmes has been informed by the standard.

The level descriptors of the Framework, the award type descriptors and consequently the standards for the specific fields of learning are divided into three different types of learning outcomes - knowledge, skill and competence.

These strands are further subdivided (sub-strands). Each strand/sub-strand is important. The relative weighting of each strand in a programme will vary from programme to programme. The weighting will be determined by many factors, including for example, the practical nature of a programme, or otherwise. Each strand/sub-strand should be addressed appropriately in every programme. Where a programme is multi-disciplinary or inter-disciplinary in nature, the use of more than one standard may be necessary. In such cases, the scope, depth and balance of concepts and application should not result in the neglect of either the theoretical, or applied, at the expense of the other.

These standards were originally determined by the Higher Education and Training Awards Council in August 2005 and reissued with a new foreword by QQI in July 2014. They are QQI awards standards under section 84 (10) of the Qualifications (Education and Training) Act 2012.

Award Standards - Science

Knowledge				
	Level 6	Level 7	Level 8	Level 9
	The graduate should be able to demonstrate:	The graduate should be able to demonstrate:	The graduate should be able to demonstrate:	The graduate should be able to demonstrate:
Knowledge-Breadth	<i>Specialised knowledge of a broad area</i>	<i>Specialised knowledge across a variety of areas</i>	<i>An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning</i>	<i>A systematic understanding of knowledge, at, or informed by, the forefront of a field of learning</i>
	The learner is expected to have a good grounding in: <ul style="list-style-type: none"> a broadly-based scientific core basic mathematics elements of specialisation in a particular sub-field of science 	The learner is expected to have a good level of knowledge of: <ul style="list-style-type: none"> a broadly-based scientific core mathematics theory and understanding in a particular sub-field of science 	The learner is expected to have a detailed knowledge and understanding of: <ul style="list-style-type: none"> the essential facts, major concepts, principles and theories associated with a particular sub-field, or sub-fields of science 	The learner is expected to have a detailed knowledge and understanding of: <ul style="list-style-type: none"> the facts, concepts, principles, theories and methods associated with a specialisation, or a small number of specialisations in science
Knowledge-Kind	<i>Some theoretical concepts and abstract thinking, with significant underpinning theory</i>	<i>Recognition of limitations of current knowledge and familiarity with sources of new knowledge; integration of concepts across a variety of areas</i>	<i>Detailed knowledge and understanding in one or more specialised areas, some of it at the current boundaries of the field(s)</i>	<i>A critical awareness of current problems and/or new insights, generally informed by the forefront of a field of learning</i>
	The learner is expected to have a good grounding in: <ul style="list-style-type: none"> the terminology, nomenclature, and/or classification systems appropriate to the subject area the general principles of the subject area, including relevant concepts and theories basic methods and scientific techniques for acquiring, processing, analysing and presenting subject-specific information relevant legal, quality and regulatory frameworks 	The learner is expected to have a good level of knowledge in: <ul style="list-style-type: none"> the terminology, nomenclature, and/or classification systems appropriate to the subject area subject-specific theories, concepts and principles methods for acquiring, processing, interpreting and presenting subject-specific information the identification, definition and resolution of routine problems relevant legal, quality and regulatory frameworks current issues of concern to society and an appreciation of the ethical issues involved some aspect of the defining elements of the subject area as a result of individual study or research 	The learner is expected to have a detailed knowledge of: <ul style="list-style-type: none"> the terminology, nomenclature, and/or classification systems appropriate to the subject area the theories, paradigms, defining concepts and underlying principles of the subject area advanced methods for acquiring, interpreting and analysing subject-specific information, with a critical understanding of the appropriate contexts for their use through the study of texts and original papers the identification, definition and resolution of complex problems relevant legal and regulatory frameworks current issues of concern to society and an understanding of the philosophical and ethical issues involved some aspects of the defining elements of the subject area as a result of in-depth individual study or research the current knowledge and development of the subject area (including current limits of theoretical and applied knowledge) 	The learner is expected to have a detailed knowledge, experience and understanding of: <ul style="list-style-type: none"> the theories, paradigms, defining concepts and underlying principles of the research area advanced methods for acquiring, interpreting and analysing current research, with a critical awareness of the appropriate contexts for their use through the study of original papers, reports, journals and data sets the identification, definition and resolution of novel, complex, research problems relevant legal and regulatory frameworks aspects of the defining elements and the inter-relationships of the research area as a result of in-depth study and research the current limits of theoretical and applied knowledge of the specific research area

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Know-How & Skill-Range	<i>Demonstrate comprehensive range of specialised skills and tools</i>	<i>Demonstrate specialised technical, creative or conceptual skills and tools across an area of study</i>	<i>Demonstrate mastery of a complex and specialised area of skills and tools; use and modify advanced skills and tools to conduct closely guided research, professional or advanced technical activity</i>	<i>Demonstrate a range of standard and specialised research or equivalent tools and techniques of enquiry</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • apply a range of broadly-based scientific laboratory skills to perform routine tasks accurately • select, gather and record data accurately • work to set targets • operate a range of laboratory and other relevant equipment safely • apply basic numerical and statistical analysis skills • maintain basic records of activities • present scientific results to peers • use standard computer-based office applications 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • apply knowledge and understanding to address familiar problems in a scientific work setting • employ data analysing, synthesising and summarising skills in a scientific work setting • source, interpret and apply appropriate and referenced literature from a specific scientific area • work independently within defined time boundaries • operate a broad range of laboratory and other relevant equipment safely • apply numerical and statistical analysis skills • maintain detailed records of activities. • communicate scientific information in a variety of forms to specialist audiences 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • solve complex technical problems • employ advanced data analysing, synthesising and summarising skills in a scientific work setting • source, interpret and apply appropriate and referenced literature and other information sources • work independently within defined time and resource boundaries • effectively and safely operate a range of complex laboratory and other relevant equipment • apply advanced numerical and statistical analysis skills • maintain detailed records of activities • communicate scientific information in a variety of forms to specialist and nonspecialist audiences • design a relevant programme of investigation 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • proactively troubleshoot and solve original technical problems • employ appropriate advanced data analysing, synthesising and summarising skills in a scientific research environment • source relevant information, critically interpret and apply appropriate referenced literature from a wide range of information sources • apply relevant numerical and statistical analysis skills • maintain detailed records of activities • present and defend scientific research findings in a variety of forms to specialists and non-specialists • formulate a hypothesis and design a relevant programme of investigation • write accurately and in a manner consistent with scientific publications in a particular sub-field of science
Know-How & Skill-Selectivity	<i>Formulate responses to well-defined abstract problems</i>	<i>Exercise appropriate judgement in planning, design, technical and/or supervisory functions related to products, services, operations or processes</i>	<i>Exercise appropriate judgement in a number of complex planning, design, technical and/or management functions related to products, services, operations or processes, including resourcing</i>	<i>Select from complex and advanced skills across a field of learning; develop new skills to a high level, including novel and emerging techniques</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • respond to problems and opportunities that are likely to be encountered by a technician, working in a structured and managed environment • participate in the day-to-day operations of a scientific industry, or other scientific work setting • assess and optimise the performance of scientific equipment 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • identify and implement solutions to problems relating to scientific processes in a logical manner • appreciate the views of others • participate fully in the day-to-day operations of a scientific industry, or other scientific work setting • make decisions in relation to a controlled environment • test simple hypotheses • appreciate limits of knowledge in a scientific area 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • think independently and make effective decisions • recognise and respect the views of others • contribute fully to the day-to-day operations of a scientific industry, or other scientific work setting • make decisions in relation to a complex, or highly regulated environment • formulate and test hypotheses • appreciate limits of knowledge in a scientific area and respond appropriately. 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> • think independently and make informed effective decisions • select from a range of routine and specialised scientific skills to apply the most appropriate in a range of situations • make decisions in relation to a complex, or highly regulated work setting • design, develop and test novel hypotheses • learn new skills with ease, either independently from scientific papers, or with minimal instruction

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Competence-Context	<i>Act in a range of varied and specific contexts involving creative and nonroutine activities; transfer and apply theoretical concepts and/or technical or creative skills to a range of contexts</i>	<i>Utilise diagnostic and creative skills in a range of functions in a wide variety of contexts</i>	<i>Use advanced skills to conduct research, or advanced technical or professional activity, accepting accountability for all related decision making; transfer and apply diagnostic and creative skills in a range of contexts</i>	<i>Act in a wide and often unpredictable variety of professional levels and illdefined contexts</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> follow documented scientific procedures and approved validation and quality assurance procedures to accurately gather, record and process technical information follow documented scientific procedures to perform routine tasks in structured/managed work settings behave responsibly in a work setting work in accordance with current health and safety regulations 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> analyse and generate data, diagnose and trouble-shoot technical problems and contribute to their resolution in a range of structured work settings use scientific skills to accurately perform tasks behave professionally in a range of structured work settings 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> use advanced scientific skills to critically interpret existing knowledge and apply in new situations make and report appropriate decisions and take responsibility for such decisions behave ethically, in a range of work settings present and engage in debate relating to general scientific issues 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> apply advanced research skills, constructively criticise, draw conclusions and offer recommendations within the particular sub-field act autonomously and think independently formulate and communicate judgements, with incomplete or limited information
Competence-Role	<i>Exercise substantial personal autonomy and often take responsibility for the work of others and/or for allocation of resources; form, and function within, multiple complex and heterogeneous groups</i>	<i>Accept accountability for determining and achieving personal and/or group outcomes; take significant or supervisory responsibility for the work of others in defined areas of work</i>	<i>Act effectively under guidance in a peer relationship with qualified practitioners; lead multiple, complex and heterogeneous groups</i>	<i>Take significant responsibility for the work of individuals and groups; lead and initiate activity</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> contribute effectively and participate in a science based team participate and contribute constructively in a structured team environment across core scientific disciplines be self-directed in terms of time, motivation and planning and be self-aware and be open and sensitive to others accept and exercise personal responsibility work under guidance within allocated responsibility work individually on routine tasks 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> take direction, accept criticism and use feed-back to enhance own performance participate in a structured team environment across a range of scientific disciplines be self-directed in terms of time, motivation and planning and be self-aware and be open and sensitive to others work with significant autonomy within allocated responsibility work individually on complex tasks exercise independent technical judgement develop a personal work plan accept responsibility for own work 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> plan for effective project implementation and manage the organisation of tasks, people and resources participate constructively in a complex team environment within a scientific field reflect on own practices accept responsibility for the work of self and others develop and train staff to meet changing technical needs 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> lead multidisciplinary teams develop novel technical solutions

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Competence-Learning to Learn	<i>Learn to evaluate own learning and identify needs within a structured learning environment; assist others in identifying learning needs</i>	<i>Take initiative to identify and address learning needs and interact effectively in a learning group</i>	<i>Learn to act in variable and unfamiliar learning contexts; learn to manage learning tasks independently, professionally and ethically</i>	<i>Learn to self-evaluate and take responsibility for continuing academic/professional development</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> demonstrate familiarity with the principles of self-directed learning evince a commitment to continuing education and lifelong learning 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> demonstrate an ability for autonomous, independent learning identify gaps in personal knowledge, understanding and skills and identify appropriate means of gain these attributes evince a commitment to continuing education and lifelong learning take appropriate action to remain aware of industrial, regulatory and societal change, which will impact on chosen specialisation 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> identify knowledge gaps and source and undertake self-learning to fill the gaps demonstrate an awareness of the need for enhanced technical competencies and continuing professional development evince a commitment to continuing education and lifelong learning 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> identify knowledge gaps and source and undertake self-learning to fill the gaps
Competence-Insight	<i>Express an internalised, personal world view, reflecting engagement with others</i>	<i>Express an internalised, personal world view, manifesting solidarity with others</i>	<i>Express a comprehensive, internalised, personal world view, manifesting solidarity with others</i>	<i>Scrutinise and reflect on social norms and relationships and act to change them</i>
	<p>The learner will be able to:</p> <ul style="list-style-type: none"> demonstrate an awareness of relevant social and ethical issues 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> discuss relevant scientific issues in a social, cultural and economic context promote science and technology to the general public demonstrate an awareness of current issues of concern to society and an appreciation of the ethical issues involved 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> develop a capacity for social responsibility contribute to the development of the role of the scientist in society demonstrate the capacity to draw complex information together and present in an understandable format demonstrate the capacity to acknowledge the current issues of concern to society and an understanding of the philosophical and ethical issues involved demonstrate a questioning attitude to the assumptions, both overt and covert, underlying modern science 	<p>The learner will be able to:</p> <ul style="list-style-type: none"> identify and articulate the key considerations of a problem critically comment on the technical, economic, environmental and social implications of own work and work of others draw complex information together and extract policy implications

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APPENDIX 1

National Framework of Qualifications - Grid of Level Indicators

	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
Knowledge - Breadth	Elementary knowledge	Knowledge that is narrow in range	Knowledge moderately broad in range	Broad range of knowledge	Broad range of knowledge	Specialised knowledge of a broad area	Specialised knowledge across a variety of areas	An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning	A systematic understanding of knowledge, at, or informed by, the forefront of a field of learning	A systematic acquisition and understanding of a substantial body of knowledge which is at the forefront of a field of learning
Knowledge - Kind	Demonstrable by recognition or recall	Concrete in reference and basic in comprehension	Mainly concrete in reference and with some comprehension of relationship between knowledge elements	Mainly concrete in reference and with some elements of abstraction or theory	Some theoretical concepts and abstract thinking, with significant depth in some areas	Some theoretical concepts and abstract thinking, with significant underpinning theory	Recognition of limitations of current knowledge and familiarity with sources of new knowledge; integration of concepts across a variety of areas	Detailed knowledge and understanding in one or more specialised areas, some of it at the current boundaries of the field(s)	A critical awareness of current problems and/or new insights, generally informed by the forefront of a field of learning	The creation and interpretation of new knowledge, through original research, or other advanced scholarship, of a quality to satisfy review by peers
Know-how and skill - Range	Demonstrate basic practical skills, and carry out directed activity using basic tools	Demonstrate limited range of basic practical skills, including the use of relevant tools	Demonstrate a limited range of practical and cognitive skills and tools	Demonstrate a moderate range of practical and cognitive skills and tools	Demonstrate a broad range of specialised skills and tools	Demonstrate comprehensive range of specialised skills and tools	Demonstrate specialised technical, creative or conceptual skills and tools across an area of study	Demonstrate mastery of a complex and specialised area of skills and tools; use and modify advanced skills and tools to conduct closely guided research, professional or advanced technical activity	Demonstrate a range of standard and specialised research or equivalent tools and techniques of enquiry	Demonstrate a significant range of the principal skills, techniques, tools, practices and/or materials which are associated with a field of learning; develop new skills, techniques, tools, practices and/or materials
Know-how and skill - Selectivity	Perform processes that are repetitive and predictable	Perform a sequence of routine tasks given clear direction	Select from a limited range of varied procedures and apply known solutions to a limited range of predictable problems	Select from a range of procedures and apply known solutions to a variety of predictable problems	Evaluate and use information to plan and develop investigative strategies and to determine solutions to varied unfamiliar problems	Formulate responses to well-defined abstract problems	Exercise appropriate judgement in planning, design, technical and/or supervisory functions related to products, services, operations or processes	Exercise appropriate judgement in a number of complex planning, design, technical and/or management functions related to products, services, operations or processes, including resourcing	Select from complex and advanced skills across a field of learning; develop new skills to a high level, including novel and emerging techniques	Respond to abstract problems that expand and redefine existing procedural knowledge
Competence - Context	Act in closely defined and highly structured contexts	Act in a limited range of predictable and structured contexts	Act within a limited range of contexts	Act in familiar and unfamiliar contexts	Act in a range of varied and specific contexts, taking responsibility for the nature and quality of outputs; identify and apply skill and knowledge to a wide variety of contexts	Act in a range of varied and specific contexts involving creative and non-routine activities; transfer and apply theoretical concepts and/or technical or creative skills to a range of contexts	Utilise diagnostic and creative skills in a range of functions in a wide variety of contexts	display mastery Use advanced skills to conduct research, or advanced technical or professional activity, accepting accountability for all related decision making; transfer and apply diagnostic and creative skills in a range of contexts	Act in a wide and often unpredictable variety of professional levels and ill defined contexts	Exercise personal responsibility and largely autonomous initiative in complex and unpredictable situations, in professional or equivalent contexts
Competence - Role	Act in a limited range of roles	Act in a range of roles under direction	Act under direction with limited autonomy; function within familiar, homogeneous groups	Act with considerable amount of responsibility and autonomy	Exercise some initiative and independence in carrying out defined activities; join and function within multiple, complex and heterogeneous groups	Exercise substantial personal autonomy and often take responsibility for the work of others and/or for the allocation of resources; form, and function within, multiple, complex and heterogeneous groups	Accept accountability for determining and achieving personal and/or group outcomes; take significant or supervisory responsibility for the work of others in defined areas of work	Act effectively under guidance in a peer relationship with qualified practitioners; lead multiple, complex and heterogeneous groups	Take significant responsibility for the work of individuals and groups; lead and initiate activity	Communicate results of research and innovation to peers; engage in critical dialogue; lead and originate complex social processes
Competence - Learning to Learn	Learn to sequence learning tasks; learn to access and use a range of learning resources	Learn to learn in a disciplined manner in a well-structured and supervised environment	Learn to learn within a managed environment	Learn to take responsibility for own learning within a supervised environment	Learn to take responsibility for own learning within a managed environment	Learn to evaluate own learning and identify needs within a structured learning environment; assist others in identifying learning needs	Take initiative to identify and address learning needs and interact effectively in a learning group	Learn to act in variable and unfamiliar learning contexts; learn to manage learning tasks independently, professionally and ethically	Learn to self-evaluate and take responsibility for continuing academic/professional development	Learn to critique the broader implications of applying knowledge to particular contexts
Competence - Insight	Begin to demonstrate awareness of independent role for self	Demonstrate awareness of independent role for self	Assume limited responsibility for consistency of self-understanding and behaviour	Assume partial responsibility for consistency of self-understanding and behaviour	Assume full responsibility for consistency of self-understanding and behaviour	Express an internalised, personal world view, reflecting engagement with others	Express an internalised, personal world view, manifesting solidarity with others	Express a comprehensive, internalised, personal world view manifesting solidarity with others	Scrutinise and reflect on social norms and relationships and act to change them	Scrutinise and reflect on social norms and relationships and lead action to change them

Note: The outcomes at each level include those of all the lower levels in the same sub-strand



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