Ergonomics /Human Factors education in United Kingdom

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Abstract. This paper presents a summary of the Ergonomics and Human Factors (EHF) professional accreditation process in the UK. EHF education can be accredited by the Chartered Institute of Ergonomics and Human Factors (CIEHF) as qualifying courses and as short (training) courses. A framework is used as professional competencies (5 units) with expected levels of proficiency to support career development through membership grades (student, graduate, registered, fellow). An example of education is given with the 5 postgraduate programmes (MSc, Postgraduate Diploma, Postgraduate Certificate) at Loughborough University: Ergonomics and Human Factors, Human Factors in Transport. Human Factors for Inclusive Design, Ergonomics in Health and Community Care, and Human Factors and Ergonomics for Patient Safety. Finally, an opportunity is offered to explore competency with an affiliate discipline (Unser Experience) in the context of usability testing for medical devices.

Keywords: Education, Competency, Accreditation

1   Introduction

The Chartered Institute of Ergonomics & Human Factors (CIEHF) is both the professional membership body and regulator for Ergonomics and Human Factors (EHF) in the UK. Professional behaviour in EHF is guided by a Code of Professional Conduct [1] and managed by the Professional Affairs Board (PAB). The PAB leads the establishment, promotion and maintenance of high standards of professional knowledge, practice and conduct in EHF in accordance with the Charter, Byelaws, General and Council Regulations, and under the policy direction of the CIEHF Council.

To address the complexity of the accreditation function, and develop a cross-cutting system, the CIEHF professional competencies [2] were reviewed and revised in 2016. An extensive project was undertaken to both simplify systems (reducing from 9 units as IEA [3] to 5 competencies) and provide a foundation for widening the reach of CIEHF accreditation to support interest from affiliate disciplines.

There are 5 universities (Fig. 1) offering qualifying courses at postgraduate (MSc) level. These can be studied full-time, part-time (usually over 3 years) and are available I [4] n 3 formats: distance learning, week block modules, weekly lectures (over 11-15 weeks).

- Heriot Watt University
  – MSc Human Factors
- Loughborough University
  – MSc Ergonomics and Human Factors,
  – MSc Human Factors in Transport
  – MSc Human Factors for Inclusive Design
  – MSc Ergonomics in Health and Community Care
  – MSc Human Factors and Ergonomics for Patient Safety
- University of Derby
  – MSc Health Ergonomics through online learning
  – MSc Ergonomics (Human Factors) through online learning
  – MSc Ergonomics and Organisational Behaviour through online learning
  – MSc Behaviour Change
- University College London
  – MSc Human-Computer Interaction with Ergonomics,
- University of Nottingham
  – MSc Human Factors & Ergonomics,
  – MSc Applied Ergonomics by distance learning

Fig. 1. Postgraduate Education in UK for EHF Qualifying Courses

2　　Professional competency

A checklist of the CIEHF professional competencies (Table 1) has been developed as both an applicant guide to expected competencies for qualification as an EHF specialist and also for assessment of applications. It is used as a cross-cutting assessment platform across CIEHF professional activities for accreditation of degree courses, short training courses, membership applications, continuing professional development etc.

Table 1. Professional Competencies (UK)

1. Ergonomics/Human Factors (E/HF) principles
1 Ability to identify and apply methods of analysis, evaluation and validation with respect to human interfaces for tasks, activities and environments.
1.1 Understands the role and application of E/HF principles in optimising system performance and wellbeing across all ages and capabilities.
1.2 Demonstrates ability to enhance health, safety, comfort, quality of life, attitudes, motivation, usability, effectiveness and efficiency.
1.3 Demonstrates ability to identify potential and existing high risk tasks, activities and environments.

2. Ergonomics/Human Factors (E/HF) theory and practice

2.1 Understands theoretical and practice bases for analysis of human interactions.

2.1a Demonstrates use of E/HF theories, methods and tools for analysis of systems (including process), tasks, workload (physical and mental) including mental models, communication and anthropometry.

2.2 Understands the theoretical and practice bases for (re)design of human interfaces (physical and mental).

2.2a Understands the influence of such factors as a person's body size, skill, cognitive abilities, age, sensory capacity, general health and experience.

2.2b Demonstrates ability to integrate E/HF principles and concepts into systems, interface and product design including requirements development and validation.

2.2c Evaluates user needs for safety, efficiency, reliability, ease of use.

2.2d Determines the match and the interaction between human characteristics, abilities, capacities and motivations, and the system(s), organisation, planned or existing environment, products used, equipment, work systems, machines and tasks

2.2e Understands the management of E/HF risks, including priorities and mitigations; potential benefits and costs of E/HF solutions; short and long term goals relevant to defined problems.

2.2f Can apply relevant legislation, codes of practice, standards (government and industry).

2.2g Determines whether the interface or interaction is amenable to E/HF intervention.

2.3 Understands the theoretical and practice bases for data collection and analysis relating to E/HF.

2.3a Understands the type of quantitative and qualitative data required for E/HF appraisal and design; selects and validates the proposed collection/analysis methods and tools.

2.3b Understands and can apply the basics of experimental design and statistics.

2.3c Understands and can apply the basics of qualitative study design and analysis including knowledge elicitation, interviews, document analysis, and observation.

2.3d Demonstrates ability to seek and obtain relevant ethical approval for E/HF data collection and analysis.

3. Human capabilities and limitations

3.1 Understands the theoretical and practice bases for E/HF relating to Physical capabilities and limitations.

3.1a Demonstrates a working knowledge of anatomy, functional anatomy, anthropometry, physiology, pathophysiology, and environmental sciences as they apply to E/HF practice.

3.1b Can apply knowledge of biomechanics, anthropometry, motor control, energy, forces applied as they relate to stresses and strains produced in the human body.

3.1c Understands the effects of the environment (including acoustic, thermal, visual, vibration) and individual sensory response (sight, hearing, touch, taste, smell) on human health and performance.

3.2 Understands the theoretical and practice bases for E/HF relating to Psychological and Social capabilities and limitations.

3.2a Understands theoretical concepts and principles of social and psychological sciences relevant to E/HF.

3.2b Recognises psychological characteristics and responses and how these affect health, human performance, attitudes, perception; stress; human reliability and error

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3.2c Can apply knowledge of Human Information Processing (including situation awareness, memory, decision making)

3.2d Demonstrates a knowledge of systems theory including socio-technical systems and culture (e.g. organisational and safety culture).

3.2e Understands the principles of group functioning, motivation, engagement and participation.

3.2f Understands the principles of organisational management including individual, group (team) and organisational change techniques, including training and work structuring.

4. Design and development of systems including products, tasks, jobs, organisations and environments

4.1 Understands the theoretical and practice bases for E/HF relating to design and development of systems.

4.1a Understands basic engineering (technology) concepts, with a focus on design solutions and contextual operation of technologies.

4.1b Demonstrates an understanding of the principles of E/HF and human-machine interface technology including hardware, software, internet and network based technologies and social media.

4.1c Understands the requirements for safety systems, the concepts of risk, risk assessment and risk management.

4.2 Utilises a systems approach to the human-aspects of the specification, design, assessment and acceptance of products, services and human factors interventions.

4.2a Applies E/HF principles to design of systems (and services), products, job aids, controls, displays, instrumentation and other aspects of tasks and activities.

4.2b Understands the iterative nature of design development including simulation and computer modelling.

4.2c Considers the options for achieving a balance between human and technological, task and environment to achieve optimal system.

4.2d Selects appropriate forms of E/HF solutions and recommendations, based on theoretical knowledge and practice and develops a comprehensive, integrated and prioritised approach.

5. Professional skills and implementation

5.1 Understands role of E/HF in change strategies.

5.1a Provides design specifications and guidelines for technological, organisational and E/HF design or redesign of the work process, the activity and the environment which match the findings of E/HF analysis.

5.1b Develops strategies to introduce a new design to achieve a healthy and safe human interaction.

5.1c Recognises the safety hierarchy, application of primary and secondary controls and the order of introducing controls.

5.1d Recommends personnel selection where appropriate as part of a balanced solution to the defined problem.

5.1e Interacts effectively to clients at all levels of personnel.

5.2 Develops appropriate recommendations for education and training in relation to E/HF principles.

5.2a Understands current concepts of education and training relevant to application of E/HF principles.

5.2b Implements effective education and training programmes relevant to understanding the introduction of E/HF measures.

5.3 Supervises the application and evaluation of the E/HF plan.

5.3a Implements appropriate design or modifications.

5.3b Incorporates methods to allow continuous improvement.

5.3c Selects appropriate criteria for evaluation.

5.3d Produces clear, concise, accurate and meaningful records and reports.

5.4 Shows a commitment to ethical practice and high standards of performance and acts in accordance with legal requirements.

5.4a Behaves in a manner consistent with accepted codes and standards of professional behaviour.

5.4b Recognises the scope of personal ability for E/HF analysis and when it is necessary to consult and collaborate with different professional experts.

5.4c Demonstrates commitment to ongoing professional development by maintaining skill set and an awareness of wider E/HF practice.

CIEHF-accredited 'Qualifying' degree courses are assessed against the professional competency checklist with accreditation renewal every 5 years (as a new application). The Degree courses provide learning for every listed competency and successful students (graduates) should have at least an awareness of every competency (proficiency level 1-3). As new Ergonomists (Graduate) career progresses and experience increases, the level of proficiency will increase through the 6 levels of competency. The level of proficiency in each competency will depend on experience, seniority and individual career paths as no-one is expected to become 'Expert' in all competencies.

0. **Unaware**: No knowledge or understanding of this competency.
1. **Aware**: Knowledge or an understanding of basic techniques and concepts particular competency for a particular competency.
2. **Novice**: Limited experience gained in a classroom and/or as a trainee on-the-job for a particular competency; expected to need help; can understand and discuss terminology, concepts, principles and issues.
3. **Intermediate**: Can successfully complete tasks independently in a particular competency; can understand and discuss the application and implications of changes to processes, policies, and procedures in this area - may need help from an expert; shows awareness of how a narrowly focused task can draw upon knowledge crossing a variety of different areas; can demonstrate the appropriate use of different techniques and methods in the application of Human Factors research or consultation.
4. **Advanced**: Can perform actions associated with this competency without assistance and recognised (by employer) as the go-to person; participates in senior level discussions regarding this competency; assists in the development of reference and resource materials in this competency; can bring together disparate theories and techniques or the application of novel solutions to complex problems; demonstrates use and application of multiple tools and techniques to more complex projects that require Human Factors integration.

5. Expert: Known as an expert or recognised authority in this area and can provide guidance, troubleshoot and answer questions related to this area of expertise with consistent excellence in applying this competency across multiple projects and/or organisations; able to create new applications for and/or lead the development of reference and resource materials for this competency.

Table 2. Proficiency Levels

Application for Grade of membership	Expected experience (years in practice)	Indicative proficiency level
Student member	Not applicable	0-1
Graduate member	On graduation	1-3
Registered member	Minimum 3 years	2-4
Fellow	10 years	3-5

3 Loughborough University

At Loughborough University the EHF MSc suite of programmes [5] is described as:

- Examining how best to ensure a good fit between people, the things they do, the objects they use, and the environments in which they work, travel and play in.
- All MSc programmes are accredited by the CIEHF (affiliated with the International Ergonomics Association).
- Teaching is provided by world leading academics, industry experts and specialists in each area (Chartered Ergonomists/Human Factors Specialists).

All the postgraduate programmes can be studied full time or part time and are offered as:

- MSc (2000 hours study)
- Postgraduate Diploma (1200 hours study)
- Postgraduate Certificate (600 hours study) –

As well as a generic Ergonomics and Human Factors programme, the 5 streams allow specialisation in Inclusive Design, Transport, Health and Community Care, and Patient Safety. The programmes were changed from weekly lectures to one week blocks of teaching in 2012, allowing learning over a one-week intensive period of teaching at the University. This has greatly increased the diversity of the student cohort in terms of age range, work experience, and professional background and resulted in an increase of 50% in admissions over previous years. In addition, it has greatly improved access for part-time students across Europe giving the flexibility to continue to work alongside academic studies. The annual intake is approximately 30 new students each year, with a total student cohort of over 65 students.

Loughborough University also offered an undergraduate programme (B.Sc). This had perennial problems with direct recruitment from school applications, but has been

popular as a transfer course (e.g. after 1 year of engineering). However increasing academic pressures has led to repeated initiatives to improve recruitment; this has included 'B.Sc. Psychology with Ergonomics' (now discontinued), 'B.Sc. Design Ergonomics' (final new intake in 2016) and most recently 'B.Sc. User-Centred Design' [6] (new in 2017). The employability of all graduates and postgraduates is high with many alumni achieving influential positions in global companies.

4   Challenges and opportunities

In an attempt to support and ensure competence in EHF provision for UK plc., and engage with a broader audience, the CIEHF is exploring how to support accreditation enquiries from user-centred design and user experience programmes. This discussion is particularly timely with the increasing number of EHF graduates being employed in healthcare, with a focus on the usability testing of medical devices.

In 2000 the FDA issued guidance on Medical Device Use Safety (incorporating Human Factors Engineering into Risk Management), revised in 2016 with clearer definitions for Human Factors and Usability [7]. :

- Human Factors are '*the application of knowledge about human capabilities (physical, sensory, emotional and intellectual) and limitations to the design and development of tools, devices, systems, environments and organisations (ANSI/AAMI HE75:2009)'* [8]
- Usability is '*Characteristic of the User Interface that establishes effectiveness, efficiency, ease of user learning and user satisfaction (ISO/IEC 62366:2007).*[9]

However, these definitions have been merged in the UK as '*Human Factors and Usability Engineering – Guidance for Medical Devices Including Drug-device Combination Products'* where the term Human Factors is used '*to encompass other terms such as ergonomics and usability'* [10].

However there are significant differences in competency expectation (and processes) in the disciplines of EHF and User Experience (UX). Furniss et al contrasted professional competency requirements between EHF and UX [11]. They identified that EHF had clearly defined (and established) competencies (IEA and UK) with a lack of 'definitive set of competencies' in UK [12]. They suggested two possible reasons including the age of the discipline (UX is relatively new compared to EHF) and '*the diverse mix of skills and roles that make up the community, making it challenging to identify an agreed set of competencies'.*

The CIEHF has started conversations with academic course providers of User-Centred Design and UX programmes to explore how the professional competencies could be used for affiliate disciplines.

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