D11.5.1 (D72.1, D107) – Fourth HBP Curriculum Teaching Cycle released (T11.5.2)

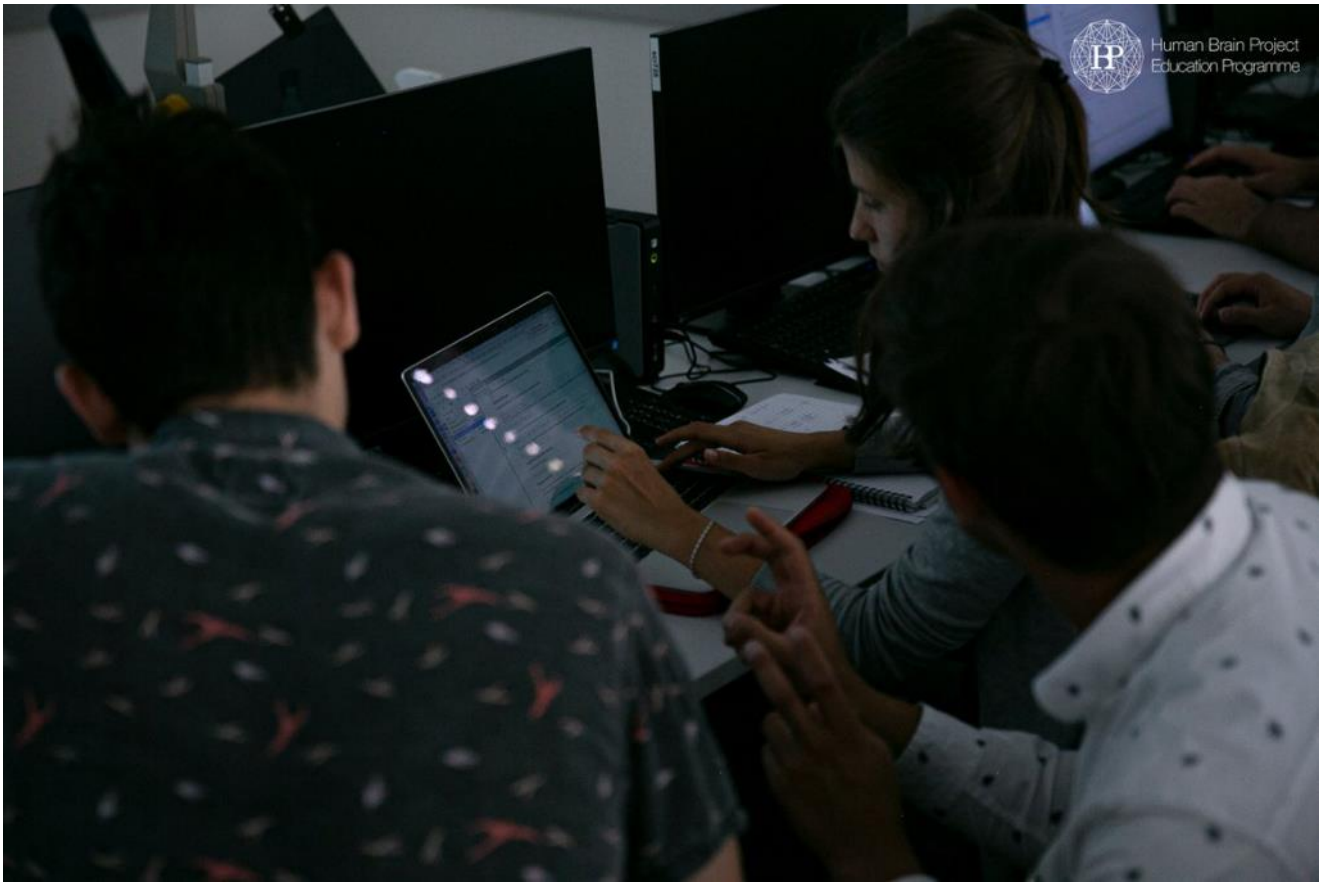

Figure 1: Hands-on session at an HBP Curriculum Workshop in Jülich, Germany, 9-11 July 2019

Comments on Figure 1. The picture shows participants and tutors of the HBP Curriculum Workshop on 'High Performance Computing for neuroscience: Hands-on introduction to supercomputing usage, tools and applications'. The HBP Curriculum Workshop format is explained in more detail in Section 2.2 of this Deliverable.

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Description in GA:	Third HBP Curriculum Teaching Cycle evaluated through online questionnaire and online courses adapted. Fourth Teaching Cycle started and Call for Expression of Interest for HBP Curriculum Workshops announced. Evaluation results are made available for Consortium members and the public upon request. Call for Expression of Interest announced to the scientific community.		
Abstract:	The HBP Curriculum on Interdisciplinary Brain Science is a blended learning format of freely accessible online courses and complementary face-to-face Workshops on the core subjects of the Human Brain Project: neurobiology/neuroscience, brain medicine, ICT and cognitive systems, as well as the complementary subjects of research ethics & societal impact and IPR, translation and exploitation of research. It is delivered in the form of Teaching Cycles and targets early-career researchers who want to gain an overview of the HBP research subjects. Participants can take exams on the contents of the online courses and receive ECTS credits, provided that they also attend one of the workshops. This Deliverable describes in detail the past 3rd Teaching Cycle and presents the results of a comprehensive evaluation of its Online courses and face-to-face Workshops, based on surveys and feedback data analysis. During the past Teaching Cycle, six Online courses and five complementary Workshops were delivered. Two further Workshops will be delivered by the end of SGA2. The evaluation results show that minor adaptions and reconfigurations of the Online courses are needed for the 4th Teaching Cycle. In particular, adaptions in descriptions and lecture titles, as well as the addition of certain topics and further learning material will enhance students' learning experience. The Workshop evaluation shows the need to make the Workshops more hands-on, with more interactive content, from which students can derive concrete takeaways. By reconfiguring and targeting the upcoming Call for Expression of Interest for Workshop Scientific Chairs (to be announced in December 2019), it will be ensured that these requirements are met in the 4th HBP Curriculum Teaching Cycle that starts in April 2020.		
Keywords:	HBP Curriculum, 3rd Teaching Cycle, course evaluation, 4th Teaching Cycle		
Target Users/Readers:	Consortium members, HPB community		

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1. Introduction

This document summarises the activities and evaluation results of the 3rd HBP Curriculum Teaching Cycle and outlines the implications for the next (4th) Teaching Cycle. Chapter 2 describes the 3rd Teaching Cycle online courses and summarises the evaluation methodology and evaluation results, as well as the resulting implications. Chapter 3 presents the 3rd Teaching Cycle face-to-face workshops, as well as their evaluation results and implications for the next cycle. Chapter 4 gives an overview of the 4th Teaching Cycle, including the adaptations of online courses and the Call for Expression of Interest for the 4th Teaching Cycle workshops.

2. Third HBP Curriculum Teaching Cycle

The third HBP Curriculum Teaching Cycle was released on 30 November 2018, in accordance with Milestone MS11.5.2. The Cycle consisted of Online courses which were publicly accessible to the entire scientific community, as well as complementary face-to-face Workshops on the core topics of the Curriculum. The following chapters will give a comprehensive overview of both the Online courses and Workshops held within the 3rd Teaching Cycle, as well as the results of the related course evaluations.

2.1 3rd Teaching Cycle Online courses

The HBP Curriculum Online Courses include basic lessons in the HBP core fields neuroscience, medicine, ICT and cognitive systems as well as lectures on the complementary subjects of ethics and intellectual property rights. The videos are publicly available throughout, and a discussion forum and additional learning material are available for each online lecture.

The courses are for early-career researchers who want to gain knowledge outside their area of specialisation or who are interested in learning about ethical challenges or intellectual property rights. Participants have the possibility of taking an exam related to the online content of the courses. Upon successful completion, European Credit Transfer System (ECTS) credits can be awarded by the Medical University Innsbruck.

The credits are distributed as follows:

Brain Medicine for non-specialists		2.5 ECTS
Neurobiology for non-specialists	Basic	1 ECTS
	Advanced	1 ECTS
ICT for non-specialists		1.5 ECTS
Cognitive systems for non-specialists		2 ECTS
Research ethics and societal impact		1.5 ECTS
IPR, translation and exploitation of research		2.5 ECTS

Details on the courses offered during the 3rd Teaching Cycle are outlined in the next sections.

2.1.1 Brain medicine for non-specialists

Access to lecture series: Brain medicine for non-specialists

Course Director: Illana Gozes (Tel Aviv University, Israel)

Course description: The human mind is a complex system that produces, processes and transmits information in an incomparable manner. Human thoughts and actions depend profoundly on the proper function of neurons. If this function is disrupted, degeneration and disease can be the

consequence. This course provides insights into state-of-the-art views on neurodegenerative, neuropsychiatric and neuroimmunological disorders as well as clinical neuroanatomy and clinical aspects of brain imaging. Apart from the scientific understanding of specific disorders and their treatment, it also discusses the latest findings in research and therapeutics. The Medical Informatics Platform developed in the European Human Brain Project is introduced with an example of how a big data approach may have the potential to improve diagnosis and therapeutic concepts of neurological diseases. Contributions for this course come from renowned researchers and clinicians from Israel, Austria and Switzerland.

Every lecture lasts approximately one academic hour (~ 45 minutes).

- **Lecture 1, part 1 and 2:** The natural history of neurodegenerative diseases: Can we modify it?
  - *Nir Giladi (Tel Aviv University, Israel)*
- **Lecture 2:** Neuroimmunology: The brain as a cognitive antigen
  - *Anat Achiron (Tel Aviv University, Israel)*
- **Lecture 3:** Motivation and addiction: Neuronetworks and treatment targets
  - *Gerald Zernig (Medical University Innsbruck, Austria)*
- **Lecture 4, part 1 and 2:** Clinical aspects of brain imaging
  - *Dafna Ben Bashat (Tel Aviv University, Israel)*
- **Lecture 5:** Neurodegenerative diseases – En route to early detection and prevention
  - *Nir Giladi (Tel Aviv University, Israel)*
- **Lecture 6:** Introduction to schizophrenia
  - *Wolfgang Fleischhacker (Medical University Innsbruck, Austria)*
- **Lecture 7:** Affective disorders: Depression and somatic co-morbidity
  - *Barbara Sperner-Unterweger (Medical University Innsbruck, Austria)*
- **Lecture 8:** A manic depressive history: The genetic discussion of complex neuropsychiatric disorders
  - *Sven Cichon (University Basel, Switzerland)*
- **Lecture 9:** HBP Medical Informatics Platform: Parkinson's disease & more …
  - *Bogdan Draganski (Centre hospitalier universitaire vaudois, Switzerland)*
- **Lecture 10:** Principles of neuropharmacology
  - *Sandra Santos-Sierra (Medical University Innsbruck, Austria)*

2.1.2 Neurobiology for non-specialists

Access to lecture series: Neurobiology for non-specialists

Course Directors: Alois Saria, Christoph Schwarzer (Medical University Innsbruck, Austria)

Course description: The field of neuroscience is one of the most interdisciplinary scientific fields. It is constantly expanded and developed further and unites researchers from a vast variety of backgrounds such as chemistry, biology, physics, medicine or psychology. By examining the principles that influence the development and function of the human nervous system, it advances the understanding of the fundamental mechanisms of human behaviour, emotions, and thoughts, and what happens if they fail. The course addresses the basic principles relevant for the performance and evolution of the nervous system and provides an overview for PhD students from a different area of specialisation. It further includes advanced lectures on more specific questions and challenges of the field.

Every lecture lasts approximately one academic hour (~ 45 minutes). Following recommendations of the review after the 1st Teaching Cycle, this online course has been split into a basic and advanced module.

2.1.2.1 Part 1: Basic

- **Lecture 1:** Intercellular signal transduction
  - *Christoph Schwarzer (Medical University Innsbruck, Austria)*
- **Lecture 2:** Intracellular signal transduction
  - *Christoph Schwarzer (Medical University Innsbruck, Austria)*
- **Lecture 3:** Glial cells
  - *Christine Bandtlow (Medical University Innsbruck, Austria)*
- **Lecture 4:** Myelination in the CNS and PNS
  - *Christine Bandtlow (Medical University Innsbruck, Austria)*
- **Lecture 5:** Neuronal networks
  - *Christoph Schwarzer (Medical University Innsbruck, Austria)*
- **Lecture 6:** Basic neuroanatomy
  - *Lars Klimaschewski (Medical University Innsbruck, Austria)*
- **Lecture 7:** Nociceptors and perceptions of pain
  - *Serena Quarta (Medical University Innsbruck, Austria)*

2.1.2.2 Part 2: Advanced

- **Lecture 1:** Neuroinflammation and demyelination
  - *Markus Reindl (Medical University Innsbruck, Austria)*
- **Lecture 2:** Neurodegenerative diseases – En route to early detection and prevention
  - *Nir Giladi (Tel Aviv University, Israel)*
- **Lecture 3:** Learning and memory: Basic concepts and medical implications
  - *Nicolas Singewald (University of Innsbruck, Austria)*
- **Lecture 4:** Learning and memory: Underlying mechanisms and networks
  - *Francesco Ferraguti (Medical University Innsbruck, Austria)*
- **Lecture 5:** Motivation and addiction: Neuronetworks and treatment targets
  - *Gerald Zernig (Medical University Innsbruck, Austria)*
- **Lecture 6:** Computational neuroscience: Bridging brain scales with mathematics
  - *Gaute Einevoll (Norwegian University of Life Sciences, Norway)*
- **Lecture 7:** The human brain atlas as a part of the HBP Neuroinformatics Platform
  - *Timo Dickscheid (Forschungszentrum Jülich, Germany)*
- **Lecture 8:** Principles of neuropharmacology
  - *Sandra Santos-Sierra (Medical University of Innsbruck, Austria)*

2.1.3 ICT for non-specialists

Access to lecture series: ICT for non-specialists

Course Director: David Lester (The University of Manchester, UK)

Course description: 'Computational thinking' refers to a mindset of sets or tools used by computational or ICT specialists to describe their work. This course is intended for people outside the ICT field to allow students to understand the way that computer specialists analyse problems and to introduce students to the basic terminology of the field.

In particular, material is provided on: Complexity measures, computability, numerical analysis, software engineering, data management, electronics and chip design, and the ethical considerations involved in ICT.

Every lecture lasts approximately one academic hour (~ 45 minutes).

- **Lecture 1:** Computational complexity
  - *David Lester (The University of Manchester, UK)*
- **Lecture 2:** Numbers, errors, chaos
  - *David Lester (The University of Manchester, UK)*
- **Lecture 3:** Turing, computability, halting problem
  - *David Lester (The University of Manchester, UK)*
- **Lecture 4:** Introduction to software engineering
  - *Jeff Muller (École Polytechnique Féderale de Lausanne, Switzerland)*
- **Lecture 5:** Cheap as chips!
  - *Steve Furber (The University of Manchester, UK)*
- **Lecture 6:** Advanced data management
  - *Thomas Heinis (Imperial College London, UK)*
- **Lecture 7:** Querying and analysing big scientific data
  - *Thomas Heinis (Imperial College London, UK)*
- **Lecture 8:** Electronics and VLSI
  - *Andreas Grübl (Heidelberg University, Germany)*

2.1.4 Research ethics and societal impact

Access to lecture series: Research ethics and societal impact

Course Directors: Manuel Guerrero (Uppsala University, Sweden), Kerstin Hakansson (Linnaeus University, Sweden)

Course description: This course explores ethical and social issues that have arisen, and continue to arise, from the rapid research development in neuroscience, medicine and ICT. Lectures focus on key ethical issues contained in the HBP – such as ethics of robotics, dual use, ICT ethical issues, big data and individual privacy, and the use of animals in research.

Every lecture lasts approximately one academic hour (~ 45 minutes).

- **Lecture 1:** Introduction to ethical theory
  - *Christine Mitchells (Harvard Medical School, USA)*
- **Lecture 2:** Computer ethics and the HBP

- *Bernd Stahl (De Montfort University, UK)*

- **Lecture 3:** The Ethical Roboticist
  - *Alan Winfield (University of the West of England, UK)*
- **Lecture 4:** Responsible Research and the Human Brain Project
  - *Nikolas Rose (King's College London, UK)*
- **Lecture 5:** Scaling up neuroscience – Responsible Research and the big brain projects
  - *Nikolas Rose (King's College London, UK)*
- **Lecture 6:** Neuroscience and the problem of dual use
  - *Malcolm Dando (University of Bradford, UK)*
- **Lecture 7:** Ethics in biomedical research and the 3Rs
  - *Viveka Hillegaart (Karolinska Institutet, Sweden)*
- **Lecture 8:** Societal attitudes to animal research
  - *Rafael Frias (Karolinska Institutet, Sweden)*
- **Lecture 9:** Research integrity and ethics management – HBP case study
  - *Emma Harris (De Montfort University, UK)*
- **Lecture 10:** Cognitive enhancement: Ethics and efficacy
  - *Sebastian Porsdam Mann (Harvard Medical School, USA)*
- **Lecture 11:** The Thinking Robot
  - *Alan Winfield (University of the West of England, UK)*

2.1.5 Intellectual property rights, translation and exploitation of research

Access to lecture series: IPR, translation and exploitation of research

Course Director: Dana Bar-On (Tel Aviv University, Israel)

Course description: Knowing how to incorporate innovation and entrepreneurial mindset and concepts into day-to-day research work can be very beneficial and rewarding; however, it is very challenging specifically for students coming from disciplines such as computer science, engineering, life science or medicine (a non-MBA background). The current course will help building personal leadership skills for early-stage researchers and group leaders from the neuroscience field by inspiring them to look for better and smarter solutions, to think outside the box and consider end-products when it comes to their present and future research. Especially at early stages of the academic career, students can benefit from learning from the experience of innovators and entrepreneurs, through their failures and successes, and gain some practical tools and advice. Additionally, the course presents the basic concepts of intellectual property and how research can be exploited and translated into products.

Every lecture lasts approximately one academic hour (~ 45 minutes).

- **Lecture 1:** Is your "Million Dollar Idea" a viable business concept?
  - *Michael Ehrlich (New Jersey Institute of Technology, USA)*
- **Lecture 2:** Bottom-up research: The most critical skill in entrepreneurship
  - *Danny Warshay (Brown University, USA)*
- **Lecture 3, part 1 and 2:** Basic elements in the patenting world

- *Eyal Bressler (Dr. Eyal Bressler & Co., Israel)*

- **Lecture 4, part 1 and 2:** Patents in the realm of neuroscience
  - *Eyal Bressler (Dr. Eyal Bressler & Co., Israel)*
- **Lecture 5, part 1 and 2:** New innovation models at the interface between academia and industry
  - *Christian Tidona (BioRN Network / BioMed X Innovation Center, Germany)*
- **Lecture 6, part 1 and 2:** Transferring innovation from academy to industry
  - *Shlomo Nimrodi, Daniel Offen, Ehud Gazit (Tel Aviv University, Israel)*
- **Lecture 7, part 1 and 2:** Looking into the future using emerging trends: What are they and how do we identify them?
  - *Iris Ginzburg (Tel Aviv University, Israel)*

2.1.6 Cognitive systems for non-specialists

Access to lecture series: Cognitive systems for non-specialists

Course Directors: Lars Muckli (University of Glasgow, UK), Tony Prescott (The University of Sheffield, UK)

Course description: Cognitive systems are devices that are designed to mimic cognitive skills of higher developed biological organisms at varying levels of complexity and performance. Models of these skills can be either abstract functional descriptions from the vast field of cognitive science or detailed simulations of brain circuits from neuroscience. Novel hardware design and the steadily increasing availability of cheap computing resources have recently yielded remarkable results especially with the latter models. The goal of this course is to provide a definitive introduction to the theory of cognitive systems. Drawing from advances in brain research, the topic is approached from a computational-neuroscientific perspective rather than an abstract-psychological one, bridging the gap between the physical structure of the brain and the logical organisation of its cognitive capabilities. Special focus is put on the role of robotics as a means to ground cognitive function in bodies that physically interact with different types of environments.

Every lecture lasts approximately one academic hour (~ 45 minutes).

- Lecture 1: Internal models and counterfactual cognition predicting our environment
  - *Lars Muckli (University of Glasgow, UK)*
- Lecture 2: Making our selves: From psychology to robotics
  - *Tony Prescott (The University of Sheffield, UK)*
- Lecture 3: Can robots ever become conscious? Insights from theory and experimental neurobiology
  - *Cyriel Pennartz (University of Amsterdam, Netherlands)*
- Lecture 4: Introduction to the Neurorobotics Platform
  - *Marie Claire Capolei (Technical University of Denmark, Denmark)*
- Lecture 5: Deep reinforcement learning for robotic control
  - *Jonathan Hunt (Google DeepMind, UK)*
- Lecture 6: Bio-inspired control architecture for mobile robotics
  - *Yannick Morel (Technical University of Munich, Germany)*
- Lecture 7: Neuroscience and robotics
  - *Tata Ramalingasetty Shravan (École polytechnique féderale de Lausanne)*

- Lecture 8: The social robot: Emotions and drives
  - *Vicky Vouloutsi (IBEC – Institute for Bioengineering of Catalonia, Spain)*

2.1.7 Evaluation of online courses

In order to evaluate the 3rd Teaching Cycle Online Courses, the HBP Education Programme Office invited the members of the HBP Education Programme Committee to review the various courses. The Programme Committee is constituted of members of each Subproject in HBP SGA2, the HBP Curriculum Online Course Directors as well as the HBP Student Representatives.

For each online course, expert panels to review and evaluate the course were formed:

- **Expert panel ICT for non-specialists:**
  - Anastasia Brovkin (Universitätsklinikum Hamburg-Eppendorf, Germany)
  - Sonja Grün (Forschungszentrum Jülich, Germany)
  - David Lester (University of Manchester, United Kingdom)
  - Anna Lührs (Forschungszentrum Jülich, Germany)
  - Maria-Ribera Sancho (Barcelona Supercomputing Center, Spain)
- **Expert panel Neurobiology for non-specialists:**
  - Gaute Einevoll (Norwegian University of Life Sciences, Norway)
  - Petra Ritter (Charité Universitätsmedizin Berlin, Germany)
  - Alois Saria (Medical University Innsbruck, Austria)
  - Christoph Schwarzer (Medical University Innsbruck, Austria)
- **Expert panel Brain medicine for non-specialists:**
  - Sandra Diaz-Pier (Forschungszentrum Jülich, Germany)
  - Illana Gozes (Tel Aviv University, Israel)
  - Mira Marcus-Kalish (Tel Aviv University, Israel)
  - Alois Saria (Medical University Innsbruck, Austria)
- **Expert panel Research ethics and societal impact**
  - Egidio d'Angelo (University of Pavia, Italy)
  - Manuel Guerrero (Uppsala University, Sweden)
  - Kerstin Hakansson (Linnaeus University, Sweden)
  - Jeanette Hellgren-Kotaleski (KTH Royal Institute of Technology, Sweden)
  - Gabriel Urbain (Ghent University, Belgium)
- **Expert panel Intellectual property rights, translation and exploitation of research**
  - Dana Bar-On (Tel Aviv University, Israel)
  - Francesco Pavone (Laboratorio Europeo di Spettroscopie non Lineari, Italy)
  - Alberto Redolfi (IRCCS Fatebenefratelli, Italy)

2.1.7.1 Evaluation methodology

The expert panels were asked to watch the lectures assigned to them and afterwards to complete an online questionnaire. In the questionnaire, experts were asked to rate each lecture regarding its

scientific content, didactic value and the overall relevance to the main theme of the course on a scale from 1 to 6. The rating scale was annotated as follows: 1 = failed, 2 = insufficient, 3 = sufficient, 4 = satisfactory, 5 = good, 6 = excellent. Experts were also invited to provide feedback in their own words. Additionally, the experts were asked for their opinion on whether any lectures should be removed from the course and whether any topics are missing and should be included for the next Teaching Cycle.

Eight members of the Education Programme Committee took part in the online evaluation of the surveys and evaluated a total of four courses. Two courses, Neurobiology for non-specialists and IPR, translation and exploitation of research, were not evaluated.

After the survey results had been summarised by the Education Programme Office, a debriefing meeting (VC) with the expert panel took place on 16 October 2019. The purpose of this meeting was to discuss the initial feedback, add any other issues and ultimately decide on the needed measures to adapt the online courses.

During the debriefing video conference, nine committee members were present and provided further feedback, also on the courses that have not been evaluated online.

2.1.7.2 Evaluation results

During the third teaching cycle, the Online courses focusing on core fields of neuroscience (Brain Medicine, Neurobiology, ICT and Cognitive Systems) were more frequently viewed than the Online courses on complimentary subjects (IPR, Translation and Exploitation of Research).

In terms of scientific content, didactic value and relevance to main theme, almost all the lectures of Online courses were evaluated as “good” or “excellent”. Only two lectures received lower ratings and it has been recommended that these be not included in the next Cycle. The evaluators also recommended that some additional lectures be included. For the ICT Online course, introductory lectures on programming, modelling and high performance computing were suggested. For the Cognitive Systems course, a general introduction to the field was considered a valuable potential addition. The Brain Medicine Online course could be usefully supplemented with lectures on learning disorders and novel treatment approaches, while the Online course on Research Ethics and Societal Impact could be enriched with lectures on neuroethics and data governance.

Furthermore, the evaluators gave some general recommendations to improve the Online courses. These included: the titles and descriptions should be revised to make them more easily comprehensible for non-specialists, information on required prior knowledge should be added and further reading material provided. Finally, a short survey should be implemented, so that feedback by the online course participants can be gathered directly.

The following sections provide more details on these main results.

2.1.7.2.1 3rd Teaching Cycle online courses: General statistics

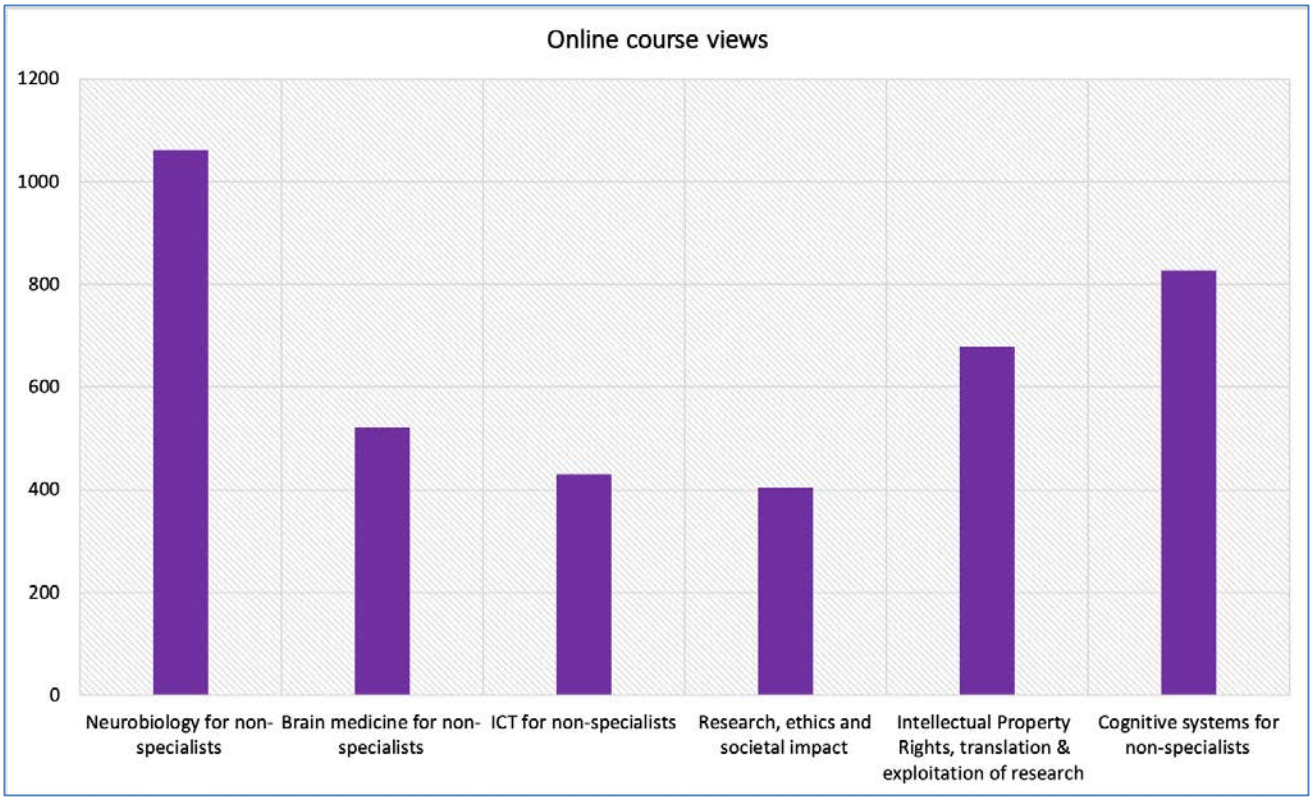

Figure 2: Online course views in 3rd Teaching Cycle

The 3rd Teaching Cycle Online Courses were released in November 2018. The overall teaching series received a total of 3,925 views. Figure 2 shows the overall views per course during the third Teaching Cycle (as of 3 October 2019). In order to acknowledge the varying number of lectures per course, Figure 3 shows the average views per lecture in the third Teaching Cycle. The Cognitive systems for non-specialists course was watched most often with an average of 104 views per lecture. The Neurobiology for non-specialists course was second with an average of 71 views per lecture, followed by ICT and Brain Medicine for Non-Specialists with averages of 54 and 52 views, respectively. Least watched were the transdisciplinary courses on IPR, Exploitation and Translation of Research, as well as Research Ethics and Societal Impact with averages of 49 and 37 views per lecture, respectively.

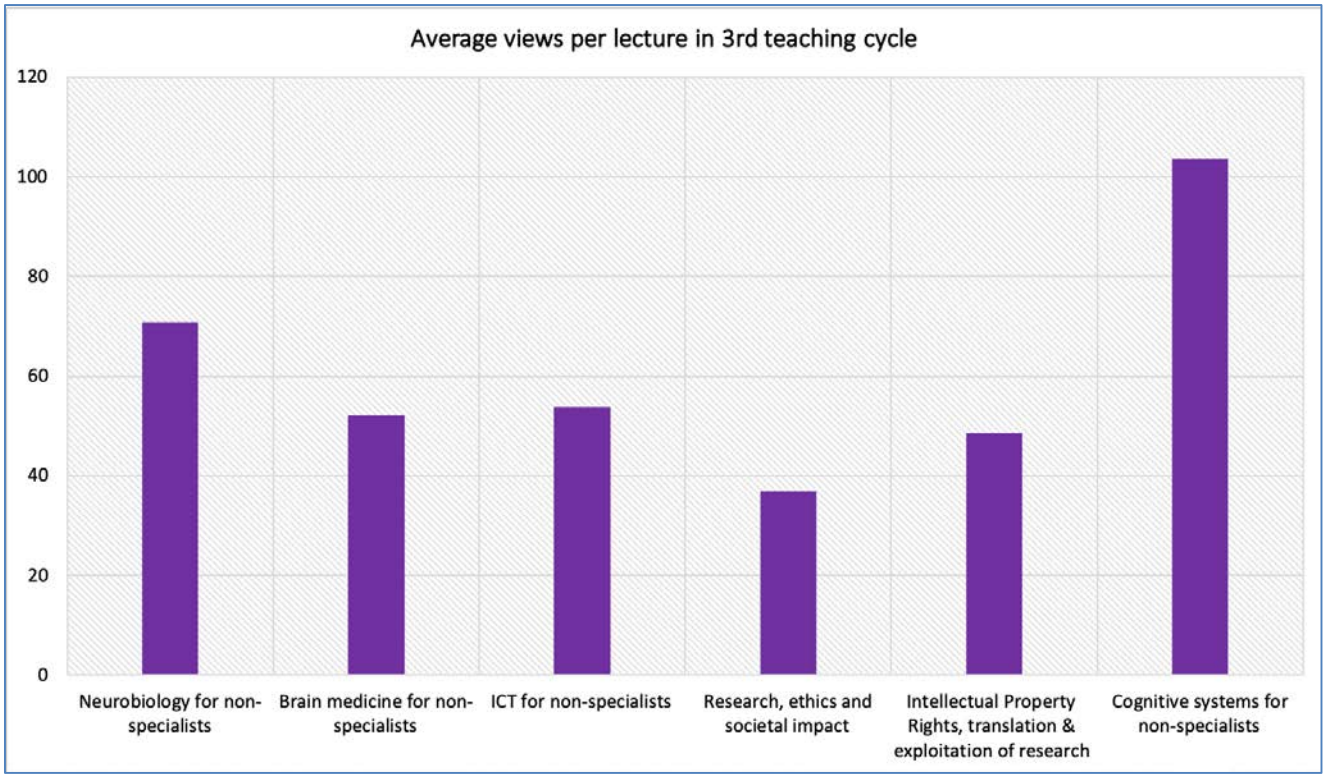

Figure 3: Average views per lecture in 3rd Teaching Cycle

During the complementary workshops, eight persons took 11 exams on the content of the following courses:

- 2 exams on ICT for non-specialists
- 4 exams on Neurobiology for non-specialists – BASIC
- 3 exams on Neurobiology for non-specialists – ADVANCED
- 1 exam on Brain Medicine for non-specialists
- 1 exam on Research Ethics and Societal Impact

9 out of 11 exams have been passed (threshold: 60 %). The average result rate was at 68.71 %.

2.1.7.2.2 Evaluation of scientific content, didactic value and relevance to main theme

The members of the expert panels who took part in the online evaluation rated each lecture regarding its scientific content, didactic value and relevance to the main theme on a scale from 1 – 6[1]. Four courses were rated via the online survey, the courses on neurobiology and IPR were not evaluated, however, feedback was provided during the debriefing meeting. Figure 4 shows the mean ratings of the three evaluation dimensions per course. The results show that all courses received good to excellent mean ratings for all dimensions. Still, two single lectures (Lecture 4 in the online course on cognitive systems and Lecture 8 in the Online course on research ethics and societal impact) received fairly low mean values (2.67 for both) and will therefore be replaced. The mean ratings for each lecture can be seen in detail in Annex A: Online lectures - evaluation results.

[1] Rating scale from 1 to 6 corresponding to 1 = failed, 2 = insufficient, 3 = sufficient, 4 = satisfactory, 5 = good, 6 = excellent

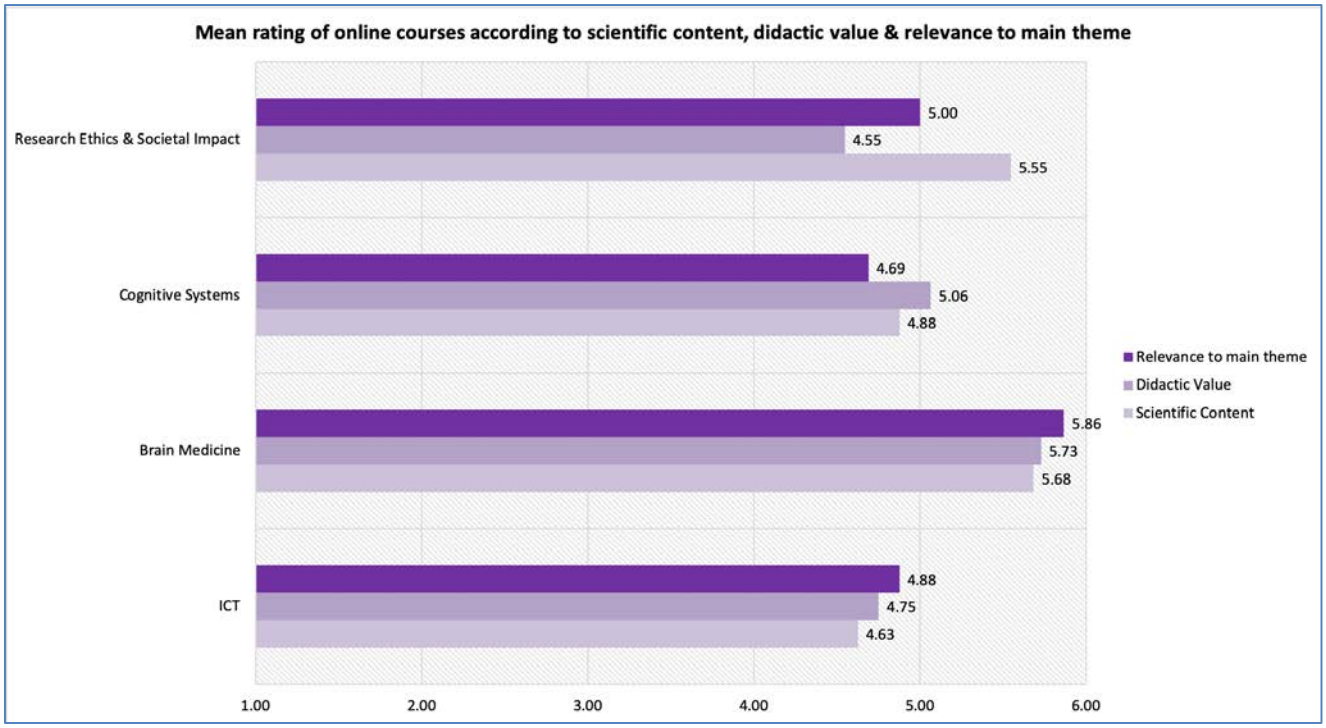

Figure 4: Online courses: Evaluation of scientific content, didactic value and relevance to main theme

2.1.7.2.3 Topics to be added, lectures to be deleted

The expert panels were asked to state any missing topics and to explicitly identify lectures that should be deleted from the 4th Teaching Cycle. Regarding deletions, the results relate to the lecture ratings above. Accordingly, the lecture on 'Introduction to the Neurorobotics Platform' within the Cognitive systems online course as well as the lecture on 'Societal attitudes to animal research' will be removed from the courses for the 4th Teaching Cycle. Regarding topics to be added, several suggestions were made (see Table 1). For the ICT for non-specialists course, introductory lectures on programming, modelling and simulations, high performance and neuromorphic computing were recommended. For the Brain medicine course, lectures on learning disorders and novel approaches through patient-specific brain devices were suggested as additions to the existing course. It was recommended to add a primer on neuroscience and cognition to the Cognitive systems course. For the Research ethics and societal impact course, additional lectures on neuroethics as well as on data use and data governance issues have been proposed. No additional lectures were proposed for the courses on neurobiology and IPR. The Education Programme Office will review existing video material to cover the suggested topics for the 4th Teaching Cycle.

Table 1: Lectures to be added / deleted for 4th Teaching Cycle online courses

Topics to be added	Lectures to be deleted
ICT	
Introductory lecture about programming	None
Introductions to modelling and simulations	
Introduction to HPC	
Introduction to neuromorphic computing	
Brain medicine	
Novel approaches for teaching through patient-specific brain devices (success stories of HBP)	None
Learning disorders	
Cognitive systems	
A primer on neuroscience and cognition: What are the brain areas that are involved with planning, decision making, processing emotions, etc.?	Lecture 4: Introduction to the Neurorobotics Platform
Research ethics & societal impact	
Neuroethics	Lecture 8: Societal attitudes to animal research
Data use, data governance issues	
Neurobiology	
None	None
IPR, translation and exploitation of research	
None	None

2.1.7.2.4 Further feedback on online courses

In addition to the evaluation results outlined above, the members of the Education Programme Committee were invited to provide further feedback. The following recommendations will be taken up and integrated for the release of the 4th HBP Curriculum Teaching Cycle:

- Inclusion of information on which prior knowledge is required to follow the courses in the course descriptions.
- Simplification of lecture titles for existing lectures.
- Inclusion of surveys to obtain online course participants' feedback.
- Revision of title and description of the course on cognitive systems to adapt it to the actual course content.
- Addition of links to further readings and learning material for the courses.

2.2 3rd Teaching Cycle Workshop Series

As a complement to the online courses, five Workshops took place during the 3rd HBP Curriculum Teaching Cycle. The HBP community and external researchers were invited to submit proposals for Workshops via a Call for Expression of Interest that was open from 12 July 2018 to 3 September 2018. Six proposals were submitted and reviewed by the HBP Education Programme Committee.

The Workshop Series consisted of the following workshops:

- **Neurobiology for non-specialists: Studying the brain**
  - 1-3 July 2019, Medical University Innsbruck, Austria
  - Scientific Chair: Christoph Schwarzer (Medical University Innsbruck, Austria)
- **Brain Medicine for non-specialists: New horizons in brain medicine: From research to clinics**
  - 3-5 July 2019, Medical University Innsbruck, Austria
  - Scientific Chair: Illana Gozes (Tel Aviv University, Israel)
- **ICT for non-specialists: High performance computing for neuroscience: Hands-on introduction to supercomputing usage, tools and applications**
  - 9-11 July 2019, Forschungszentrum Jülich, Germany
  - Scientific Chair: Abigail Morrison (Forschungszentrum Jülich, Germany)
- **ICT for non-specialists: Spiking neural networks: Applications to computing, algorithmics, and robotics**
  - 18 September 2019, Technical University of Munich, Germany
  - Scientific Chair: Alois Knoll (Technical University of Munich, Germany)
- **Research Ethics and Societal Impact: Same, same or different? Neuroscience, robotics, AI and medical informatics: New insights with diversity & ethics**
  - 26-27 September 2019, Graz University of Technology
  - Scientific Chair: Karin Grasenick (Convelop knowledge design GmbH)

The Workshops were mostly organised as two-to-three-day events that included a mixture of lectures, tutorials, hands-on sessions, discussions and lab visits. A total of 79 participants and 52 speakers and tutors attended the 3rd Workshop Series. The overall gender ratio was at 49.47 % female to 50.53 % male. The workshop programmes can be viewed on the HBP Education Programme Website:
https://www.humanbrainproject.eu/en/education/participatecollaborate/curriculum/workshops/

Two additional Workshops will be organised in remaining part of SGA2. One Workshop on the topic of cognitive systems titled 'Modern trends in cognitive architectures and systems: From theory to implementation in natural and artificial agents' will take place in Glasgow, 11-13 December 2019. A final Curriculum Workshop in SGA2 with the title 'Measuring and modelling brain states' will take place in Sölden, Austria, 28-29 March 2020.

For each Workshop, a detailed post action report was produced by the Education Programme Office, describing the set-up of the Workshop, as well as statistics on attendees and the evaluation results of the post-Workshop survey. The detailed reports have been shared with the Consortium and can be made available upon request. Some central key performance indicators for the 3rd Curriculum Workshop Series including the Workshops from July to September 2019 are provided in Table 2. In comparison to previous teaching cycles, the key performance indicators regarding quality of scientific content as well as lecturer / attendee satisfaction could be improved. The participant / faculty ration KPI has been held constant in comparison to the Second Teaching Cycle.

Table 2: Key figures for 3rd Teaching Cycle Curriculum Workshops

	Key performance indicator[2]	TC3	TC2	TC1
1	Participant / Faculty ratio for Education Programme events optimising quality[3]	1.61	1.10	2.31
3	Attendees' average rating of the quality of scientific content in Curriculum Workshops	5.34	5.18	5.34
4	Attendees average satisfaction of the lecturer / attendee interaction in Curriculum Workshop	5.61	5.53	5.38

In the following sections of this Deliverable, the evaluation methods, the most important aggregated evaluation results and feedback from different sources for the Workshops, as well as the most central implications for the next Teaching Cycle, will be presented.

2.2.1 Promotion of the HBP Research Infrastructure

In each of the Workshops, participants were introduced to the HBP research infrastructure. A lecture on the 'HBP at the Half-Way Point', giving a high-level overview of the HBP Platforms, was delivered at three of the Workshops (Neurobiology for non-specialists, Brain Medicine for non-specialists, Research Ethics and Societal Impact). At the ICT Workshop in Jülich, participants were introduced to the High Performance Analytics and Computing (HPAC) Platform. At the ICT Workshop in Munich, a tutorial on the Neurorobotics Platform was given. After three of the Workshops, participants were invited to sign up to the HBP Collaboratory. 43.75 % (n=14) accepted the invitation.

2.2.2 Evaluation methodology

Workshop evaluation has been performed by quantitative participant surveys after each Workshop as well as content analysis of a collection of open feedback data from various sources.

2.2.2.1 Quantitative participant surveys

In order to evaluate the Curriculum Workshops, post-Workshop surveys were sent out to participants and faculty members after each Workshop, with a run time of approximately two weeks. The surveys included quantitative questions with matrix scale questions on different aspects of the Workshops, such as organisation of sessions, scientific content, programme schedule, interaction with lecturers, etc., questions on perceived impact on participants' future careers as well as multiple choice questions on attendees' motivation to join a Workshop, as well as information on the communication channels through which participants learned about the Workshop. The mean overall satisfaction was rated by matrix scales.

Chapter 2.2.3 presents the findings of the participant surveys.

2.2.2.2 Open feedback data

In order to aggregate open feedback from the SGA2 Workshops, a 'feedback database' has been created in Excel, containing diverse feedback items. The purpose is to gather a comprehensive overview of users' perceptions regarding our Workshop format and support planning and mitigation activities for the HBP Curriculum in SGA3. The database is structured as shown in Table 3.

[2] KPI 2-4 are based on the following rating scale: 1 = failed, 2 = insufficient, 3 = sufficient, 4 = satisfactory, 5 = good, 6 = excellent

[3] Represents the mean participant/faculty ratio for all workshops.

Table 3: Feedback database structure

Column title	*Description*	*Remark*
N	Consecutive numbering	
Topic	Short topic title (self-chosen)	
Addressee	Who is the main addressee? (e.g. HBP Office)	
Description	Feedback content (preferably quoted verbatim)	
Keyword	one keyword (used to classify feedback)	
Specific / General	Is the feedback applicable to one workshop specifically or can it be generalised?	
Teaching Cycle	In which Teaching Cycle has the feedback been expressed?	
Workshop acronym	-	Use pre-defined
Workshop title	-	Auto-complete
Date	-	Auto-complete
Venue	-	Auto-complete
Scientific Chair	-	Auto-complete
Author	Who documented the item originally / who entered to spreadsheet?	
Provenance	What is the source of the item?	

The following feedback sources and documents have been considered:

- Post-Workshop surveys (open questions)
- Various 'lessons learned' documents compiled by event owners after the respective workshops
- Workshop reports
- Internal notes by HBP Education Programme Office / discussion minutes

In total, 129 feedback items have been aggregated, for the evaluation at hand only feedback from SGA2 Workshops has been considered as the Workshop format has been kept similar during this phase. Therefore, 71 feedback items have been used for this evaluation. Figure 5 shows the provenance of the respective feedback.

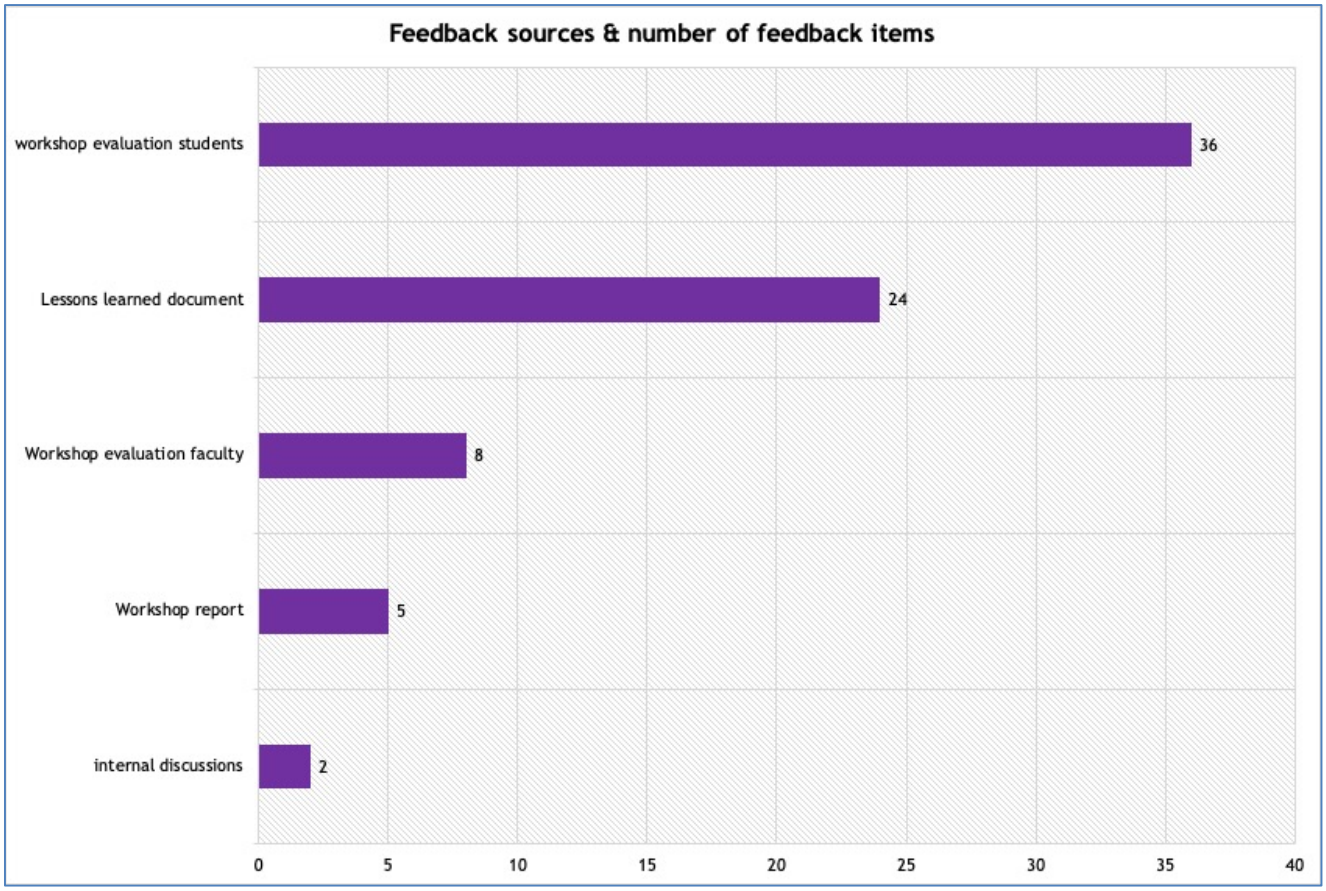

Figure 5: Feedback items by source

Most items (n = 36) stem from participant surveys, 24 items are drawn from 'lessons learned' documents. Faculty surveys (n = 8), Workshop reports (n = 5) and internal discussions (n = 2) are other, though less frequent, sources of feedback.

The feedback items were entered *verbatim* into the feedback database and annotated with keywords that summarise the central statement. Those keywords were used to categorise the collected feedback and produce a coherent narrative for each keyword from which implications for an improvement of future Workshop formats can be drawn.

2.2.3 Evaluation results overview

The survey evaluation results indicate that participants' overall satisfaction with the Workshops was high (mean = 5.24). Scientific content, programme quality, didactic value and organisation of the Workshops were generally rated "excellent". However, participants felt that the hands-on value of the Workshops could be increased. The main motives for participation were a general interest in the topic and the wish to gather knowledge in a different discipline. This was also reflected in the degree of interdisciplinarity of the Workshops: at least three different disciplines were present in each Workshop. The main post-Workshop benefits were acquisition of new information and exchanges with other scientists. The results show that word-to-mouth marketing has been efficient in reaching participants, as most participants learned about the Workshops from colleagues or supervisors. HBP-specific communication channels were cited less frequently as a source of information.

Further feedback indicated that the focus on hands-on content should be increased in the future by providing more tutorials and trainings as part of the Workshops. Also, more opportunities for interaction should be provided; for example, via discussions, group work and social gatherings. In terms of programme planning, it was suggested that the common thread running through the whole programme be made more visible. In addition, supplementary topics such as Ethics or Translation of Research could usefully be integrated in Workshops on core neuroscience subjects.

The following sections provide more details on the results.

2.2.4 Evaluation results survey questions

A total of 38 persons took part in the Workshop evaluations. Their motivation to apply for a Workshop in the first place was mostly stated as a general interest in the topic of the Workshop (stated by n = 31) or a general interest in the HBP (n = 20). Also, the wish to acquire knowledge in a different discipline from their own turns out to have been a strong motivator for respondents. This points to the fact that the intended interdisciplinary character of the format is actually realised within the Workshops. The actual extent of interdisciplinarity within Workshops is shown in Figure 7.

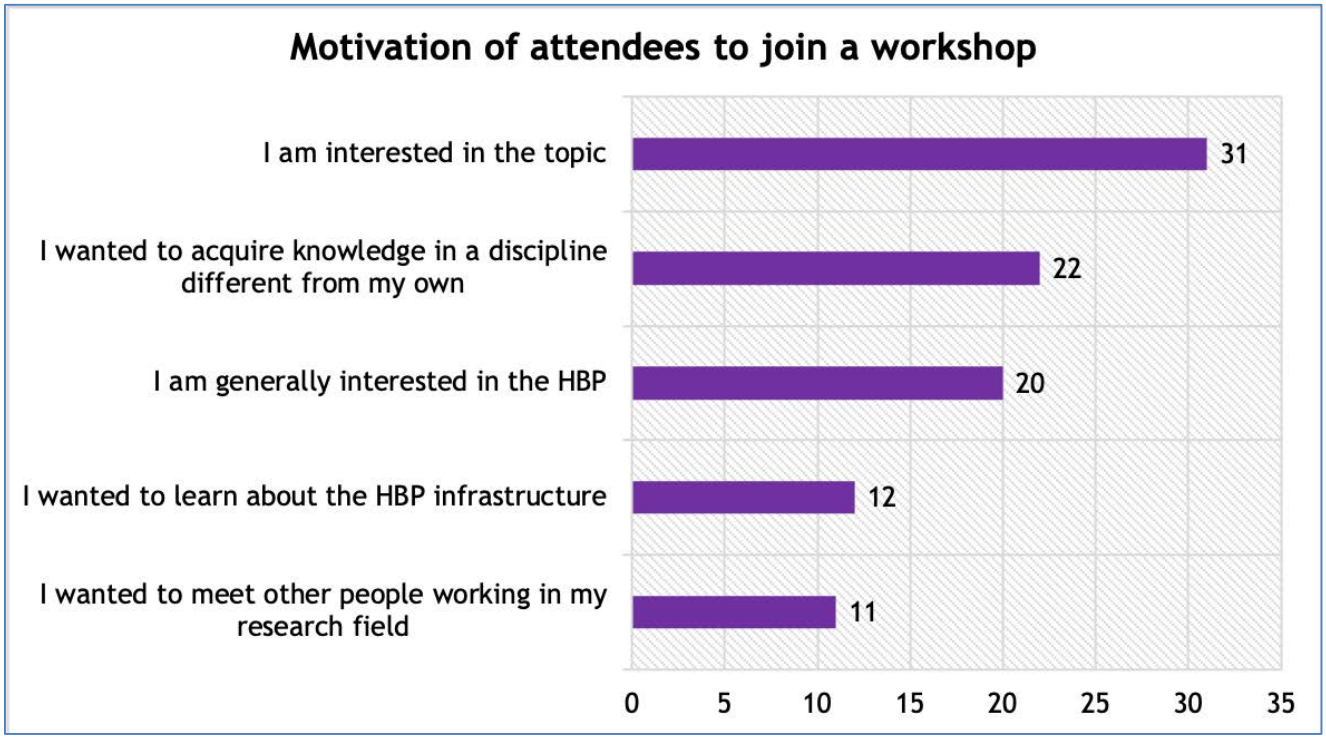

Figure 6: Attendees' motivation to join a workshop (n = 38)

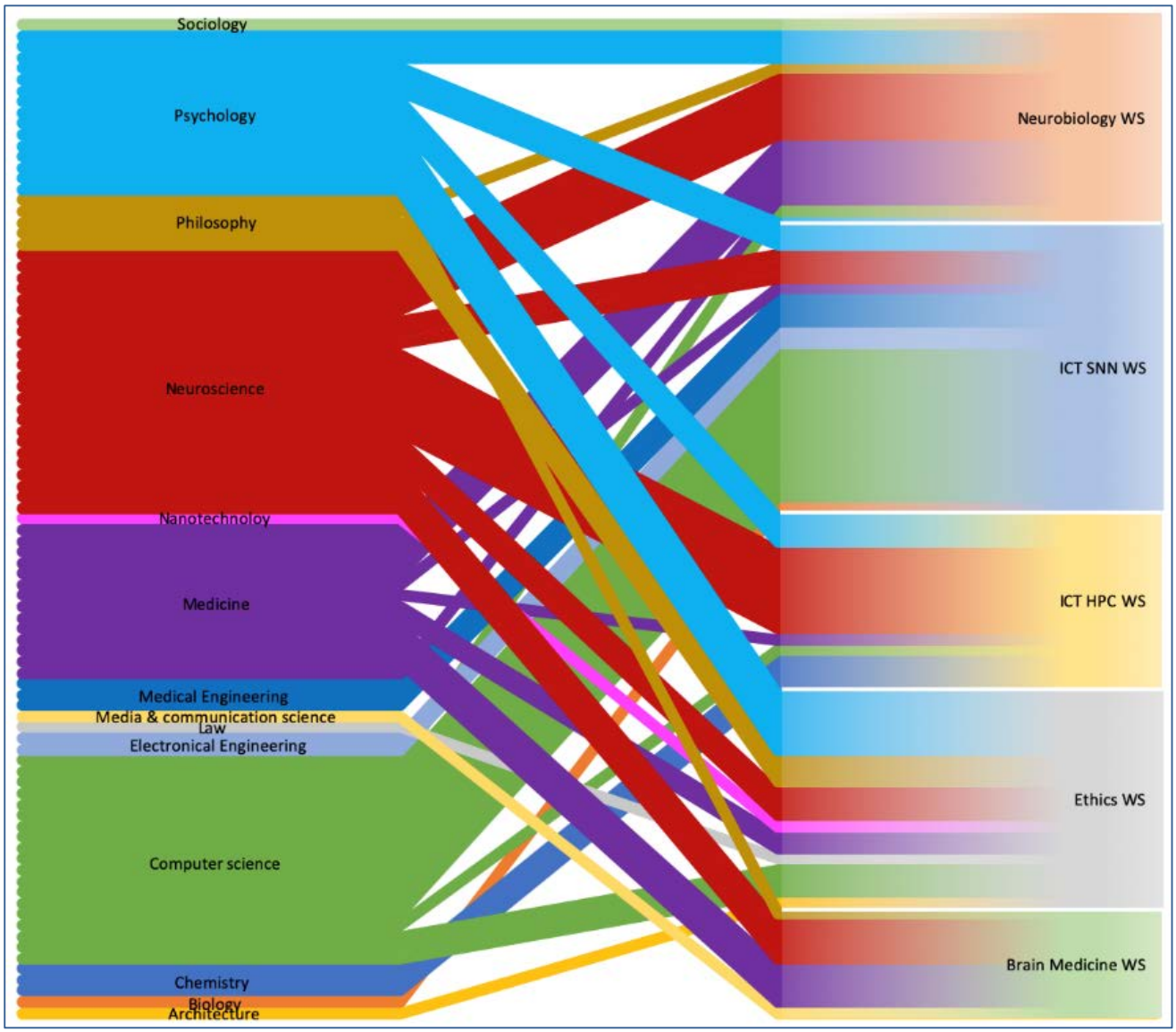

Figure 7: Disciplinary background of workshop participants[4]

Figure 8 shows the information channels through which participants learned about the Workshops (multiple answers were possible). It is clearly evident that word-of-mouth has been the most effective channel. A total of 19 respondents stated that they learned about the Workshop either through their colleagues or fellow students or their PIs, supervisors, mentors or tutors. Online event calendars and mailings were selected as information channels by nine respondents, while HBP-specific communication channels, such as the HBP Education website (n = 6), the HBP Education Newsletter (n = 6), the HBP public website (n = 4) only come in fourth and lower. HBP social media was selected as an information channel by only one survey respondent.

[4] As a data source for this figure, we used the workshop application form, where participants had to state their current subject(s) of study. The answers have been standardised using keyword index of the Austrian Systematic of Branches of Science ("Österreichische Systematik der Wissenschaftszweige", retrieved from: https://www.fwf.ac.at/fileadmin/files/Dokumente/Antragstellung/wiss-disz-201507.pdf, last accessed: 24 October 2019). Students' answers have been categorised to science branches of the second level, e.g. a student stating 'Artificial Intelligence' (index 102001) as study subject has been categorised to the overarching branch of Computer Sciences (index 102). Cases where no clear assignment has been possible from a participant's answer have been excluded from the analysis.

Figure 8: Information sources used (n=38)

Workshop participants were asked to rate their experience according to various dimensions on a scale from 1-6[5]. Figure 9 shows the mean rating of these dimensions. Most dimensions, including organisation of the sessions, interaction with lecturers, relevance to main theme, scientific content, programme schedule, didactic value and personal relevance received mean ratings between good and excellent. The only dimension that received a merely satisfactory mean value was the perceived hands-on value of the workshops. This also relates to the results of the second evaluation part (open feedback data evaluation shown in Chapter 2.2.4).

Regarding participants' overall satisfaction with the Workshops, all Workshops received close to good or excellent mean values. The overall mean satisfaction with the 3rd Teaching Cycle Curriculum Workshops is 5.24. Details are shown in Figure 10.

[5] 1 = failed, 2 = insufficient, 3 = sufficient, 4 = satisfactory, 5 = good, 6 = excellent

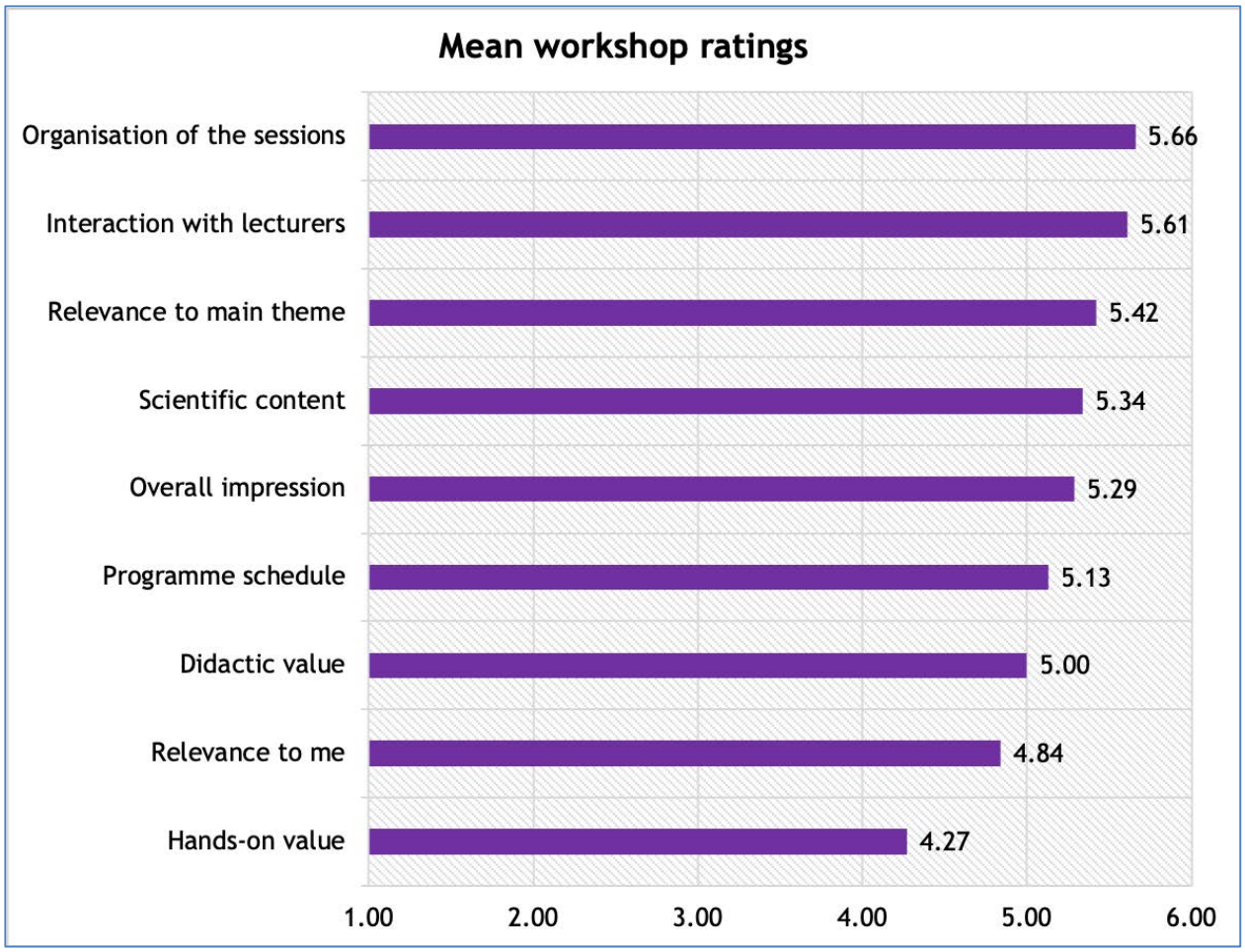

Figure 9: Mean rating of workshops along evaluation dimensions (n = 38)

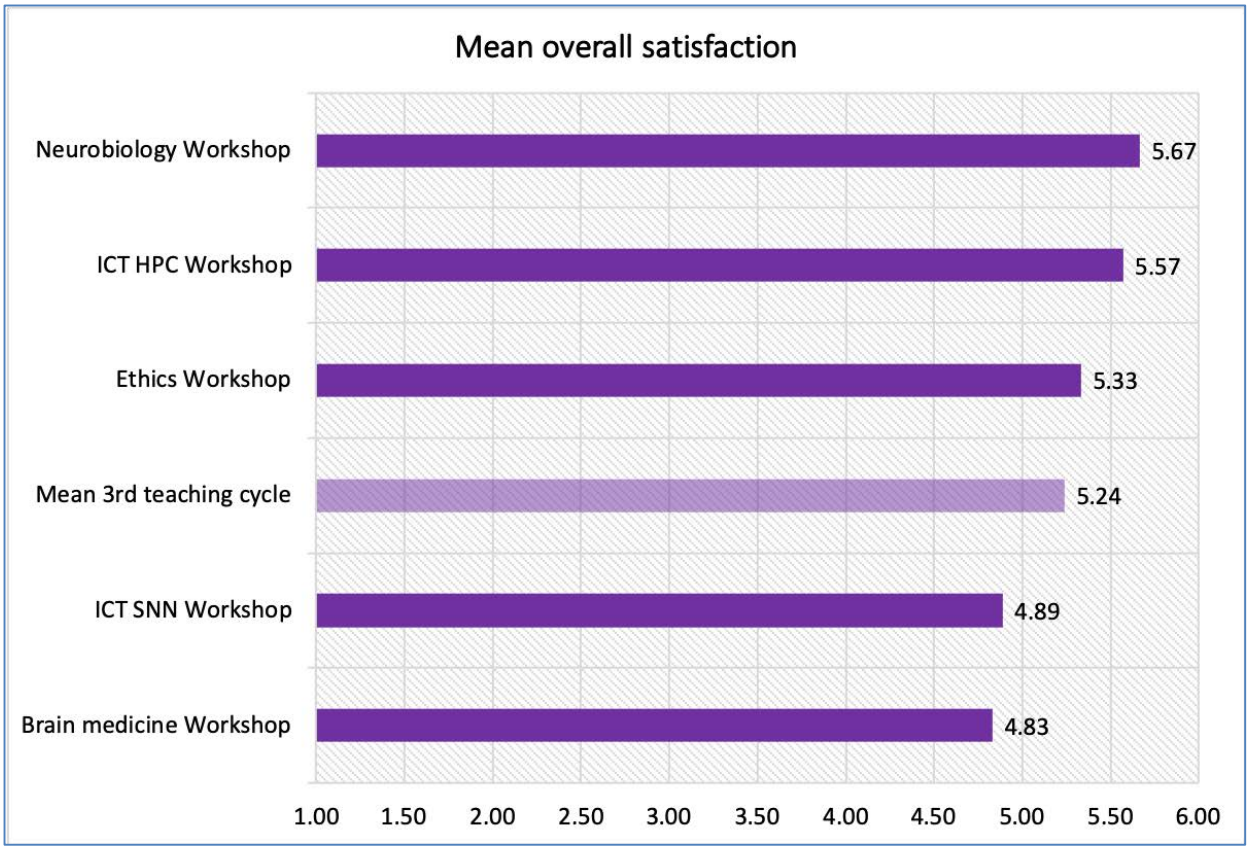

Figure 10: Mean overall attendees' satisfaction

Participants were further asked to rate different aspects of the Workshops' impact on their future career. All aspects were rated satisfactory to good, whereby general aspects, such as the acquisition of new information or the contact with other early-career scientists, were rated higher than concrete outcomes, such as skills development in both techniques or project planning, which again corresponds to other results concerning specific hands-on contents in the Workshops. The overall mean impact rating is 4.57.

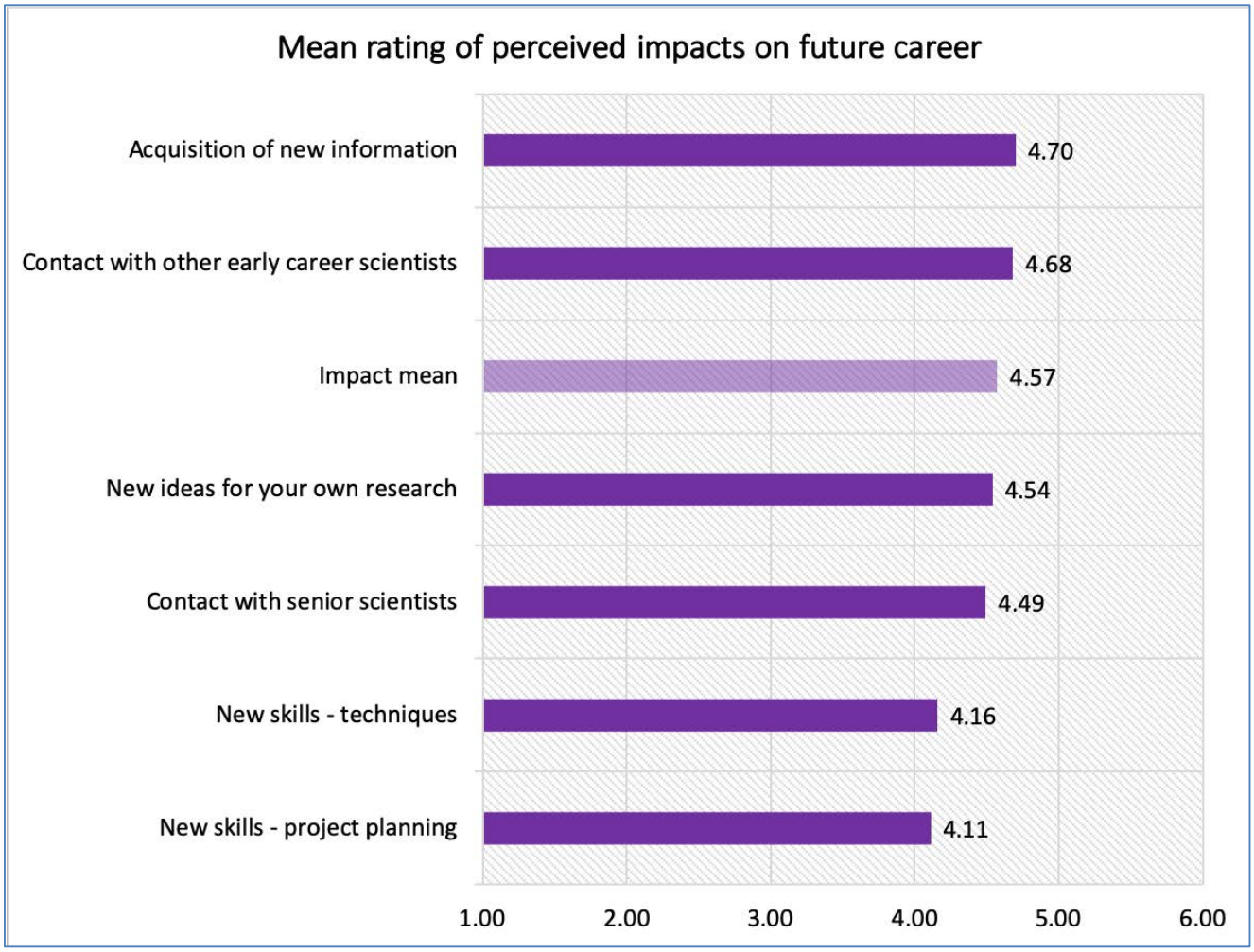

Figure 11: Mean rating of perceived impact on future career

2.2.5 Evaluation results from feedback sources

The outcomes of the open feedback analysis by keyword categorisation is shown in Figure 12. The most important content aspects relate to hands-on content, interaction, programme planning and common thread, financial support and marketing. Time planning and future format were further, though less frequent, feedback items. The category 'operative' shown in the table regards logistical aspects of the Workshops. These will not be outlined in detail in the following sections, as most of them have already been implemented in recent Workshops or are related to the specific properties of the Workshop venues and cannot be meaningfully generalised.

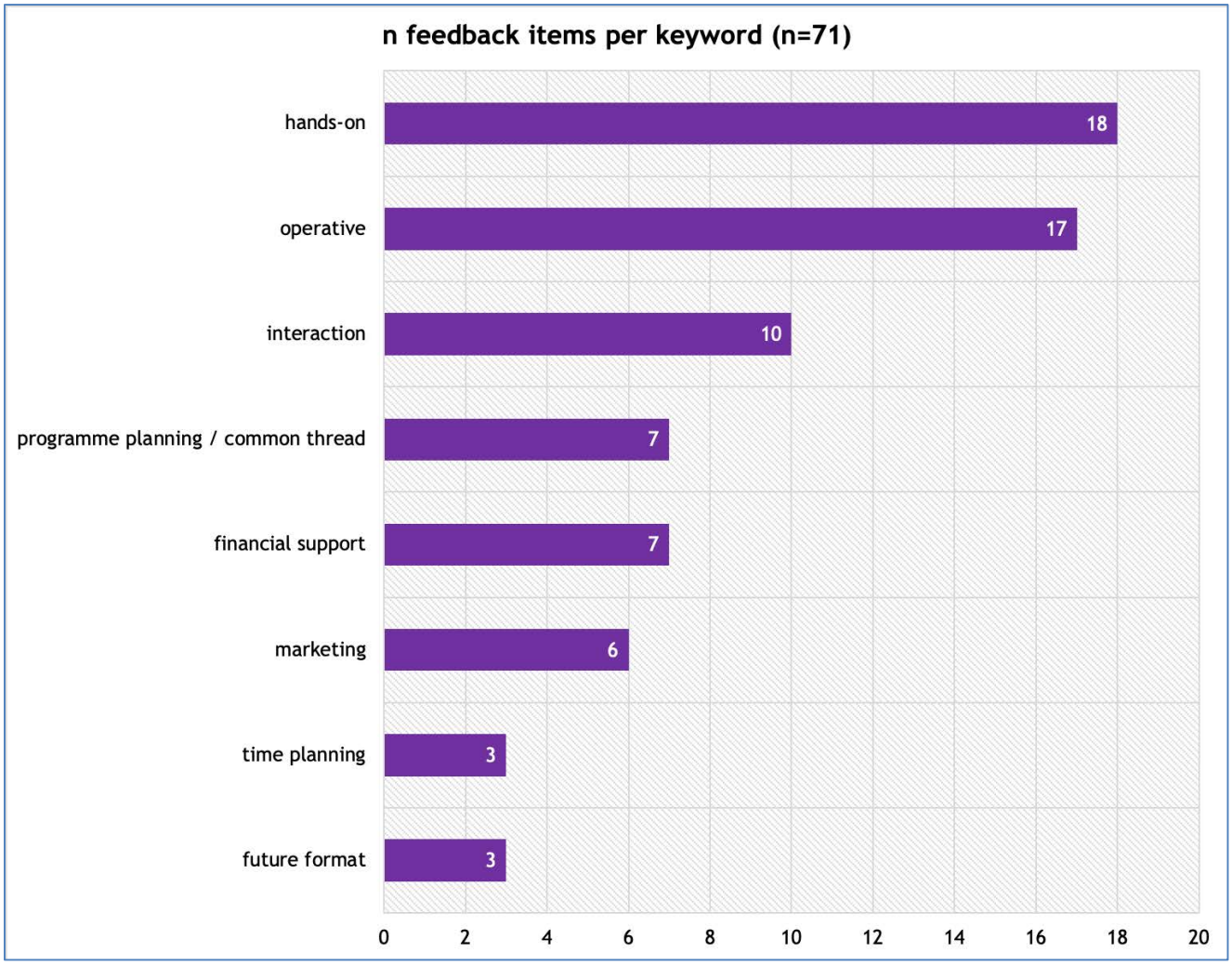

Figure 12: n feedback items per keyword

2.2.5.1 Focus on hands-on format

The biggest number of feedback items concerns the wish for more hands-on content within the Workshops (n = 18). Participants remarked that more time for hands-on-sessions would be very valuable. Various recommendations for potential formats and improvements were provided. They include ideas on how to increase hands-on value within lectures, e.g. by

- Including case studies / real-world applications of theoretical constructs to lectures and discussing these
- Including concrete examples.

However, also a higher proportion of alternative formats was suggested as a supplement to classical lectures. This includes

- Lab visits
- Excursions
- Provisions of toolboxes
- Tutorials

Additionally, several items concern the wish for more HBP-specific hands-on training. Participants would like to receive basic training for the HBP Infrastructure Platforms. From the feedback received it becomes clear that the participants actually expect concrete takeaways from the Curriculum Workshops. They want to learn something specific that they can apply right away in their day-to-day

work and research. Also, several positive comments on hands-on sessions within the past Workshops support the argument for more hands-on content.

2.2.5.2 Focus on interaction

The wish for more interaction was the second main theme of received feedback. The following aspects were mentioned in various sources:

- More formal interaction (within sessions) by interactive formats (discussions, group work etc.)
- Opportunities for informal (breaks / social gatherings) and semi-formal (e.g. letting participants introduce themselves) interaction
- Increasing interdisciplinary interaction through greater variety in participants' background
- Mixed formats within one Workshop: Lectures, tours, demos, team learnings etc.
- 'Interactive design of physical space': e.g. by choosing seating formats where participants can see each other, avoiding lecture seating
- Creating an atmosphere for interactive learning
- Overall design of event as a Workshop, rather than a conference format
- Letting participants prepare questions beforehand

In the Workshop surveys, the opportunity to get in touch with speakers and other participants was mentioned as one of the reasons to take part in the workshop in the first place. Thus, interaction between speakers and participants should be highly emphasised in SGA3 Curriculum Workshops.

2.2.5.3 Common thread in programme

Some feedback concerned a lack of common thread or didactic concept in some of the Workshops. It was proposed that the programme should have a coherent structure starting from the theoretical to the specific (specific tools, application examples – see also the section on hands-on focus). A didactic concept should be visible and learning outcome should be defined and specified prior to the Workshop.

From the faculty's side, it was implied that closer knowledge of the disciplinary background of the participants prior to the Workshop would help to align the lecture contents to their requirements and needs.

Also, a common introduction to the field and Workshop programme at the beginning of each Workshop would be valuable (this also needs a lot of prior coordination of all speakers).

2.2.5.4 Financial support & fees

In some cases, the registration fees were considered a hindering factor for participants to be able to take part in a Workshop. Some faculty members proposed that this is a factor to be thought about, while still considering that certain costs (catering, venue rent, etc.) have to be covered.

2.2.5.5 Marketing

As the number of participants was relatively low in some of the past Workshops, several feedback items concerned recommendations for increasing the number of participants via marketing measures (more extensive, more targeted). A revised communication strategy is already partly tested for the 3rd Teaching Cycle autumn workshops (especially with regard to communication channels). The feedback given concerned:

- More marketing in general
- More marketing at universities close to the Workshop venue
- More marketing concerning fee waivers and student support options (travel grants etc.) if applicable
- Encouraging the speakers to promote the Workshops within their communities

2.2.5.6 Time planning

Time planning on the one hand concerns an *a priori* schedule that is to be discussed and agreed with the Scientific Chairs in order to better plan any communication and organisational measures. On the other hand, it concerns the aim to set the deadlines for application earlier before the event so that planning certainty for both the organisers and the participants (travel) can be increased. Also, the scheduling of Workshops on dates that fit into students' term (e.g. during their holidays, or in less work-intensive periods during the semester) was suggested.

2.2.6 Future formats

Some comments regarding adaptions of the future Workshop format have been made. These relate to methodological as well as content-wise recommendations. Their feasibility has to be examined in detail.

- Defining competencies and include them in all workshops
- Enforcing support for training on the HBP Infrastructure

Also some comments were made regarding the inclusion of new content:

- Implementing a blended education programme on innovation and technology foresight
- Including new emergent issues such as open science, democratisation of infrastructure
- Ethics should be part of all courses, as this would align with the horizontal way of looking at HBP in SGA 3

3. Fourth HBP Curriculum Teaching Cycle

The fourth HBP Curriculum Teaching Cycle will be released with the start of SGA3 funding period on 1 April 2020. The following chapter provides further details on the online courses and workshops foreseen in the 4th Teaching Cycle.

3.1 Online courses for the 4th HBP Curriculum Teaching Cycle

The online courses for the fourth Teaching Cycle will be adapted as outlined in Chapters 2.1.7.2.2, 2.1.7.2.3 and 2.1.7.2.4. Changes from the third Teaching Cycle include the removal of one lecture in the course on Cognitive systems and one lecture in the course on Research ethics and societal impact. Additionally, minor adaptions of titles and descriptions will help to better target the course offer to interested early-career researchers. Links to further reading and other material will enrich the course participants' learning experience and the inclusion of a survey will enable the Education Programme Office to gather direct feedback from the course participants.

3.2 Call for Expression of Interest (CEoI) for 4th HBP Curriculum Workshop Series

In order to identify Scientific Chairs for the fourth HBP Curriculum Workshop Series, a Call for Expression of Interest (CEoI) will be opened in December 2019. The call targets researchers within or outside the HBP, including HBP Partnering Projects, who would like to chair a workshop and develop the scientific programme schedule together with the HBP Education Programme Office.

The tasks of the Scientific Chairs include:

- Selection of dates and venue (together with the Education Programme Office)
- Set-up of programme schedule
- Speaker invitations (supported by the Education Programme Office; follow-up on invitations as well as speaker administration)
- Communication with speakers regarding the scientific programme
- Regular meeting attendance (video conferences) with HBP Education Programme Office to discuss the progress of the Workshops
- Participant selection (supported by the Education Programme Office; communication with participants handled by the Education Programme Office)
- On-site attendance for the full duration of the Workshops

Administrative and financial support will be provided by the HBP Education Programme Office. More specifically, this includes:

- Selection of dates and venue (together with the Scientific Chair)
- Management of applications
- Communication with participants
- Communication with speakers (follow-up on invitations by Scientific Chairs, logistics)
- Promotion and outreach (newsletter, social media, event calendars)
- Collection of registration fees
- Management of budget

- Management of student financial support
- Preparation of workshop materials (e.g. programme, badges, etc.)
- On-site administrative support
- On-site media support (photographing, video recording if required)
- Post-processing of Workshop (photo and video editing, report, Workshop survey)

The content of the Workshop proposals should target the HBP core research areas. However, they will no longer be restricted to one single theme, but can also reflect the integrated view that is central to the Human Brain Project in SGA3. Some key evaluation findings from the Third Teaching Cycle will be reflected in the call guidelines or other guidance documents by the Education Programme Office:

- Submitted proposals should contain a to-be-defined minimum proportion of hands-on sessions in their proposed programme.
- Draft guidelines / best-practice examples on hands-on sessions will be delivered as supporting information for proposal submitters.
- Proposals will include a section on how the Workshop programme relates to the HBP Infrastructure.
- Submitted proposals should include a to-be-defined minimum of different session formats.
- Draft guidelines / best-practice examples on interactivity will be delivered as supporting information for proposal submitters.
- Proposals will include a section where submitters explicitly have to state what participants can gain from the Workshop.
- Proposal evaluators will be advised to especially look at a common thread within the programmes suggested in the proposals.
- Sessions on ethical questions will be included in all workshops in collaboration with the HBP's ethics team and the Work Package Ethics Rapporteurs.

The Call for Expression of Interest will be announced through the HBP Education Programme's communication channels. The announcement can be viewed on the official HBP Open Calls subpage at https://www.humanbrainproject.eu/en/collaborate/open-calls/

Annex A: Online lectures - evaluation results

Lecture name	mean lecture rating	n
ICT for non-specialists		
Lecture 1: Computational complexity	4.67	2
Lecture 2: Numbers, errors, chaos	4.50	2
Lecture 3: Turing, computability, halting problem	4.00	2
Lecture 4: Introduction to software engineering	5.17	2
Lecture 5: Cheap as chips!	5.00	2
Lecture 6: Advanced data management	5.33	2
Lecture 7: Querying and analysing big scientific data	4.67	2
Lecture 8: Electronics and VLSI	4.67	2
Brain medicine for non-specialists		
Lecture 1, part 1 and 2: The natural history of neurodegenerative diseases: Can we modify it?	5.83	2
Lecture 2, part 1 and 2: Clinical neuroanatomy: From a lesion to a symptom	6.00	2
Lecture 3: Neuroimmunology: The brain as a cognitive antigen	5.83	2
Lecture 4: Motivation and addiction: Neuronetworks and target treatments	5.17	2
Lecture 5, part 1 and 2: Clinical aspects of brain imaging	5.83	2
Lecture 6: Neurodegenerative diseases - En route to early detection and prevention	5.83	2
Lecture 7: Introduction to schizophrenia	5.83	2
Lecture 8: Affective disorders: Depression and somatic co-morbidity	5.67	2
Lecture 9: A manic depressive history: The genetic dissection of complex neuropsychiatric disorders	6.00	2
Lecture 10: HBP Medical Informatics Platform: Parkinson's disease and more …	5.83	2
Lecture 11: Principles of neuropharmacology	5.50	2
Cognitive systems for non-specialists		
Lecture 1: Internal models and counterfactual cognition predicting our environment	5.50	2
Lecture 2: Making our selves: From psychology to robotics	5.33	2
Lecture 3: Can robots ever become conscious? Insights from theory and experimental neurobiology	5.00	2
Lecture 4: Introduction to the Neurorobotics platform	2.67	2
Lecture 5: Deep reinforcement learning for robotic control	5.67	2

Lecture 6: Bio-inspired control architecture for mobile robotics	4.33	2
Lecture 7: Neuroscience and robotics	5.00	2
Lecture 8: The social robot: Emotions and drives	5.50	2
Research ethics and societal impact		
Lecture 1: Introduction to ethical theory	5.67	1
Lecture 2: Computer ethics and the HBP	5.67	1
Lecture 3: The Ethical Roboticist	5.33	1
Lecture 4: Responsible Research and the Human Brain Project	5.67	1
Lecture 5: Scaling up neuroscience - Responsible Research and the big brain projects	5.00	1
Lecture 6: Neuroscience and the problem of dual use	4.67	1
Lecture 7: Ethics in biomedical research and the 3Rs	5.67	1
Lecture 8: Societal attitudes to animal research	2.67	1
Lecture 9: Research integrity and ethics management - HBP Case study	5.00	1
Lecture 10: Cognitive enhancement: Ethics and efficacy	4.33	1
Lecture 11: The Thinking Robot	5.67	1