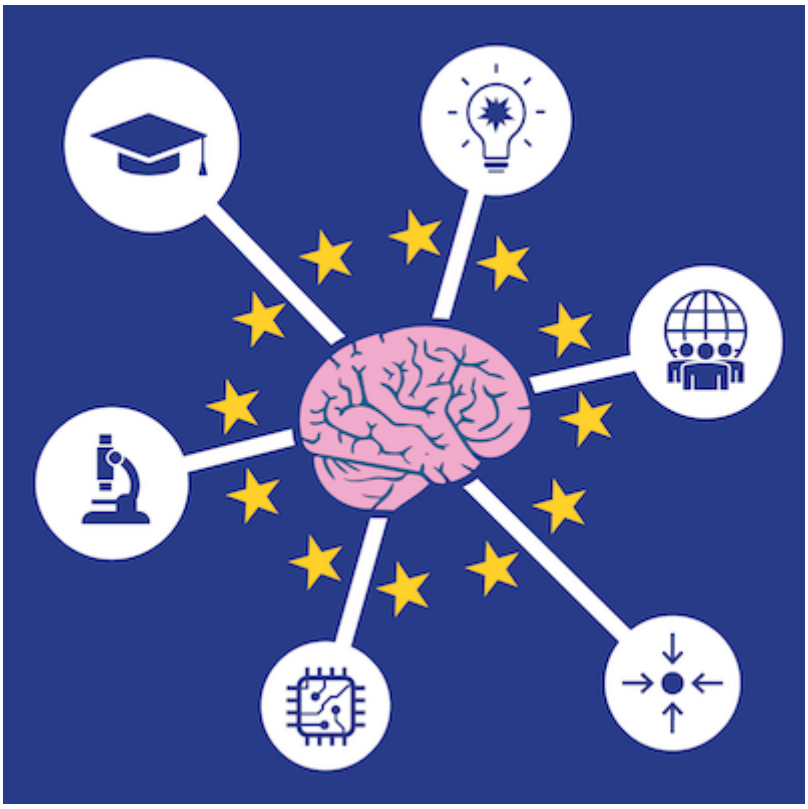
Neurotech^{EU}

The European University of Brain and Technology



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Unique higher education programs for technological innovation

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R&D School

Introduction

Neurotechnology is a transdisciplinary field that combines neuroscience, engineering, informatics, and technology to develop innovative solutions for challenges related to human health and function. It encompasses a wide range of techniques, devices, and interventions aimed at understanding, monitoring, and manipulating the nervous system. Additionally, as neurotechnology ventures into this human-related territory, it is vital to explore the connections of neurotechnology with humanity and social sciences.This transdisciplinary approach should address the questions about ethics, social impact, and the wider implications of these neurotechnological solutions on individuals and society. Although the field has seen significant progress in fundamental research, technological innovations, and clinical applications, there is still much to explore and develop in neurotechnology to fully harness its potential.

Neurotechnology requires collaboration between researchers, engineers, clinicians, and industry experts from diverse disciplines, and its multidisciplinary nature poses challenges in terms of effective communication, knowledge sharing, and collaborative problem-solving. Moreover, it demands a wide range of skills and expertise, including knowledge of neuroscience, engineering principles, data analysis, computational modeling, and clinical understanding. However, educational programmes often struggle to provide comprehensive training that integrates all of these diverse disciplines [1].

Another concern is the translational gap between academic research and real-world applications. Many promising neurotechnological solutions developed in research environments struggle to be successfully translated into practical use due to various factors, including patenting issues, scalability, regulatory challenges, ethical considerations, and limited integration with existing healthcare systems [2].

Therefore, we propose to establish a Research and Development (R&D) School as a lifelong learning programme that can foster multidisciplinary collaboration by providing a common educational platform for these stakeholders to come together, exchange ideas, and work towards shared goals in enhancing the translation of neurotechnological innovation into the industry and market. The R&D School can also offer specialized training programmes tailored to the specific needs of enthusiasts or professionals in the neurotechnology field and bridge the knowledge gaps between academic research and clinical applications. Moreover, the R&D School, with an associated educational platform, can serve as a hub for knowledge dissemination by providing accessible training content, organizing conferences, workshops, and seminars, and facilitating collaboration and networking among researchers and professionals in the field.

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Establishing an R&D School that serves as a foundation for an educational platform and facilitates ongoing development is essential to advancing neurotechnological solutions, meeting industry needs, bridging the gap between academia and industry, enhancing professional development, and achieving widespread impact through knowledge dissemination. By providing a dedicated space for translational research, university-industry collaboration, and skills enhancement, the R&D School can contribute significantly to the growth and advancement of the field of neurotechnology and its impact on not only human health, but also industry, economy and society.

The R&D school aims to facilitate collaboration between academia and industry in the field of neurotechnology. We aim to enable both participants and researchers to comprehend and appreciate the impact of real scientific research projects on industry and daily life. Additionally, we would like to foster reflection on the formation of scientific thought and its practical application in everyday scenarios. Furthermore, the scope of this initiative will remain open to continuous development and expansion.

Motivation

The findings of the study carried out by the central organizational structure for university-industry collaboration (NeurotechEU-NEURICOO) have yielded important findings (Figure 1). In this study, the participants were asked to vote for each topic by choosing scores from 1 (least important) to 5 (most important) to understand the needs of NeurotechEU stakeholders' technological innovation challenges. The study indicated a distinct demand for dedicated certificate programmes that focus on R&D and entrepreneurship education. These findings highlight the importance of providing targeted educational programmes that cater to the specific requirements and interests of individuals involved in neurotechnology. By offering certificate programmes in R&D and entrepreneurship, NeurotechEU-NEURICOO can effectively address the identified needs and support the development of skills and knowledge in these areas. The significance of such certificate programmes lies in their potential to bridge the gap between academic knowledge and practical application in the field of neurotechnology.

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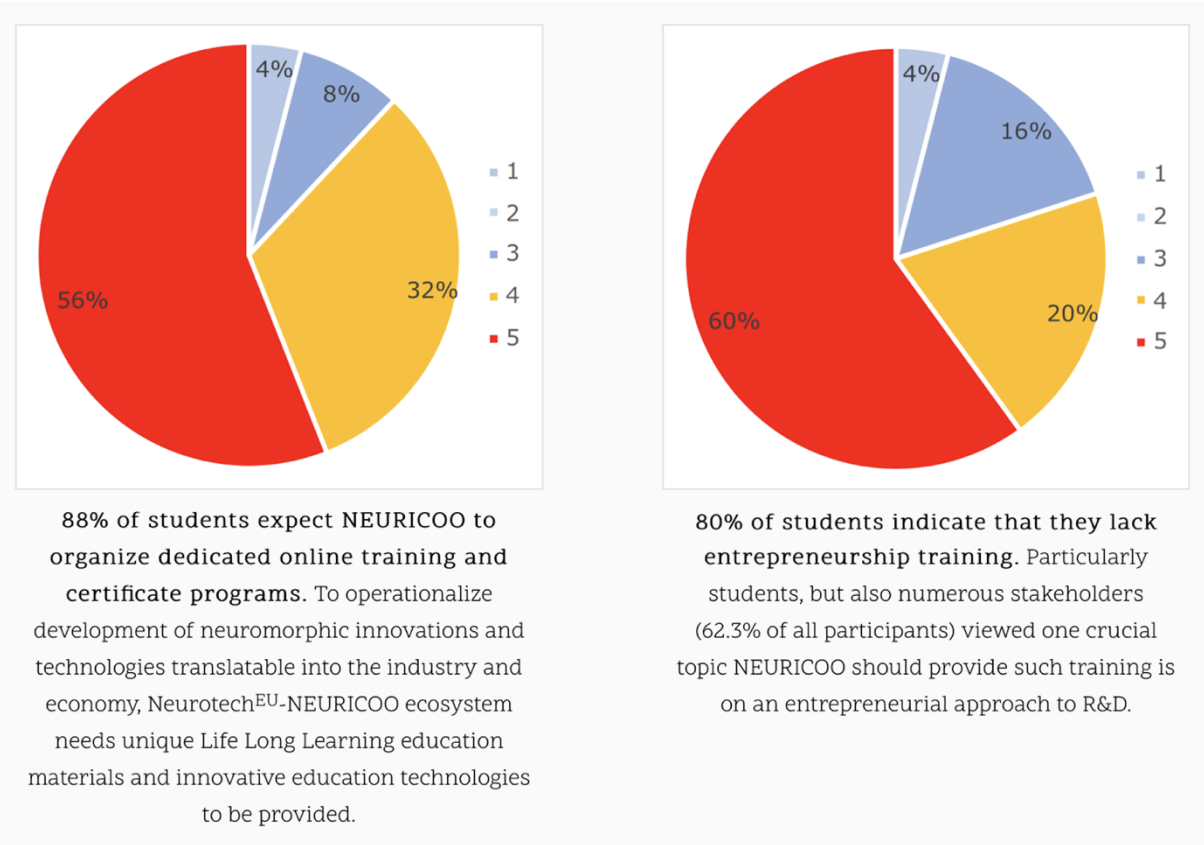

Figure 1. NeurotechEU-NEURICOO survey results show the importance of certification and R&D-targeted training. 1= least important to 5= most important. The percentages indicated in the text are the summed percentages of participants answering 4 and 5 for each category. Reference: https://theneurotech.eu/neuricoo/

Aims of the R&D School

The R&D School aims to develop an educational platform for advancing the professional training of scientists and engineers, whether they are relatively new to the profession or are lifelong learners, to guide them in the development of neurotechnological solutions that will address challenges threatening human health. The specific objectives of the R&D school are as follows:

1. Develop 'train the trainer' programmes for industrial partners, who could then share their knowledge with the trainees of the R&D school in a more concise manner;

2. Teach the trainees the important components of the full cycle of the research and development journey of neurotechnological products;

3. Promote lifelong learning to advance the knowledge base of trainees for neurotechnological product development;

4. Foster interaction and collaboration among academic and industrial stakeholders, creating an environment conducive to information sharing regarding R&D processes.

Target Groups

The project targets four main groups: (i) senior high school students, who are on the verge of selecting a profession, (ii) senior students in science and engineering disciplines, who are about to embark on their professional careers, (iii) scientists and engineers, who are within their first five years of professional experience, (iv) more senior lifelong learners.

The intention is to conduct a needs analysis for these trainee groups and design a training platform that aligns with their specific needs. The R&D School will be committed to developing a continuous professional development platform targeting everyone: those who are still in training, or relatively new to the profession, or lifelong-learning enthusiasts.

Neurotechnological Product Development Cycle

The R&D School will provide education to its trainees on the full *neurotechnological product development cycle,* which includes,

- *Idea Generation:* This is the initial stage where ideas for new products or product improvements are generated. It can come from various sources such as market research, customer feedback, or brainstorming sessions. It also involves defining the target customer base of the solution and forming a team.

- *Research and Feasibility Analysis:* Once an idea is identified, research and analysis are conducted to assess its feasibility. This includes evaluating market demand, competition, technical feasibility, cost implications, and potential risks.

- *Concept Development:* In this stage, the idea is further refined, and a concept for the product is developed. This involves creating sketches, prototypes, or conceptual designs to visualize and communicate the proposed product structure.

- *Design:* Detailed design involves overall structure design and detailed design specifications. The design phase includes creating drawings and methods, and selecting materials or components, user interface design, data models and manufacturing processes.

- *Prototype Development or Implementation:* A prototype is created so that the design specifications can be developed, tested and validated. It can be a physical prototype, a virtual model, software, or a functional representation of the product. For software development, this phase is where the actual coding takes place through developing individual modules and integrating them based on design specifications. Prototyping helps identify design flaws, make necessary iterations, and gather feedback for further improvement.

- *Testing and Validation:* The prototype undergoes rigorous testing to ensure it meets the desired specifications, functionality, and quality standards. This includes performance

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testing, usability testing, safety testing, and compliance with relevant regulations or standards. Bugs and issues are identified, reported and fixed during this phase.

- *Manufacturing and Production or Deployment:* Once the design and prototype are finalized and have passed all the necessary tests, the product moves into the manufacturing phase. The production processes, tooling, scaling and supply chain logistics are established to mass-produce the product efficiently and cost-effectively. For software products, the deployment process includes preparing infrastructure and configuring the software for actual use and installation.

- *Regulations and Certification:* Before a product can be marketed, it is necessary to certify it in accordance with the medical devices regulation (MDR) of the EU. (https://health.ec.europa.eu/medical-devices-new-regulations/getting-ready-new-regulations_en)

- *Marketing and Launch:* Marketing strategies are developed to create awareness, generate demand, and promote the product to the target audience. This includes branding, packaging design, pricing, distribution channels, and marketing campaigns. The product is officially launched into the market.

- *Sales and Distribution:* The product is made available to customers through various sales and distribution channels. Sales teams are trained, distribution networks are established, and inventory management systems are set up to ensure smooth availability of the product.

- *Evaluation, Feedback and Maintenance:* After the product is launched, its performance and customer feedback are continuously monitored and evaluated. This phase helps to fix bugs, make improvements, address customer concerns, and plan for product updates or future iterations.

Approach

To achieve the R&D School's objectives, the following steps will be followed.

- *Step 1 Needs Analysis:* What are the training needs of the target groups participating in the R&D School?

    - Final-year high school students preparing for university entrance exams and focusing on studying science and engineering;

    - Final-year science and engineering students at the university;

    - Scientists and engineers who have recently started working in the industry;

    - Lifelong learners.

- *Step 2 Selection of Training Contents and Instructors:* In which subjects will R&D School provide education, and how will the instructors be selected?

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- *Step 3 Train the Trainer:* What kind of training will the instructors at the R&D School undergo regarding course content preparation, determining the pedagogical methods for delivering the course, course delivery, and evaluation?

- *Step 4 Development of an Educational Platform:* Which steps are needed to develop an interactive distance-portal for R&D School?

- *Step 5 Evaluation:* What are the reflections of the educators and participants at the R&D School regarding the course content, the pedagogical methods, and the learning outcomes they aim to achieve in the course? Are the participants satisfied with the course? Did they achieve their objectives?

Needs Analysis

The target groups identified in the scope of the project have different learning needs. A needs assessment should be performed to gather information from different participants, who have diverse purposes, and are at varying levels of proficiency. The development and implementation of this needs analysis is the first objective of this project. For the first target group, which consists of final-year high school students who are in the process of choosing a educational path, these needs will be addressed mainly in the context of career awareness. For the next two groups, represented by final-year university science and engineering students about to enter the profession and scientists and engineers in their first five years of their career, these needs will be addressed mainly in the context of solution-oriented product research and development processes. For the lifelong learners, the needs will be determined based on new developments in the field of neurotechnology. The needs analysis will be conducted at the beginning of the establishment of the R&D School, and the contents will be determined and shaped accordingly. In this context, the necessary content will be created to prepare the training programmes targeting the groups specified in the R&D School.

Surveys and focus group interviews will be used as data collection instruments to conduct the needs analysis. A separate survey will be created for each target group. The survey questions will be prepared based on comprehensive field scans explicitly conducted for the target groups and the topics within the framework of this R&D School. It is planned to distribute the surveys to the relevant groups online using tools such as SurveyMonkey or Google Forms. The results from the surveys will be analyzed using statistical software such as SPSS in the light of a comprehensive literature review. In addition to the surveys, face-to-face focus group interviews will be conducted with small representative subgroups of each group. Participants will be asked open-ended questions during the interviews, and a collaborative discussion environment will be created. These interviews will be recorded with the participants' consent. The audio recordings will be transcribed later and analyzed using qualitative methods (e.g., content analysis). Pilot studies will be conducted with representative subgroups of the target groups before upscaling the analysis to the broader target groups. Based on the results of the pilot studies, changes may be made to some of the survey or focus group interview questions. The research instruments will be prepared for implementation based on the pilot study data.

The training structures, which refer to the appropriate methods used to train participants in the R&D School (syllabus, courses, other resources, etc.) will be designed to suit the target groups' characteristics and needs. The target groups for the training will include the participants and the

trainers who will deliver the training. The training content will be created regarding the characteristics and needs of the target group.

The R&D School Course Contents

In the scope of the R&D School, entrepreneurship and innovation support activities will be carried out. The process of product/idea/project development starts at the idea stage and continues until the product is sold and scaled up. During this process, entrepreneurs pass through the different stages as a function of the nature of the product and require different types of support. Systematic approaches are recommended, especially for health technologies where product development processes and costs are relatively high.

The R&D School will offer courses that teach the necessary steps for developing a neurotechnological product. The Biodesign Programme, which includes the "Define, Design, Implement" processes, offered at Stanford University (https://biodesign.stanford.edu/), can be given as an example for identifying real needs in a clinical environment and designing appropriate and marketable products.

The following are the courses that may be required during the idea development stage:

- Writing a Business Plan
- The Canvas Business Model
- Advanced Presentation Techniques
- Team Creation and Management
- Design Thinking
- Product/Technology Management
- Designing a Revenue Model
- Accounting, Finance, and Financial Statements
- Intellectual Property Rights Management

To support the product development processes, more focused trainings can be added as follows:

- Business Modeling
- Product-Market Fit
- Business Plan
- Startup Law
- Investment Processes

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- Advanced Entrepreneurship Ecosystem
- Effective Presentation Techniques
- Financial Literacy
- Intellectual and Industrial Property Rights

During the scaling-up processes for projects that have been transformed into products and resulted in sales, the following training courses can be provided:

- Production Techniques
- Pricing Strategies
- Digital Marketing
- Project Management
- International Trade
- Grants, Funds and Investments
- Research Techniques
- Industrial Design
- Company Valuation and Investment Processes
- Customer Development

In addition to these training courses in health technologies, the following technical and thematic training topics can be offered:

- Technical Infrastructure Usage and Operation Training
- Product Development
- Licensing
- MDR Process Consultancy
- Quality and Certification Consultancy and Training
- Training on the Use of Devices in the Laboratory
- Environmental and Waste Management
- Safety Procedures and Human Health
- GMP Process Consultancy
- Validation and Maintenance, Repair Support

In addition to the training topics listed above, ventures also require consultancy and mentoring support in areas such as

- Law and Ethics
- Finance
- Entrepreneurship
- Patenting and intellectual property management

To provide career awareness in high school students, the following content might be included.

- Neurotechnology
- Science and engineering in a nutshell

Before being fully accessible to the target groups, the training contents will undergo pilot studies by experts in adult education, allowing for further refinement and development of the activities. To ensure the modules forming the foundation of the R&D School align with industry requirements, they will be developed in collaboration with industrial partners. The activities and studies conducted within this framework will provide valuable support to industry professionals attending the school.

An interactive distance learning portal will be developed as the R&D School educational platform. The integration of the training content and related activities into the platform will be provided.

Evaluation Procedure

The feedback and evaluations of the participants regarding the content presented throughout the R&D School will be analyzed through qualitative measurements (continuous interviews - at least at the beginning, middle, and end of the school) and surveys. The collected data will be analyzed and interpreted based on thematic analysis. Surveys conducted at the beginning and end of the project will also provide a quantitative analysis infrastructure for a broad audience regarding the content included in the project and its presentation methods. The aim is to understand how the students/participants comprehend and evaluate the presented content using scales. Scales will be selected from existing scales in the field and adapted to the project for implementation.

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