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NEURO PEDAGOGY

GOOD PRACTICE GUIDE BASED ON NEUROSCIENCE

NEUROPEDAGOGY

2020-1-PL01-KA203-081740

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OVERVIEW

The general objective of the Neuropedagogy project is to improve European higher education learning quality by generating an innovative didactic proposal based on neuroscience. Although educational and cognitive sciences offer a wealth of theories and associated best classroom practices, neuroscience can bring a biological approach that can explain why these practices work and may suggest additional approaches. Learning is the result of changes which take place in the brain, so higher education should aim to understand those changes and present new information in a way that the students' brain will receive more effectively.

Universities and higher education institutions must recycle to adapt to the needs of their students and to the current social and employment situation. The information era and the new technologies have brought about a change in our brains, which, thanks to neuronal plasticity (the ability of the brain to adapt to new environments), today obey different stimuli. Oral language from the pulpit in teaching is no longer enough. Image and interaction are vital to learning today, and teachers must know how to use them effectively, as well as their non-verbal communication, gestures, behaviour, etc.

This good practice guide is part of the second Intellectual Output of the Neuropedagogy project, and a continuation of the first Intellectual Output, which consisted of a series of studies on neuroscience applied to higher education and a study to identify training needs in higher education instructors.

The aim of this good practice guide based on neuroscience is to present a series of examples of best practices, in order to prepare appropriate pathways for the development of the training skills required by higher education instructors in their teaching.

This document will present some examples of neuroscience applied in a variety of educational settings. Principles of neuroscience have mostly been tested and applied in school education programs, from early years to secondary education. In higher education, nonetheless, the cases are scarce, hence the relevance of this

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Neuropedagogy project. This guide will also outline two examples of European Strategic Partnership projects in which training educators in the principles of neuroscience has been considered important, for them to have a better idea about how the brain functions and improve their teaching practice.

COLLECTION OF GOOD PRACTICES

Here are nine examples of how different educational institutions have drawn on neuroscience to improve their teaching practice.

These institutions, which include primary schools, secondary schools, and universities, have carried out a series of programs or pilot exercises in which they have applied a variety of neuroscience principles to their educational offer.

The selected examples present some of the topics and methods that have been mentioned in the previous Intellectual Output, the study to identify training needs in higher education instructors, such as diminishing the fear of punishment, gamification or monitoring the attention capacity of students.

Name and location	Learnus working with schools: Kilgarth School (Birkenhead, UK).
Type of activity	A community dedicated to bringing educators and those who specialize in the study of the brain working with a secondary school for boys aged 11-16 who are experiencing social, emotional, and mental health difficulties.
Links	https://learnus.co.uk/ https://learnus.co.uk/schools.html https://www.sec-ed.co.uk/best-practice/case-study-the-school-that-abolished-punishment/
Description of good practices performed	Learnus is a community dedicated to bringing educators and those who specialize in the study of the brain, the mind and behaviour together in order to use the insights gained from high quality research to improve and enrich learning for all. Their members

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	include neuroscientists, cognitive scientists, educationalists, psychologists, teachers, policy makers and commentators. They started working with Kilgarth School an implemented behavioural modification and management systems. The systems are predicated upon the belief that sanctions do not work for the majority of pupils and may militate against positive behaviour modification. Their approach to behavioural modification is based on three main components: • An effective reward system based on short, medium and long-term rewards, a reduced behaviour monitoring period and an emphasis on positive reinforcement. • Curriculum modification to enhance teaching of social skills, social problem-solving skills and emotional regulation. • Intervention to ensure that post event learning opportunities are fully utilized. There is no use of sanctions and staff do not use language that can be associated with punitive approaches. All of their interactions with pupils are positive, avoid confrontation and promote de-escalation. Headteacher Steve Baker believes that the measure has been incredibly fruitful, and that they are now supporting other schools to implement this system. Baker states that they have helped train over a thousand teachers and teacher assistants on non-confrontational behaviour management.
Transferability to higher education	Although this system does not allow for direct implementation to higher education as it is, there are aspects that can be transferred, such as finding ways of implementing positive reinforcement, and considering curriculum modification to enhance teaching of social skills, social problem-solving skills and emotional regulation.

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Name and location	Neuroscience & the Classroom: Making Connections (Los Angeles, US).
Type of activity	A video course that acquaints schoolteachers with current neuroscience research that they can apply in their own classrooms.
Links	https://www.learner.org/series/neuroscience-in-the-classroom/ https://dokumen.tips/documents/neuroscience-the-classroom-making-connections-the-classroom-making-connections.html
Description of good practices performed	*Neuroscience & the Classroom: Making Connections* is a self-contained distance-learning course distributed free of charge on the Web. One of the central goals of the course is to help teachers learn to use research to create their own solutions to their classroom challenges. Another important goal is to provide new and useful metaphors that we all can use to describe teaching and learning and that are grounded in modern neuroscience. Through this course, teachers learn to think critically about the field of Mind, Brain, and Education and thus learn to be informed consumers of information about brain science, better able to separate science from myth and misinterpretation. The course was designed for teachers (from nursery to secondary school), other educators, researchers, and adult learners who want to learn more about current issues in education.
Transferability to higher education	By adapting the contents to target higher education instructors, this type of course and format is highly transferrable to higher education.

Name and location	Stop and Think (London, UK).
Type of activity	Computer game that can help improve children's maths and science achievement.
Links	https://www.ucl.ac.uk/ioe/news/2019/sep/researchers-create-computer-game-can-help-improve-childrens-maths-and-science-achievement

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	https://www.bbk.ac.uk/news/neuroscience-based-educational-intervention-can-improve-primary-school-maths-and-science-performance
Description of good practices performed	Research investigating brain activation of adults completing maths and science problems shows that the need to inhibit pre-existing beliefs is true even for science experts. It is not that experts have completely replaced their 'naive beliefs' with new more advanced scientific ideas, but rather that experts have become better at inhibiting those early beliefs to allow the more advanced scientific ideas to come to the fore. Researchers from the Centre for Educational Neuroscience developed a computer game called 'Stop and Think', for teachers to use, that will help primary school children use their inhibition skills effectively in maths and science lessons to overcome their 'naive beliefs' and learn the correct concepts. A large-scale randomised control trial was funded by the Education Endowment Foundation and Wellcome to test the efficiency of the computer game. 6672 children from Year 3 (7- to 8-year-olds) and Year 5 (9- to 10-year-olds) in 89 schools across England took part in the study. Pupils who participated in the program made the equivalent of +1 additional month's progress in maths and +2 additional months' progress in science, on average, compared to children in the lessons-as-usual control group. Professor Denis Mareschal (Birkbeck, University of London), Principal Investigator of the project, said: "This project illustrates how findings from cognitive neuroscience, when properly interpreted, can have a positive impact on educational practice and outcomes".
Transferability to higher education	This type of computer game could perhaps be used in higher education, if adapted to scientific graduate or postgraduate courses, to inhibit pre-existing beliefs.

Name and location	ST Math - Tradigital Learning Plan (Ohio, US).

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Type of activity	Game-Based Math Learning.
Links	https://www.educationnext.org/the-case-for-game-based-math-learning/ https://cdn2.hubspot.net/hubfs/237516/Operations/Collateral/Profiles%20in%20Success/Profile_OH_Pickerington_EP-GN-152_Web.pdf https://www.stmath.com/
Description of good practices performed	ST Math is a supplemental visual instructional program from the MIND Research Institute, for students from early childhood education to middle school that leverages the brain's innate spatial-temporal reasoning ability to comprehend and solve mathematical problems presented as a game. ST Math avoids complex abstractions when a student is first encountering a mathematical concept. Twenty-five years ago, neuroscience researchers from the University of California, Irvine, had the insight that our brains are hardwired for visual pattern manipulation. These researchers created visual puzzles to test this observation and found that all students had a surprisingly high visual reasoning ability. They knew that this innate ability was not being leveraged to solve a serious education problem: a lack of deep conceptual understanding of mathematics. This led to the founding of ST Math, which created a math curriculum that uses visual puzzles. Pickerington Schools, a group of schools in Ohio, incorporated the ST Math game-based learning program to support their educational plan. The school introduced the 'Tradigital Learning Plan', a big shift in classroom instruction, and as with any kind of change, teachers responded with excitement mingled with some nervousness. "The greatest impact ST Math had on teachers is the impact on their mindset," one of the teachers stated. "At first they were afraid of the games and hadn't thought about maths that way. They were intimidated." But eventually, it was the students who showed the teachers the way. Students were excited about celebrating their progress on ST Math. Now teachers are using games to strengthen their lessons and studying the ST Math data reports that show each student's area of need.

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	"ST Math has really helped us move away from the teacher-led classroom to the student-driven," Pickerington's Director of Instructional Technology Brian Seymour stated. "The mindset that it's ok for kids to fail or to struggle, and not to try to jump in as the teacher to save the day, this change is happening."
Transferability to higher education	The validity of this type of game-based learning that tackles the spatial-temporal reasoning ability is not exclusive to school education. This format could be used in a higher education setting, adapting the contents and the difficulty. Higher education instructors could benefit from these sorts of tools with a neuroscience basis, to teach their curriculum in a more dynamic way.

Name and location	Hubee (Israel).
Type of activity	'Bee-like' approach to education.
Links	https://www.jpost.com/jpost-tech/transforming-classroom-learning-so-students-can-bee-their-best-593915 https://new.methodic.co.il/en/edu_en/
Description of good practices performed	Guided by leading neuroscience researcher Dr. Hadas Harel, one Israeli company – Methodica – is transforming classrooms across the country, designing engaging learning environments for pupils based on neuropedagogy, or educational neuroscience. Methodica has developed "Hubee," described as a bee-like approach to education. Just as bees manipulate nectar to convert it into honey, Methodica believes that pupils need to manipulate content presented in the classroom to ensure effective thinking and learning. For educational material to be learned successfully, Methodica says it must be taught in a practical manner every day, and all day long. Already active in 40 schools across the country, Methodica's pedagogical approach splits up classrooms into several learning corners, facilitating group study and station rotation models of education. Frontal learning is limited to just 30% of lesson time.

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	The company also integrates smartphone application-based testing into lessons, enabling teachers to monitor the responses of all pupils in the classroom in real-time. The model's success is evaluated through a combination of external and internal school inspections, exam results and parent feedback.
Transferability to higher education	This type of 'bee-like' approach to teaching could be easily transferred to a higher education setting. Higher education instructors could replicate this method and split classrooms into learning corners, facilitating group study and station rotation models of education. Limiting frontal learning to just 30% of lesson time could also be applied to higher education.

Name and location	**Artificial Intelligence and Neuroscience to improve education (Malaga, Spain)**
Type of activity	A project that works to improve education through the use of Artificial Intelligence and Neuromarketing.
Links	https://www.laopiniondemalaga.es/malaga/2021/06/09/inteligencia-artificial-neurociencia-mejorar-educacion-52794742.html http://www.colegioblasinfante.es/noticias/
Description of good practices performed	The Blas Infante school in Malaga (Spain) and the company *Goli Neuromarketing* started a pioneering project to improve the quality of teaching using Artificial Intelligence and Neuroscience. It consists of the design of a tool that allows teachers to draw profiles of learning behaviour and adapt the different resources at their disposal, to the way in which students assimilate the contents. To do this, their levels of attention, emotion and gaze tracking will be measured with an artificial intelligence platform for several days, which will allow to have a mass of data that will be analyzed later and that will serve as the basis for the creation of this tool. This trial was conducted with primary school students. A government representative stated "We all know the importance of

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	direct observation of students in the classroom to follow their progress. Thanks to this tool, which works with artificial intelligence, we will be able to have more information about the response of students to certain stimuli, and thereby facilitating the work of the teacher."
Transferability to higher education	This project could be replicated in higher education by using a similar attention-tracking tool to analyze attention patterns in higher education students and optimize the way in which information is presented.

Name and location	Soaring Heights PK-8 (Colorado, US).
Type of activity	STEM-focus school with an emphasis on neuroscience.
Links	https://www.cpr.org/2018/11/05/can-a-school-built-on-brain-science-alter-the-learning-landscape/ https://shpk8.svvsd.org/academics/neuroscience-focus/
Description of good practices performed	Soaring Heights PK8 has a focus on STEM with an emphasis on neuroscience education that is implemented across grade levels that creates a framework for students to engage in a series of hands-on, student-driven, design thinking activities. This is a hybrid model that brings together traditional aspects of a curriculum with more innovative and cutting-edge practices that are designed to prepare students for the jobs of the future. Each of these project-based activities are rooted in the standards and will complement core instruction but can be a stand-alone module. The application of this framework offers students a variety of entry points to study how the brain affects learning and behaviour based on student interest and grade level appropriateness. Students learn everything kids at other schools do, but the STEM-focused school also uses principles of neuroscience to help students persevere, concentrate, unleash creativity, regulate their emotions, and even develop empathy. They use the latest insights about how the brain works to inspire how the classrooms work. The school's

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	method is the result of the vision that Principal Cyrus Weinberger had for a school with a strong scientific approach. Understanding how the brain works and adapts to stress, for example, increases self-awareness. In turn, that helps students navigate a test, go to a dance or understanding how their body works. It also helps with peer interactions. The school's ultimate goal of incorporating neuroscience into a school is to get students to think outside the box and practice critical and creative thinking.
Transferability to higher education	There are aspects of this method that emphasizes neuroscience that can be applied in a higher education setting. Higher education students could benefit from studying how the brain affects learning and behaviour, in order to increase their self-awareness and understand how the brain is affected by stress. This method could also potentially encourage students to increase their critical and creative thinking skills, which is something that higher education institutions should strive to do.

Name and location	The CircleIn app (Indiana, US).
Type of activity	Tool based on neuroscience to encourage collaboration and promote student success.
Links	https://swinchamber.com/vincennes-university-is-among-the-first-in-the-country-implementing-tool-based-on-neuroscience-to-encourage-collaboration-and-promote-student-success/ https://www.circleinapp.com/
Description of good practices performed	For Vincennes University (Indiana, US), relationships are essential to student success, which is why they are introducing an academic and social virtual space where students can study with their peers, collaborate on projects, exchange ideas, engage in brainstorming sessions, and chat with classmates, all while forming a sense of community and creating an engaging and positive learning environment.

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	The CircleIn app, an all-in-one studying platform where students thrive and collaborate with classmates at home or anywhere, is the latest technology that Vincennes University has adopted to support its students. The app has helped 80 percent of students realize an increase in academic performance, and 66 percent gain more confidence in their ability to pass their courses. Sixty-four percent of students experienced an increase in productivity.
Transferability potential	This model of app can be used by higher education instructors or universities across the world that wish to support their students engage with each other and potentially see their academic performance increased.

Name and location	Meditation course (Michigan, US).
Type of activity	A mindfulness class created by two neuroscientists to improve students' well-being.
Links	https://www.nature.com/articles/d41586-021-00928-w
Description of good practices performed	Since 2019, the University of Michigan has been offering a semester-long, one-credit course in the neuroscience department to deeply ingrain the practice of meditation in their students. Complementing - but flipping the focus of- conventional neuroscience offerings, the emphasis is not on studying the brain, but on understanding one's own mind. Each class begins with a brief yoga or 'mindful movement' session followed by meditation practice. Students then share observations about what they have encountered and learnt through their meditation. Course sizes have ranged from 5 to 16 graduate students, predominantly those studying neuroscience but also those from other departments. The two neuroscientists that created this class, Kevin Boehnke and

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	Richard E. Harris, said that they felt that this kind of self-care is still crucial for graduate students, given the high rates of anxiety and depression they report, which tends to affect their academic performance. There were improvements of 30–40% in scores on a scale used to measure the anxiety and depression of the students over the semester.
Transferability potential	These sort of additional classes/courses can be introduced by any higher education institution that has the means/facilities to impart mindfulness as a way to support students alleviate signs of depression or anxiety, and their possible negative consequences on their academic performance.

SIMILAR EUROPEAN PROJECTS

The two Strategic Partnership projects below are examples of similar work done by other European organizations, in which training opportunities have been created to enhance the capacities of teachers and instructors. These projects offer good inspiration for the development of different intellectual outputs.

Name	IlluminatED: Illuminating Effective Teaching Strategies with the Science of Learning. A project to empower teachers with cognitive neuroscience informed educational practices.
Type of project	Strategic Partnerships for school education.
Links	http://www.illuminatedproject.eu/ https://www.facebook.com/illuminatedproject/
Description of good practices performed	Project IlluminatED empowers teachers and students with cognitive neuroscience informed educational practices (i.e. the Science of Learning). In the project, experts in education technology, teacher development, and cognitive neuroscience were brought together to develop open educational resources (OER) aimed at raising the quality

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	of teaching and learning in school education. IlluminatED developed OER to train teachers and students. The materials focused on cognitive principles that underlie durable learning and strategies to support durable learning with the aim of supporting teachers so that they can better design learning, evaluate various teaching approaches, and guide students towards the selection of effective study strategies. Further, a student workshop was created on the Science of Learning (SOL) and effective study strategies so that teachers could share knowledge of SOL with their students.
Transferability potential	The IlluminatED project and the Neuropedagogy project share a similar purpose: educate teachers on how to apply neuroscience to their teaching practice. This model, nonetheless, is designed for schoolteachers, whereas Neuropedagogy concentrates on higher education instructors. The type of intellectual outputs developed, and learning activities designed, can serve as inspiration for other higher education projects that wish to draw on neuroscience.

Name	Neuroandragogy Against Exclusion.
Type of project	Strategic Partnerships for adult education.
Links	http://www.neuroandragogy.eu/
Description of good practices performed	The project aims to introduce the idea of using the latest knowledge on neurodidactics in adult education addressed to disadvantaged groups of people (including the unemployed, inactive people, people 50+, disabled, immigrants, low-skilled people, people from low-urban areas, etc.) to encourage them to be part of lifelong learning process. These people often show deficits related to competencies that determine effective participation in social and professional life, such as: information acquisition and processing, critical thinking, problem solving, self-motivation, self-analysis, creativity. This affects the occurrence of problems such as unemployment, poverty, social and

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	cultural exclusion in these groups. The project developed the following outputs: - A teachers' training program "Neuroandragogy in adult education at risk of exclusion", including educational materials. - Training materials for disadvantaged adults, developing their skills of effective learning, using the rules of neuroandragogy. An interactive educational platform "Neuroandragogy against exclusion". - Publication: "Neuroandragogy against exclusion". The project results were created with the intention of helping teachers realize the great potential offered by neuroandragogy in adult education. They will develop their knowledge concerning the assumptions of teaching based on knowledge of brain functioning. They will obtain information related to using neuroandragogy in the personalization of work with an adult student. Participation in the project will also allow teachers to acquire lesson planning skills in order to support the adult students' motivation to work and development and include their individual capacities related to the learning methods.
Transferability potential	The use of neurodidactics in this project can be transferred to higher education. Although the final recipients are adult learners at risk of social exclusion, the type training materials developed in the Neuroandragogy project can be replicated when training higher education instructors.

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