NEUROSCIENCE APPLIED TO HIGHER EDUCATION

Study to Identify Training Needs

NEUROPEDAGOGY · 2020-1-PL01-KA203-081740

This study is the result of the research conducted by six European Universities: UC Leuven and UC Limburg from Belgium; University of Ruse Angel Kanchev from Bulgaria; University of Patras from Greece; University of Business and Health Sciences in Łódź from Poland and Fundación Universitat Jaime I-Empresa from Spain.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

GLOSSARY OF KEY TERMS

Attention	Cognitive concentration of students during teaching without external distractions.
Attention Span	The length of time in which students can stay concentrated on a particular activity.
Communication Skills	Skills that help you interact with your students during the teaching and learning procedures in a classroom, online or in a combination of both methods.
Concentration	The ability of your students to pay attention and stay focused to a single activity.
Emotions	If and how you express yourself and communicate with your students during teaching (e.g., if you express or not your feelings, how you interact with them etc.)
Engagement	When students make an investment in learning, they are alert and listening, track the lesson with their eyes, take notes and ask questions.
Neuropedagogy	When science and education meet, and whose scientific aims are to learn how to stimulate new zones of the brain and create connections. It is targeted at stimulating the brains of all types of learners.

OVERVIEW

The general objective of the Neuropedagogy project is to improve European higher 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

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

explain why these practices work and may suggest additional approaches. Learning is the result of changes which take place in the brain (Hebb, 1949), so higher education should aim to understand those changes and present new information in a way that the students' brain will receive more effectively.

The aim of this study is to identify training needs of higher education instructors, with the objective of implementing neuroscience in the field of higher education and benefiting from the "new" knowledge that neuropedagogy can provide to improve the teaching and learning process. This study is the compilation of the research conducted by six European universities and part of the first Intellectual Output of this project.

The research has been carried out using a mixed methodology, which has combined quantitative, qualitative, and documentary approaches to obtain a diagnostic assessment of the needs of higher education instructors. A questionnaire has been conducted, in which 149 higher education instructors from 5 different European countries have been questioned on their current knowledge of neuroscience applied to higher education teaching. The instructors, coming from different scientific fields, have been asked about a series of topics related to neuroscience and its application to higher education teaching. These topics have been divided in the following sections: Communication and Emotions, Concentration and Engagement, Didactic Methodologies, Creativity and Critical Thinking and Neuroscience and Neuropedagogy.

This study will display the conclusions of this questionnaire combined with the findings from the desk research conducted by partners and will present the training needs in higher education instructors that have been identified. Identifying these training needs is the first stage of what will follow, which is the second Intellectual Output, an 'Innovative training methodology and good practice guide based on neuroscience'. The training needs identified as a result of this study will be the starting point for developing this methodology.

PROFILE OF THE PARTICIPANT

A questionnaire was completed by 149 academic instructors from different universities

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

in the 5 participant countries (19 from Belgium, 11 from Bulgaria, 60 from Greece, 13 from Poland and 46 from Spain). The sample is evenly distributed when it comes to representation from a variety of scientific fields: Humanities, Social Sciences, Educational Sciences, Economic Sciences, Natural Sciences, Engineering and Health Sciences. In general, in terms of age, gender and experience of the participant, the majority are over the age of 45, have been teaching for more than 10 years, and there is a slight majority of females.

No conclusions have been drawn based on the profile of the participants, and no pattern has been identified in their responses, based solely on their nationality, scientific field, age, gender, or years of experience.

COMMUNICATION AND EMOTIONS

Positive communication and emotional skills are becoming important in teaching practice. It is understood that learning is influenced by emotions, both in memory storage processes and in memory (Blasco et al., 2017). In teaching, emotions play a vital role in the cognitive and efficient learning processes.

A 2020 study by Jiménez et al. found that, just like positive communication leads to effective learning, negative moods can influence too, generating low levels of assimilation of information. The study reveals that it is necessary to provide new educational models that involve emotional development and positive attitude and reinforcement and suggests that in order to enhance educational processes such as learning, it is necessary to include innovative and emerging technologies. Therefore, an appropriate emotional climate should be fostered in the classroom, generating confidence and effective communication in the day-to-day practice.

In the survey conducted, participants were asked if they agreed with the statements '*The teaching and learning procedures are influenced by teachers' and students' emotions'* (F1) and *'A teacher with high communication skills captures students' attention and interest using emotions*' (F2). The respondents almost unanimously *'agreed'* or *'strongly agreed'*, showing a high level of understanding of the influence of

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

emotions in learning.

Figure 1- 'The teaching and learning procedures are influenced by teachers' and students' emotions' (Answered 'Agree' or 'Strongly Agree')

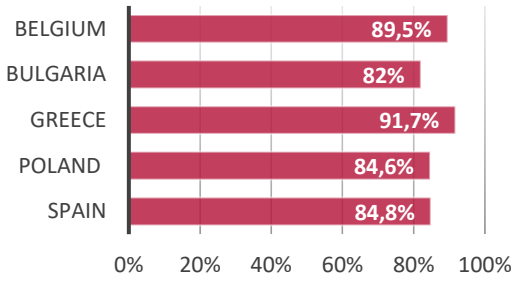
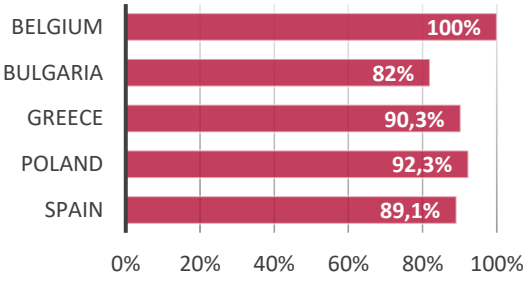


Figure 2 - 'A teacher with high communication skills captures students' attention and interest using emotions' (Answered 'Agree' or 'Strongly Agree')



When asked to agree or disagree with the statement *'I believe that I have strong communication skills'* (F3) although there was some discrepancy amongst countries, the tendency was that the vast majority believed that they did. However, when asked if they agreed with the statement *'I believe that I teach expressing my emotions'* (F4) the percentages went down slightly, and almost a third of respondents either felt indifferent or that they did not teach expressing their emotions. Furthermore, when asked if they agreed with *'I believe that I teach taking into account the emotions of my students'* again, about a third of respondents either felt indifferent or did not believe that they took into account their students' emotions when teaching.

Figure 3 - 'I believe that I have strong communication skills'

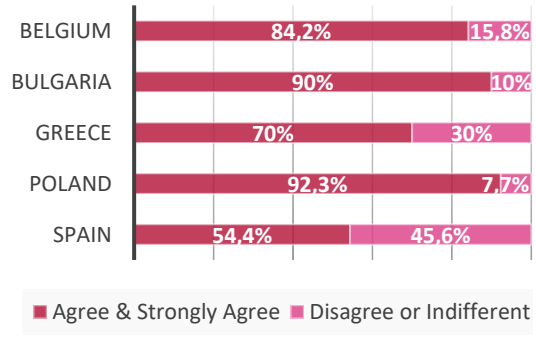
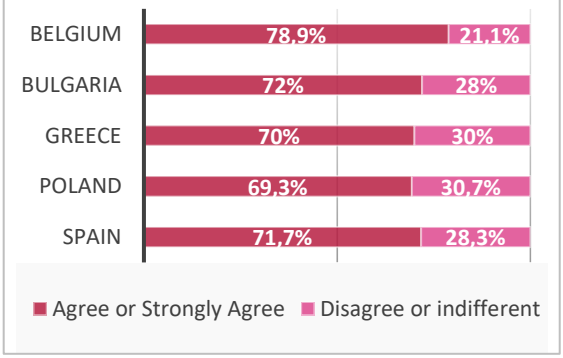


Figure 4 - 'I believe that I teach expressing my emotions'



This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

These results show that instructors seem to know about the usefulness of managing communication together with emotions, but not all of them seem to apply this knowledge to their own practice. It has been found that almost a third of participants did not believe that they taught expressing their emotions and did not think that they took into account their students' emotions in their teaching. This proportion is significant enough to highlight a training need. Participants could benefit from practical training on how to transmit their knowledge using positive emotions and considering the emotions of their students, using the correct methodology that fosters an emotionally positive learning environment.

CONCENTRATION AND ENGAGEMENT

Student capacity to stay concentrated and engaged in one activity is limited. Student attention levels can vary according to motivation, mood, perceived relevance of the material, and other factors. Determining the exact length of university students' attention span is not an easy task.

There has been a variety of findings and opinions on the topic, and there does not seem to be consensus amongst the scientific community. Many authors claim that students' attention declines approximately 10 to 15 minutes into lectures, while others suggest that students can stay focused on one activity for as long as 48 minutes (Wilson & Korn, 2007). However, there is not enough evidence to support either theory. Some studies by psychologists (Bunce et al., 2010) have monitored notetaking during lessons and observed that after a certain period the rate declines, which could indicate loss of concentration and/or attention, however no clear pattern was found. In other studies, observers watched students during a lecture and recorded perceived breaks in attention. They noted attention lapses during the initial minutes of 'settling-in', again at 10-18 minutes into the lecture, and then as often as every 3-4 minutes towards the end of class. Again, observers were not able to accurately measure students' attention spans and noted that while there was a certain pattern of student attention decrease during a lecture, the exact length of the average attention span was not determined.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

This lack of consensus amongst the scientific community seems to be prevalent in higher education instructors too. The survey conducted shows a disparity of responses in terms of the capacity of concentration and engagement.

Participants were asked if they were aware of the attention span capacity of the age group that they teach. With some discrepancies between countries (F5), the trend was to believe that they considered that they were aware of the attention span of their students. When they were asked if they structured their lessons considering the attention span capacity of the age group that they teach, again, answers indicated similar levels of agreement (F6). Participants were then asked if they felt a decline in the students' attention after a certain period, which brought almost unanimous responses of agreement.

Figure 5 - Are you aware of the attention span capacity of the age group that you are teaching? (Answered 'Agree' or 'Strongly Agree'

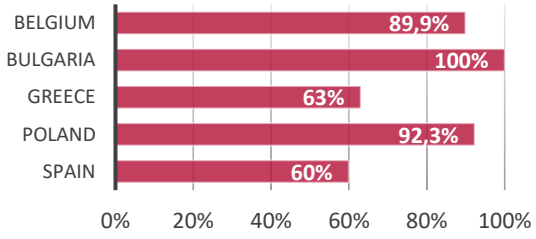
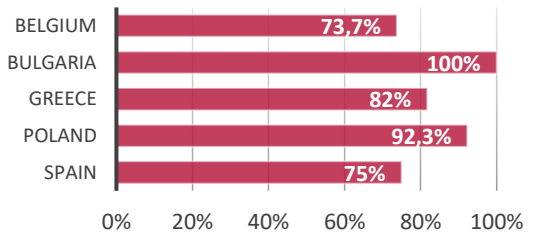


Figure 6 - Do you structure your lessons considering the attention span capacity of the age group that you are teaching? (Answered 'Agree' or 'Strongly Agree')



However, when asked *'How long do you think they can stay engaged for?'* the responses were quite different (F7-F11). No single country provided the same answer, and no clear pattern was found. For example, while the majority of participants from Poland believed that students could stay engaged for as long as 45 minutes, others split their answers in thinking it was 15 or 30 minutes. A very small number of participants believed that attention stays steady.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Figure 7 - Belgium

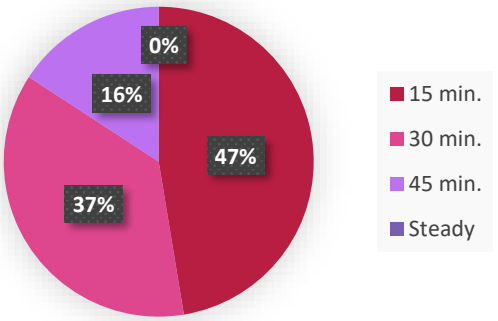


Figure 8 - Bulgaria

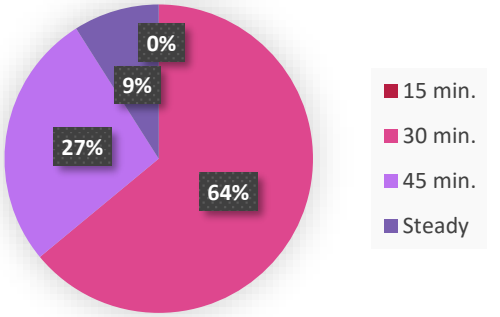


Figure 9 - Greece

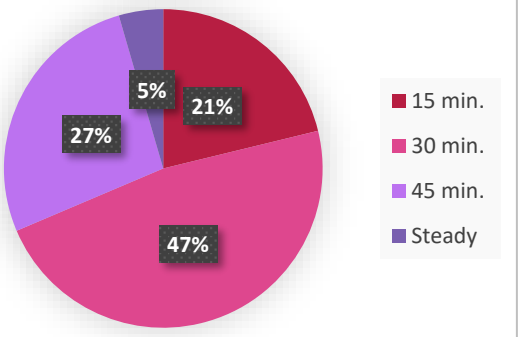


Figure 10 - Poland

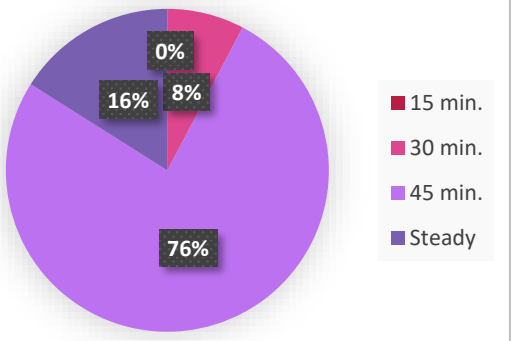
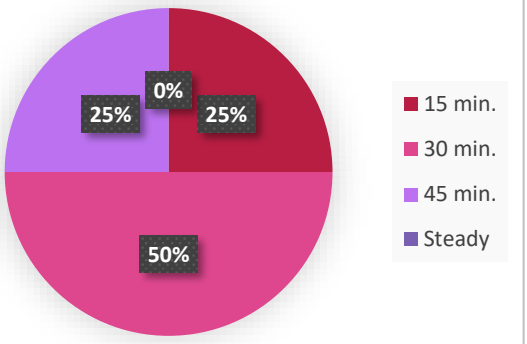


Figure 11 - Spain



Moreover, when asked about what factors distract students the most, the majority of respondents provided similar answers, with 'monotonous tone/style' and 'excessive theory' being the most repeated. Learning occurs more efficiently when information is presented in multiple modes (Hattie and Yates, 2014), so this that teachers are aware of principles to avoid monotonous and excessively theoretical styles when planning

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

their lessons. Furthermore, when participants were asked what factors keep students engaged/interested, the most repeated answers were 'diversification of activities' and 'active participation'. These answers also show an efficient understanding of ways to maintain the interest of students. If students have personally contributed to a lesson, they are much more likely to stay interested to see how it plays out (Bunce et al., 2010).

These results highlight that participants seem to be sure that students' attention declines after a certain period; that they are aware of the attention span capacity of the age group that they teach; and that they plan their lessons according to that attention span. However, they do not seem to have a clear understanding of what that attention span is, and therefore are not in a position to plan their lessons according to it. This lack of clear understanding is indeed in line with the lack of consensus amongst academics.

Due to this lack of consensus, it cannot be asserted that instructors would require training on attention span specifically, nonetheless they could still benefit from learning about the different methods of measuring attention decline. Additionally, and although instructors have shown a good knowledge of distracting and engaging factors, they could receive advanced training on ways to avoid using a monotonous tone/teaching style and how to communicate in a dynamic manner; and on how to effectively diversify the activities and involve students in their lessons so they have a more active participation.

DIDACTIC METHODOLOGIES

The use of different didactic methodologies can influence the learning process. The participants of the survey were questioned on their knowledge and use of different methods of both teaching and assessment.

Participants were first asked '*Which methods do you use when teaching in a classroom or auditorium?*' (F12-F19). The most used methods were lectures, problem solving, practical exercises, and group work. It seems clear from this data that the more

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

classical teaching methods still predominate.

Figure 12 - Lectures

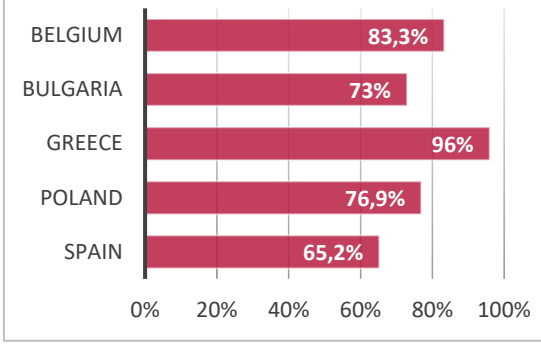


Figure 13 - Projects

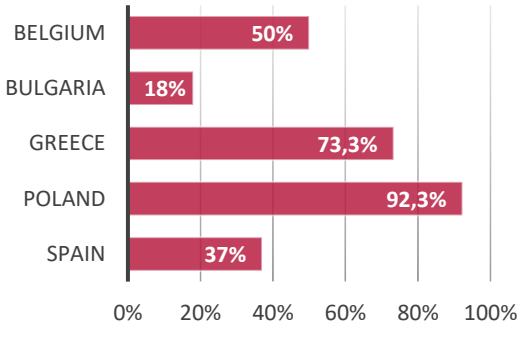


Figure 14 - Problem Solving

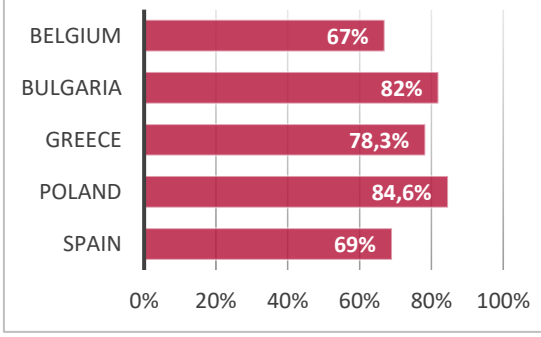


Figure 15 - Flipped Classroom

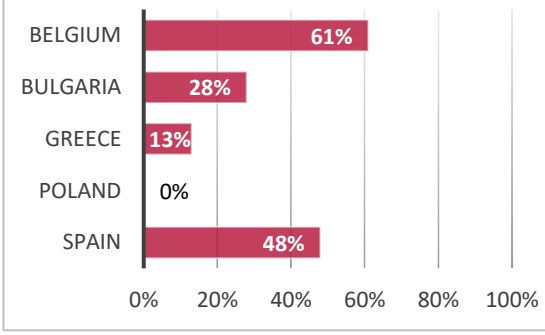


Figure 16 - Practical Exercises/Lab experiments

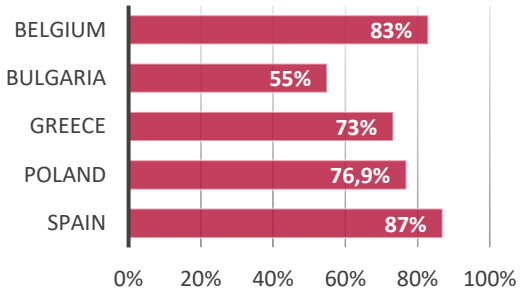
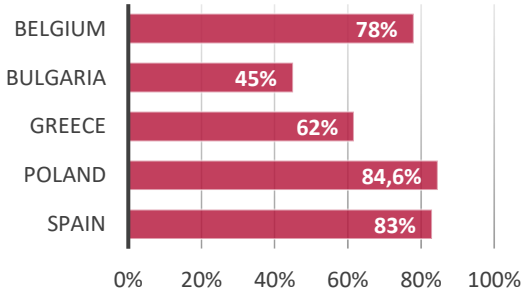


Figure 17 - Group Work



This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Figure 18 - Gamification

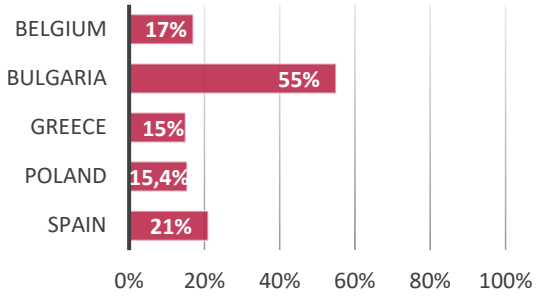
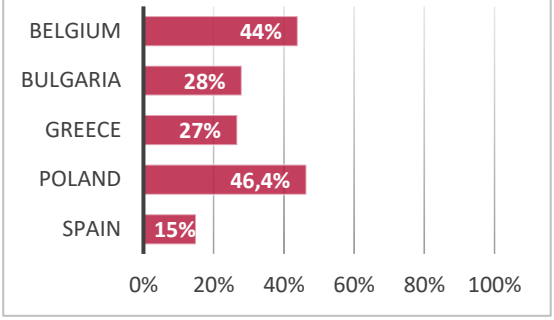


Figure 19 - Design Thinking

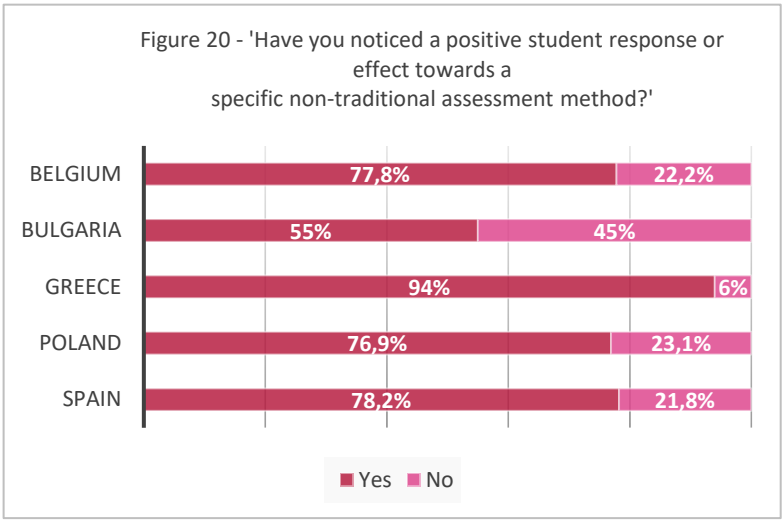


With some exceptions by countries, methods such as 'flipped classroom', 'gamification' or 'design thinking' obtained very few responses. Gamification, for instance, has been regarded as an effective method to increase the motivation and academic performance of university students (Baena-Extremera et al. 2021). Based on neuroscientific insights, gamification may be an interesting approach to promote learning. In a gamification environment, the learner-player can always start over again, diminishing the fear of punishment and leading to more effective and integrative learning (Luria et al. 2021). Due to the low number of respondents using gamification in their teaching, it has been identified as a training need that instructors obtain information on the benefits of using this teaching method in their practice, as it has many proven benefits. Higher education Instructors could also benefit from learning about the benefits of using 'flipped classroom' and 'design thinking' in the classroom, and how to apply them into their teaching.

Along the lines of diminishing the fear of punishment, participants were also questioned on their assessment methods. They were asked '*When given the opportunity, do you use any other students' assessment method other than the traditional ones such as exams with grades?'*. There were some discrepancies in the answers. Overall, the majority responded that they did, however there was still a high proportion in some of the participant countries (65% in the case of Greece and 38% in the case of Bulgaria) that would not use an alternative method of assessment, even when given the choice. If learning is influenced positively by challenges and negatively by threats (Blasco et al., 2017), the ideal atmosphere for teaching should be one of

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

relaxation, free from situations that can be perceived as threatening. Exams are known to be stressful situations for students that not always reflect the totality of their knowledge and capabilities. Stress can impair the ability of the brain to encode and recall memories (Betts et al. 2019), which could clearly affect performance during exams. When participants were asked if they had noticed a positive student response or effect towards a specific non-traditional assessment method, the vast majority replied that they did (F20).

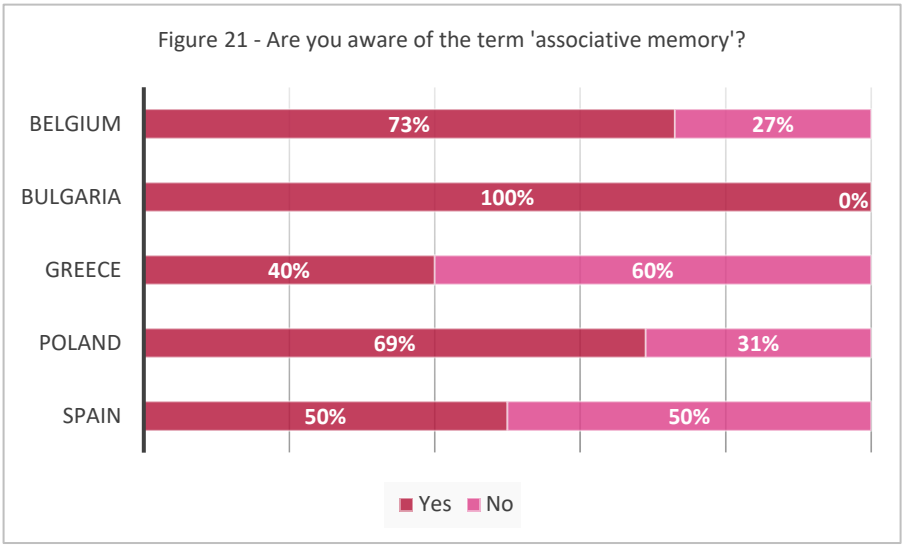


These two findings, the fact that respondents were clear stating that they noticed positive student response towards non-traditional methods of assessment, but still a considerable proportion of the participants would not consider alternative assessment methods, show that perhaps they could benefit from obtaining training in different types of methods of assessment available and suitable for university students and what their benefits are.

Participants were also asked if they were aware of the term 'associative memory'. There were significant discrepancies in responses amongst countries (F21), however it could be said that although the tendency was that the majority of respondents are aware of the term, almost half of them are not. Interestingly, when asked '*Do you try to teach new concepts using day-to-day experiences, practical examples, and*

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

applications?', which is part of what associative memory is, participants almost unanimously answered that they did.



Learning is encouraged with the development of associative memory (Blasco et al., 2017). The further the new information moves away from previous ideas or lived experiences, the more it will depend on repetition to consolidate itself in the brain. It is advisable to avoid teaching by focusing on memorization to transform new information into learning, grounding theoretical concepts in real-life scenarios and drawing on examples from students' daily routines.

It is recommended that instructors receive training on what associative memory is. Although they seem to be using some aspects of associative memory unknowingly, they could still benefit from training on the terminology and benefits of associative memory in order to use it effectively during their lessons.

CREATIVITY AND CRITICAL THINKING

Creativity and critical thinking are desirable qualities for both students and graduates looking to enter the job market. However, higher education does not always provide

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

the opportunity for students to develop these (Bresciani, Henning and Wolff, 2016).

The participants were questioned about the methods they utilize to encourage and cultivate their students' creativity and critical thinking.

First, participants were asked in separate questions if they encouraged creativity and critical thinking (F22 and F23). Both questions obtained almost unanimous answers, with most participants affirming that they did. Participants that responded that they did not, justified their answer saying that creativity and critical thinking were not relevant or did not apply to their field.

Figure 22 - 'Do you encourage students to develop their creativity in your course(s)?'

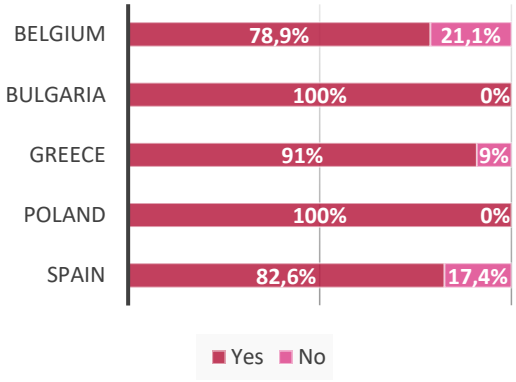
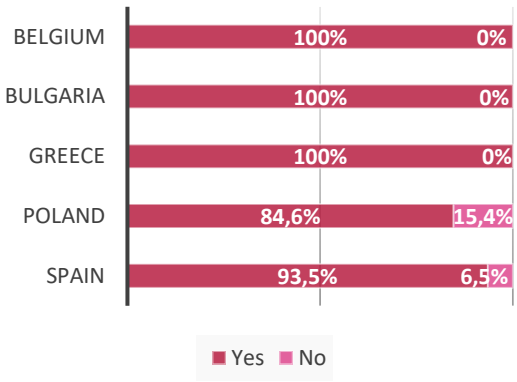


Figure 23 - 'Do you encourage students to develop their critical thinking in your course(s)?'



When asked how they encouraged students to develop their creativity, some of the most repeated answers were:

- Problem solving based on case studies.
- Seeking alternative solutions.
- Allowing students to come up with their own questions for research papers.
- Working with projects.

When asked how they encouraged students to develop their critical thinking, some of the most repeated answers were:

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

- Giving students different perspectives on the same subject, so they can reason their argument based on evidence/literature. Learn how to defend an opinion with a basis.
- Present ethical questions to debate.
- Analyzing materials.

Finally, participants were asked *'Do you think you need to improve the existing curriculum of your course(s)to create favourable conditions for the development of your students' creativity and critical thinking? If yes, please explain how.'* The majority of the participants said that they did, with some of the most repeated topics being:

- More face-to-face class time, because creativity and critical thinking needs time to mature.
- Smaller student ratio, to be able to pay more attention to students.
- Allowing more time for dialogue and interaction.
- Less rigid contents.

These suggestions might not be considered training needs per se, but they can certainly be seen as feedback and suggestions for improvement.

NEUROSCIENCE AND NEUROPEDAGOGY

Translating the framework of neuroscience into day-to-day practice is a challenge for instructors, supported by neuroscientists (Bell & Darlington, 2020). A series of questions were designed to find out the participants' knowledge on neuroscience applied toteaching to identify what their training needs on the subject are.

Firstly, participants were asked if they had heard of the terms 'neuroscience' and 'neurodidactics' (F24). The majority had heard of the terms, however there are still twocountries with considerable percentages (Spain with 47,8% and Greece with 28%), that said they had not. When asked *'Are you familiar with or do you have any basic*

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

notions of neuroscience?' (F25), although there was some disparity of answers amongst countries, more than a third of the responses indicated that participants did not have basic notions of neuroscience. They were also asked *'Are you familiar with or do you have any basic notions of* neuropedagogy?' (F26) which provided a similar number of positive responses, with more than a third of the respondents saying that they did not.

Figure 24 - 'Have you ever heard of the terms 'neuroscience' and 'neurodidactics?'

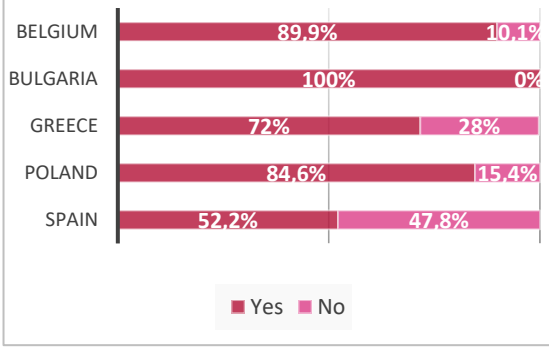


Figure 25 - 'Are you familiar with or do you have any basic notions of neuroscience?'

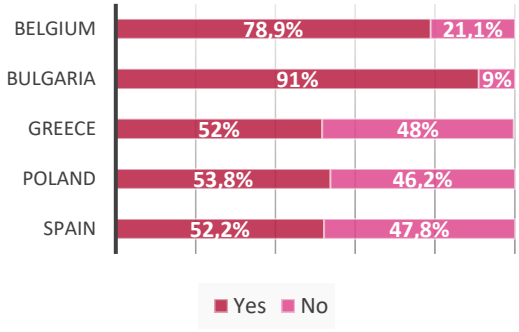
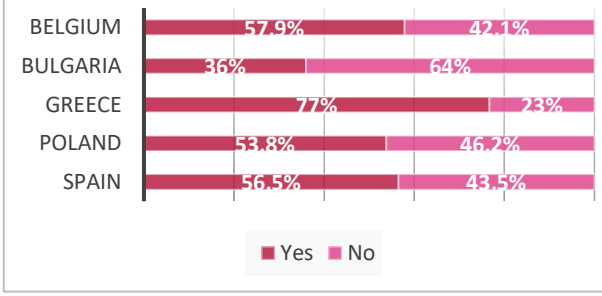


Figure 26- 'Are you familiar with or do you have any basic notions of neuropedagogy?'



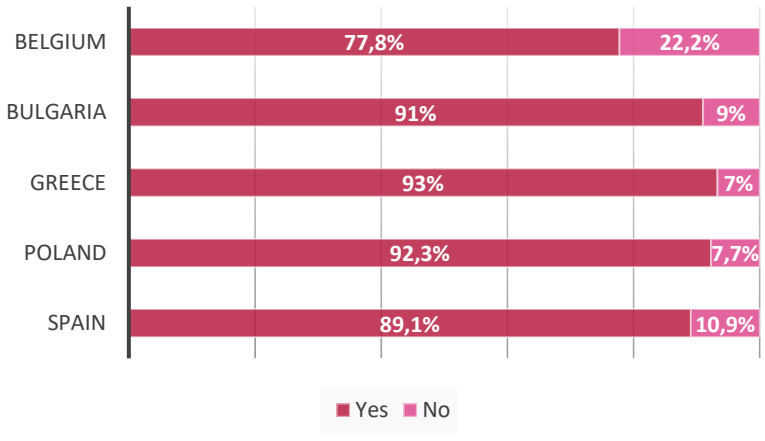
Moreover, participants that answered 'yes' to the last question were asked 'Do you apply your knowledge of neuropedagogy to your teaching practice?'. Interestingly, around half of the participants that claimed to have basic notions of neuropedagogy responded that they did not apply it in their teaching. This could mean that they do not have the necessary tools to do so.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Some training needs can be extracted from these answers. Firstly, and if the aim of this project is to apply neuroscience to higher education, instructors should be given basic training on what neuroscience and neurodidatics are. This would be the starting point for the rest of the training needed. Responses indicate that around half of the participants do not have basic notions on either neuroscience or neuropedagogy. This would also call for training on both sciences and their applications to higher education.

Participants were asked directly if they felt they could benefit from specialized neuropedagogy training on teaching and learning assessment. The vast majority of the respondents answered that they believed they did (F27). They were also asked to expand on how they thought they could benefit from that type of training or what they would like to learn. The most commonly repeated answers were: concentration on different groups of different ages (this is directly related to the attention span section), be taught examples of good practices in neuropedagogy, specific training coming directly from neuroscientists (there was a special emphasis put on this requirement), how to maximize attention (also related to the attention span section), and how to apply this science to large audiences . These petitions should be taken into consideration when designing the training methodology for higher education instructors.

Figure 27 -Do you feel that you could benefit from specialized neuropedagogy training on teaching and learning assessment?



This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

NEUROMYTHS

Whilst conducting the desk research for this study, the topic of 'neuromyths' became worth mentioning. Neuromyths are the result of biased distortions and oversimplification of information obtained by neuroscience (Howard-Jones, 2014). These unscientific ideas are often associated with ineffective or unevaluated teaching in the classroom.

Various studies have examined the prevalence of neuromyths amongst instructors and how this can impact the way they teach. A recent study by Torrijos-Muelas et al. (2021) has found that neuromyths are the consequence of a lack of scientific knowledge, a communicative gap between scientists and teachers, and the low-quality information sources consulted by instructors. This study finds a need to improve the scientific content in higher education and highlights the importance of in-service teacher training. It suggests that university instructors actively engage in research on this topic and calls for 'neuroeducation' to serve as a bridge that unites scientific knowledge and practical application in education, with a rigorous, standard method for the entire scientific- educational community.

Other studies (Betts et al. 2019) have captured the neuromyths that higher education instructors are most susceptible to believe:

- Listening to classical music increases reasoning ability.
- A primary indicator of dyslexia is seeing letters backwards.
- Believing that due to hemispheric dominance (left brain-right brain) people learnin one way or another.
- Humans only use 10% of their brains.

This research, along with the results from the surveys, seems to point out that instructors appear to have basic knowledge about the brain and at the same time hold some common misconceptions about brain-based educational concepts. This prevalence may reflect the fact that neuroscience is rarely included in instructors' training (Howard-Jones, 2014), who are therefore ill-prepared to be critical of ideas and educational programs and are susceptible to believe commonly known

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

conceptions that lack scientific rigour.

A clear training need has been identified here: higher education instructors should receive training on neuromyths, so they can avoid falling into this 'trap' and apply unscientific methods into their teaching practice.

CONCLUSIONS

As a result of the research conducted, this study has identified a series of training needsin higher education instructors. This study has found weaknesses in a series of topics related to neuroscience applied to higher education teaching and recommends that they are fulfilled with appropriate training. These training needs are:

- Practical training on how to transmit their knowledge using positive emotions, fostering an adequate emotional climate in the classroom, and taking into consideration the emotions of their students.
- Training on different methods of measuring attention decline and effective practices to keep students engaged.
- Advanced training on ways to avoid using a monotonous tone/teaching style and how to communicate in a dynamic manner. Advanced training on how to effectively diversify the activities and involve students in their lessons so they have a more active participation.
- Information on the benefits and the application of 'gamification', 'flipped classroom' and 'design thinking' in the classroom.
- Training in different types of methods of assessment available and suitable for university students and what their benefits are.
- Training on what associative memory is. Although they seem to be using some aspects of associative memory unknowingly, they could still benefit from training on the terminology and benefits of associative memory in order to use it effectively during their lessons.
- Basic training on what neuroscience and neurodidatics/neuropedagogy are, and their applications to higher education.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

- Specific training with neuroscientific basis on: concentration ability of different groups of different ages, be taught examples of good practices in neuropedagogy, specific training coming directly from neuroscientists, how to maximize attention, how to apply this science to large audiences of students.
- Training on neuromyths in order to avoid applying unscientific methods into their teaching practice.

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

References

Baena-Extremera, A., Ruiz-Montero, P.J., & Hortigüela-Alcalá, D. (2021). Neuroeducation, Motivation, and Physical Activity in Students of Physical Education. International Journal of Environmental Research and Public Health. 18(5), 2622. https://doi.org/10.3390/ijerph18052622

Bell, D., & Darlington, H.M. (2020). Educational Neuroscience: So What Does It Mean in the Classroom. Educational Neuroscience: Development Across the Life Span, 500-526.

Betts, K., Miller, M., Tokuhama-Espinosa, T., Shewokis, P., Anderson, A., Borja, C., Galoyan, T., Delaney, B.,Eigenauer, J., & Dekker, S. (2019). International report: Neuromyths and evidence-based practices in higher education. Online Learning Consortium: Newburyport, MA.

Blasco, J., Lledó, A., Martínez, J. & Pellín, N. (2017). Redes colaborativas en torno a la docencia universitaria. Alicante: ICE de la Universitat d'Alacant.

Bresciani, M., Henning, G. & Wolff, R., (2016). The neuroscience of learning and development. Washington.

Bunce, D., Flens, E. & Neiles, K. (2010). How Long Can Students Pay Attention in Class? A Study of Student Attention Decline Using Clickers. Journal of Chemical Education 87 (12), 1438-1443.

Hattie, J., & Yates, G. (2013). Visible Learning and the Science of How We Learn. 1st ed., Routledge.

Hebb, D., (1949). *The organization of behavior*. New York: John Wiley and Sons.

Howard-Jones, P. A. (2014). Neuroscience and education: myths and messages. Nature Reviews Neuroscience, 15(12), 817-824.

Jiménez, Y., Vivanco, O., D., Torres, P., & Jiménez, M. (2020, June). Artificial Intelligence in Neuroeducation: The Influence of Emotions in Learning Science. In International Conference on Innovation and Research, 67-77.

Luria, E., Shalom, M., & Levy, D. A. (2021). Cognitive Neuroscience Perspectives on Motivation and Learning: Revisiting Self-Determination Theory. Mind, Brain, and Education, 15(1), 5-17.

Torrijos-Muelas, M., González-Víllora, S., & Bodoque-Osma, A. R. (2021). The persistence of neuromyths in the educational settings: A systematic review. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2020.591923

Wilson, K., & Korn, J.H. (2007). Topical Articles: Attention during Lectures--Beyond Ten Minutes. *Teaching of Psychology*, 85-89. https://doi.org/10.3389/fpsyg.2020.591923https://doi.org/10.1080/00986280701291291

This project (project n° 2020-1-PL01-KA203-081740) has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.