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Nature-Based Solutions Education Network (NBS EduWORLD)

Initial Report on NBS in Higher Education

Including principles, NBS content, pedagogy, gaps, and
priorities for NBS in higher education and entrepreneurship
architecture



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Abstract	<p>This report explores the current understanding, approaches, and pedagogies of higher education in NBS, encompassing vocational, entrepreneurial, and tertiary domains.</p> <p>The primary aim of the report is to summarise existing and potential needs-based education approaches at higher level to present a state of the art of NBS in higher education and entrepreneurship architecture. This output will form the core input on which the design of educational learning units can be based. These learning units will be developed for NBS EduWORLD's work on NBS in Higher education under Work Package 4 (WP4).</p>
Keywords	Higher Education, third level, vocational, entrepreneurial, nature-based solutions, NBS
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List of Abbreviations

CMA	Camara Municipal De Almada
CPD	Continuous professional development
EU	European Union
EUN	European Schoolnet
HNUA	Horizon Nua
ICLEI	ICLEI EURO
MNHN	Museum National D'Histoire Naturelle Paris
MOOC	Massive Open Online Course
NBS	Nature-Based Solutions
NBE	Nature-Based Enterprise
OCC	Offaly County Council
PPMI	Public Policy and Management Institute
SDG	Sustainable Development Goals (UN)
SUDS	Sustainable Urban Drainage System
TCD	Trinity College Dublin
WP	Work Package
VET	Vocational Education and Training

1. Introduction

In an era marked by unprecedented environmental challenges, the imperative for sustainable solutions has never been more urgent (Seddon et al., 2020). Higher education focused on Nature-Based Solutions (NBS) has emerged as a pathway towards a more harmonious coexistence between humanity and the natural world. At its core, NBS represents a paradigm shift in addressing global challenges such as climate change, biodiversity loss, and resource depletion. Unlike conventional approaches that often rely on technological advances, NBS leverage the inherent resilience and efficiency of natural systems. Higher education plays a pivotal role in cultivating the knowledge and skills necessary to unlock the potential of NBS.

As the nexus of research and advanced learning, universities and research institutions play a central role in advancing the frontier of knowledge in this field. Through interdisciplinary programs and research initiatives, tertiary education not only expands our understanding of NBS but also develops the critical thinkers and problem solvers needed to address complex environmental challenges. Moreover, higher education institutions serve as hubs for collaboration, bringing together diverse stakeholders to co-create and implement effective NBS strategies.

As the world transitions towards sustainability, there is an unprecedented opportunity for innovative business models that integrate environmental stewardship with economic viability. Entrepreneurs educated in NBS can pioneer ventures that not only restore ecosystems but also generate economic value, creating a win-win scenario for both humanity and the planet. This strand of education empowers individuals to become change agents, fostering a generation of eco-entrepreneurs capable of driving transformative environmental initiatives. As businesses develop their NBS offerings vocational education is critical in equipping individuals with practical expertise to implement and manage NBS on the ground.

NBS EduWORLD's work on NBS in Higher education will deliver education strategies for higher education using a range of participatory and co-design methods that improve stakeholder participation in NBS education and innovations. The overarching goal of NBS EduWORLD in that respect is to maximise the adoption of NBS approaches and behaviours through higher level education and entrepreneurial stakeholders by:

- (1) Enhancing the understanding and implementation of NBS in higher education and entrepreneurship;
- (2) Building degree and vocational modules and approaches on using nature to make societies more inclusive, cohesive, and participative; and,
- (3) Implementing new pedagogies and dissemination strategies to enable lifelong learning in relation to NBS through citizen science.

This report serves as a foundational document for subsequent phases of NBS EduWORLD's work on NBS in Higher education, including the baseline information for Deliverable D4.1 NBS Higher Education and Entrepreneurship Architecture and the design of the Tier-1 workshops (Tier-1 as NBS demonstrators with an educational dimension) scheduled for early 2024.

2. Methodology

In this section, we present the research methods and data sources underpinning the initial analysis of NBS in higher-level education. In the first instance it is important to acknowledge that this analysis is inclusive of three focus areas of higher education: 3rd level; entrepreneurial; and vocational education (see figure 1). Our analysis is presented under the headings of these three areas.

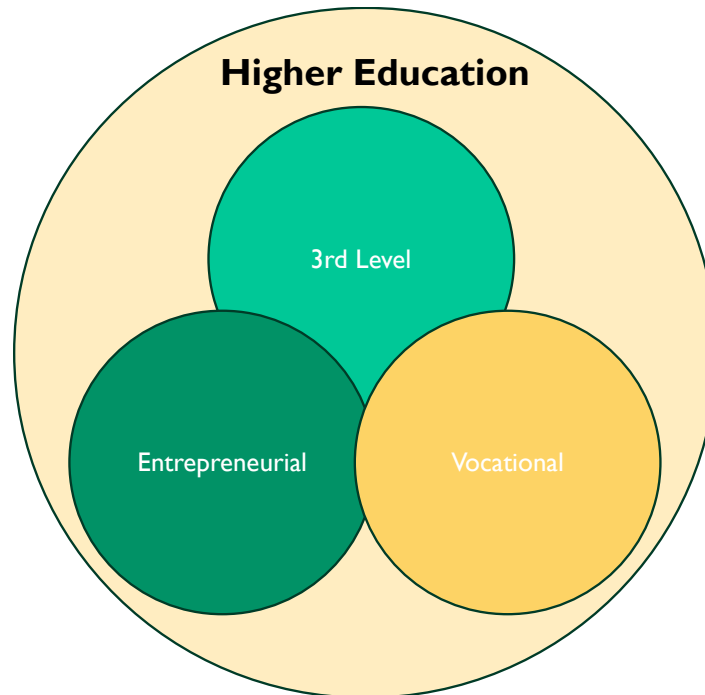


Figure 1: Focus Areas for Higher Education in NBS EduWORLD

During the NBS EduWORLD General Assembly in October 2023 and monthly meetings, detailed planning was facilitated for individual partner research based on their core competencies: This research focused on specific aspects of higher education with a view to understanding the current state of the art, gaps, and potential focus areas for the development of learning units. This mixed methods approach involved a range of research types including stakeholder interviews, focus groups, surveys, and EU project analysis. These interrelated elements are presented in figure 2:

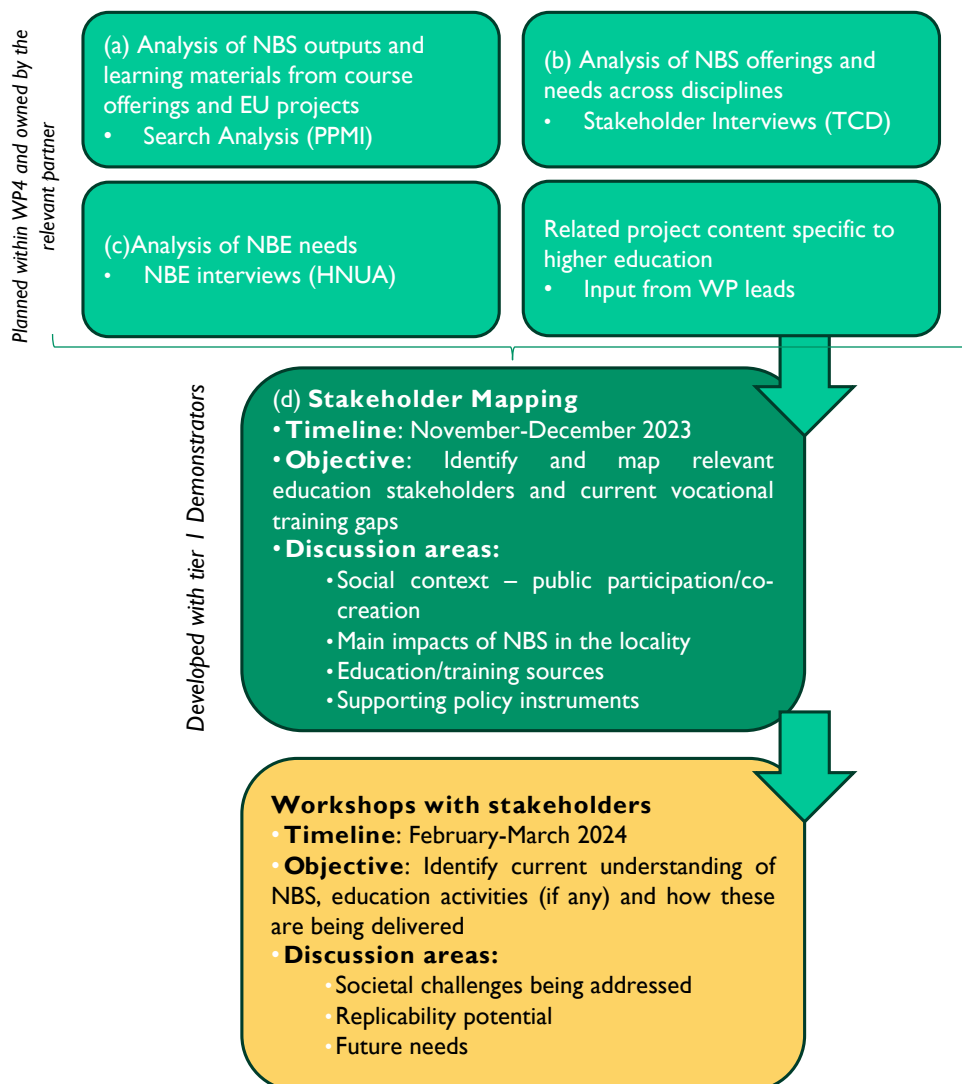


Figure 2: Research Flow for NBS in Higher Education under NBS EduWORLD

Workshops with the Tier-1 demonstrators will be informed by the research gathered for the report and delivered to gather further baseline information developing contextual understanding, peer learning and knowledge exchange among key stakeholders. This will include thematic priority focus groups for institutional leaders and senior managers to ascertain current understanding and practices involving NBS in higher education and industry settings for adaptation.

The information gathered through this research flow and culminating with the workshops in early 2024 will form the basis of the learning unit design for the upcoming Deliverable D4.1 NBS Higher Education and Entrepreneurship Architecture by NBS EduWORLD.

a. European NBS Education

PPMI conducted an expansion of and revision to the primary research done for the State of the Art Report on NBS education in Europe (Mulvik et al., 2023). The focus here is higher

education, primarily in-person courses offered as part of university degrees, university Masters and VET programmes, and short courses most often conducted online with the option of certification that are categorised as adult learning or Continuous professional development (CPD).

Desk research was conducted, using key words relating to NBS, Ecosystem-based solutions, Ecological solutions, Nature-based enterprise) and relevant education contexts (Higher education, Vocational education and training (VET), Adult learning, Continuing professional development (CPD), Teacher training, Online courses, Micro-credentials, short courses). Only cases that directly corresponded to the concept of NBS were included in the final list, which resulted in the elimination of several courses and study programmes that had been identified prior for the State-of-the-Art Report. Additional newly identified cases were also added.

Sources for identifying formal NBS HE courses and programmes included adult learning and CPD platforms (e.g., EU academy, Erasmus teacher academy, SDG academy, FutureLearn, Coursera, MOOC LIST, European Schoolnet Academy, and others), university degree and programme search platforms, general search engines, AI platforms and other. Data collection was conducted in English, and several additional languages (Czech, French, Lithuanian, Slovak, Spanish) by using the equivalent translated search key words. For each identified course or programme, we gathered data on price, language of delivery, pedagogies, competences and skills, form of teaching, target audience, thematic scope (including coastal/urban/rural focus), and whether it offers certification or not. All identified cases are either offered at present time of research or had been available within the last two years.

An additional list was compiled of resources which were not part of study courses or programmes, but nonetheless offer valuable learning materials (e.g., videos, webinars, readings) to NBS post-secondary education.

b. 3rd Level Interviews

In Q4 2023, TCD, as the project's 3rd level education institution, interviewed relevant leading academics and stakeholders in the Dublin local authorities working on NBS. A range of senior lecturers were selected across disciplines and research backgrounds. Semi-structured interviews were undertaken with these stakeholders to analyse current NBS teaching approaches and opportunities to incorporate NBS in curricula across disciplines. A thematic analysis (Braun and Clarke, 2012) of the interviews was carried out to identify common themes and their relevance to education development.

In addition to academic staff, the Dublin local authorities were contacted and invited to discuss the use of NBS, training and dissemination of projects with the public. The local authorities had published their climate action strategies specifically addressing NBS use and so this was a particularly timely source of information for their 3rd level and vocational needs. These interviews followed the same structure and focused on cultural understanding and use of NBS, internal CPD training and procurement challenges. This element of the interviews was supportive of the Offaly focus group design in particular with several points of overlap confirming priorities and gaps for vocational education.

Table 1: Interviewee list of 3rd Level Stakeholders

	Interviewee	Position	Institution
1	Dr Mary Lee Rhodes	Associate Professor of Public Management	Trinity College Dublin
2	Dr Sarah Jane Cullinan	ESD Fellow Lead	Trinity College Dublin
3	Dr Iris Moeller	Professor of Geography	Trinity College Dublin
4	Dr Mary Bourke	Associate Professor of Geography	Trinity College Dublin
5	Dr Marcus Collier	Associate Professor of Botany	Trinity College Dublin
6	Dr John Gallagher	Assistant Professor in Environmental Systems modelling	Trinity College Dublin
7	Dr Stuart Connop	Associate Professor in Sustainability	University of East London
8	Fionnghuala Ryan	Climate Change Awareness Officer	South Dublin County Council
9	Sabrina Dekker	Climate Action Coordinator	Dublin City Council
10	Ultan Downes	Senior Executive Scientist	Dún Laoghaire Rathdown County Council

c. NBE Surveys & Interviews

To better understand Nature-based Enterprise (NBE) needs and preferences as regards education, training and skills development, HNUA undertook a survey and interviews in Autumn 2023-Spring 2024.

Interview methods: In-depth interviews were carried out with 42 Nature Based Enterprises (NBEs) between October 2023 and April 2024. These interviews were semi-structured and took place online. Interview questions were informed by previous NBE research and the format was tested and updated in 3 pilot interviews (Kooijman et al 2021, McQuaid et al 2021). Data from interviews was recorded and transcribed, and transcripts imported into a qualitative data management tool (MAXQDA). Thematic analysis is ongoing, and is expected to be completed by the end of August 2024. See questions in Appendix 1.

Survey methods: Findings from the first tranche of 10 NBE interviews informed the development of a NBE survey, which further builds on and updates previous research (Kooijman et al 2021, McQuaid et al 2021). The survey included 6 questions on education, training and support (see Annex 1). The survey was distributed through the networks of [Connecting Nature Enterprise Platform](#) members, Invest4Nature partners, at events such as [Nature Futures 2024](#), during webinars hosted on the Connecting Nature Enterprise Platform, and via social media (LinkedIn and X). Of 176 survey responses received between January and April 2024, 125 were included in the analysis. The reasons for exclusion of responses were: low data quality and completeness (7); duplicate responses (2), and organisations not fitting the NBE definition - e.g. Universities, public sector bodies, not engaged in economic activity, or not nature-based (42). All inclusion/exclusion decisions were assessed by a minimum of two members of the research team. There were no geographical restrictions to participation, but recruitment prioritised European networks.

Free text data was analysed by importing survey responses into a qualitative data analysis tool (MAXQDA) and carrying out inductive coding, initially by question, and then across the data set, to ensure connections within responses and between questions were retained. Initial coding was completed by one researcher, with coding subsequently reviewed, discussed and further developed by the multidisciplinary research team, to build consensus and enhance reliability.

This NBS EduWORLD research is being conducted in collaboration with [Invest4Nature](#), a Horizon Europe research and innovation action that is undertaking complementary research on the market development and financing environment of NBEs. In the interviews and surveys, additional data was collected relating to the financing and business models of nature-based enterprises.

d. Focus Groups

TCD, in collaboration with HNUA, and ICLEI conducted stakeholder mapping focus groups with each Tier-1 demonstrator in NBS EduWORLD (Offaly, Almeda, and Paris) to identify target audiences and internal stakeholders for upcoming workshops. Through these focus groups, a preliminary understanding of current training/education approaches, challenges, and culture of NBS was developed. Through the focus group protocol, a series of open questions and themes structured the sessions to address the core issues around NBS education in each local context.

Table 2: Tier-1 Focus Group Participants

Tier 1	Type	Participant	Organisation	NBSEW
Offaly, Ireland	Rural	John McNally	OCC	TCD/HNUA/ICLEI
		Mark Mahon	OCC	
		Aisling Lambe	OCC	
Almada, Portugal	Coastal	Mario Estevens	CMA	TCD/HNUA/ICLEI
		Joao Pedro Silva	CMA	
		Pedro Pinho	University of Lisbon	
Paris, France	Urban	Simon Benatau	MNHN	TCD/HNUA/ICLEI
		Martin Jeanmougin	MNHN	
		Vincent Chassany	Education Nationale	

In addition, this report is developed and designed in conjunction with the following project documents and events:

- **D2.1 State of the art report** (In particular section 4.4 NBS in higher education);
- **D3.1 NBS Nature-Based Solutions Education Flipbook**, this report provides concise accessible examples of NBS in practice and a novel approach to promote NBS in education;
- The first **NBS EduCommunity workshop**, this online event on 28 November 2023 brought together a wide range of interested stakeholders, ranging from teachers, students/youth, to NBS practitioners and third sector organisations, among others; and,
- NBS EduWORLD WP Leaders were consulted on this process through monthly meetings to ensure that input from across the project and contributions from other Work Packages were included.

3. Current Approaches

a. 3rd Level

Desk research identified 18 courses and/or degree programmes that included NBS at formal higher education level. The search for NBS projects offered at the level of formal vocational education and training (VET) resulted in only one programme. Higher education programmes are found in 8 European countries, most of them in the UK and Italy (4 each), followed by Spain (3), with a further two each in Austria and Ireland and one in Finland, Belgium and the Netherlands. All university courses are developed by universities based in those countries. One identified VET, Junior Water Programme rotates between several countries.

Most of the courses are related to topics such as understanding NBS (5), water management (3), climate resilience (2), natural and climate hazards (2). Focus on urban transformation and regeneration, green infrastructure and green space management resulted in five findings. Few courses also included participatory planning and governance. Overall, the courses are not specific to either urban, rural or coastal areas, but are rather general in their coverage. Where specific, urban examples dominate (6), focusing on urban ecology, green cities or ecological transition of urban areas.

Most courses are at graduate and postgraduate level. We identified 12 such courses. Undergraduate students are limited to 3, and another 2 courses in Spain are available to both graduate and postgraduate students. With the exception of the latter two only available in Spanish, all other courses are offered in English. The VET programme is designed for young European water management professionals with experience working in water related organisations. Thematic courses on water management or green infrastructure are primarily designed for engineering and technology students, as well as for students of environment & agriculture, medicine and health, environmental sciences, architecture, urbanism, or geography.

In most cases, various pedagogical methods are used to develop learners' competences. Several courses combine transmissive (lectures and theory-based learning), inquiry-based (problem solving, case studies), collaborative (such as teamwork on projects or case studies, group discussions, peer learning) and experiential learning (hands-on experience to connect theory and practical NBS activities). Integrative approach is also quite common, with the aim of making learning real-world focused through interdisciplinarity. In total, 9 courses offer either field trips and excursions or field work and projects.

The competences that students attribute to their studies are diverse and extensive. Most of the competences relate to transversal skills which include teamwork (10), presentation and communication skills (8) and critical thinking (7). There is also mention of creative thinking (4), writing skills (4), and management and leadership (3). As part of transversal competences, few courses also explicitly mention active citizenship and action-oriented competences (3). More advanced and specialised courses (those for engineering or technology students) provide practical and technical skills related to the design of NBS in practice, analytical skills (GIS) or methodological skills to establish planning, implementation, monitoring and evaluation of NBS (6).

Only 6 courses explicitly mention assessment. Mostly it is a combination of written (mid-term or final papers or projects, essays, reviews, scientific papers) and oral examinations (presentations of seminar work or practical examples). Final presentations are often part of group work. Two courses introduce a final exam/test. Another two require students to write essays critically evaluating an NBS strategy case. Emphasis is also placed on active participation in class discussions.

There are multiple examples of interdisciplinarity across the courses. They consist in the partnerships with public institutions, NGOs or business representatives to engage students in different NBS perspectives and ecosystems and develop their understanding of cross-cutting issues.

Advanced Masters in Belgium (University of Antwerp) focuses on water management. The MSc in the UK (UCL) falls under the Department of Chemical Engineering. While both are interdisciplinary and last 1 year, in order to obtain the MSc degree, students must acquire 60 ECTS credits in the former and 180 ECTS credits in the latter throughout their studies. These stand-alone programmes have the highest fees. The full tuition fee in Belgium is €2,985. At UCL, UK tuition fees (2024/25) are £19,300, while overseas tuition fees (2024/25) are £37,500. Other university courses are subject to overall tuition fees.

Credits that one might acquire after completion of other courses or course modules vary from 1,5 to 15 ECTS credits, with overall workload ranging from 20 to 200 hours. All university courses are rewarded by credits. It was not specified in the case of summer school in Spain. University courses organised during semesters have meetings on weekly (once or twice a week) or bi-weekly basis. Few courses, such as summer schools or blended intensive programmes take place between one to three weeks. Two courses are delivered online, one offers blended mode of delivery, and the rest are delivered on-site.

Future potential for NBS courses in higher education include creating a more specialised focus on coastal and rural areas; offering courses for undergraduate students; and including a broader geographical and linguistic coverage. As NBS provides environmental, social and economic benefits, it should not be confined to the technical/engineering field but should also be mainstreamed and taught in other fields, especially social sciences, and promote social justice and social cohesion.

b. Entrepreneurial

The concept of NBS to address climate change has gained widespread acceptance of late, pivoting the perception of nature as a 'cost' to society towards nature as a 'solution' ((Dorst et al., 2019). NBS such as green spaces, parks and forests or blue-green infrastructure have been shown to generate multiple benefits from reduced temperatures to mitigation against flooding while simultaneously helping to increase the health and well-being of citizens amongst many other benefits (Kabisch et al., 2016). Despite the increasing acceptance of NBS in policy, a myriad of challenges to up-scaling and out-scaling of NBS in practice have been captured in the literature. An emerging issue are challenges finding skilled suppliers of NBS (Mačiulytė and Durieux, 2020).

Recent research has shed new light on the type of organisations engaged in the supply of NBS, including private sector enterprises, termed ‘nature-based enterprises’ (NBE) (Kooijman et al., 2021). An NBE can be defined as ‘an enterprise, engaged in economic activity, that uses nature sustainably as a core element of their product/service offering (Kooijman et al, 2021). Within this context, nature may be used directly by growing, harnessing, harvesting or sustainably restoring natural ecosystems, and/or indirectly by contributing to the planning, delivery or stewardship of NBS.

McQuaid (et al., 2021) identified the key factors influencing the success of NBEs. Access to high quality education was considered an important enabler. A total of 59% of 148 respondents to a survey conducted as part of this research study agreed on the importance of access to education, training, and skills development, making it the second most important enabler identified. This research also identified important barriers to success including lack of public sector awareness and understanding of NBS, lack of evidence of NBS effectiveness and knowledge on measuring impact, financing and public procurement barriers.

Where you would like to see more support in terms of **capacity building and skills development** for NBE?

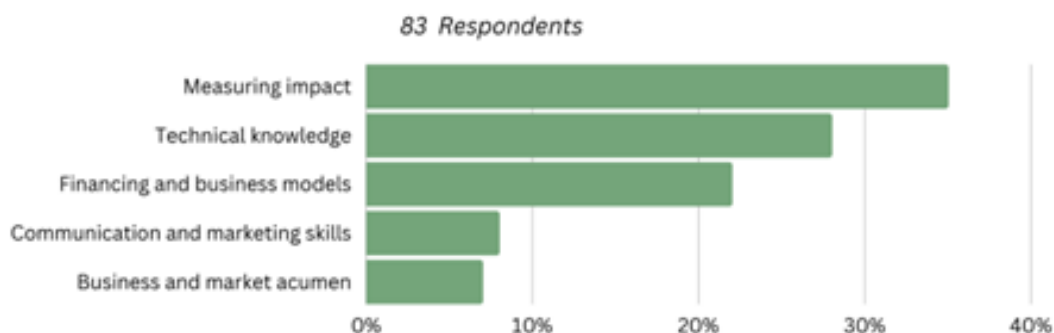


Figure 3: Results from poll of NBEs on capacity building and skills development needs

Figure 3 shows the results from the preliminary poll of NBEs which took place on 15th March 2023. On the basis of 83 responses, the top three priorities for capacity-building and skills development were identified as:

- Measuring Impact - this corresponds with previous research which highlights the challenges faced in measuring the effectiveness of NBS.
- Technical Knowledge - this may include a lack of knowledge on how to implement NBS, different technical and industry standards etc
- Financing and business models - this may include a lack of knowledge of financing and business models at different stages of start-up and development.

These findings were broadly consistent with previous research and provided guidance for the development of interview questions. From October to November 2023, 25 interviews were conducted with NBEs from 11 European countries. The highest numbers of respondents came from Ireland and the Netherlands closely followed by the UK.

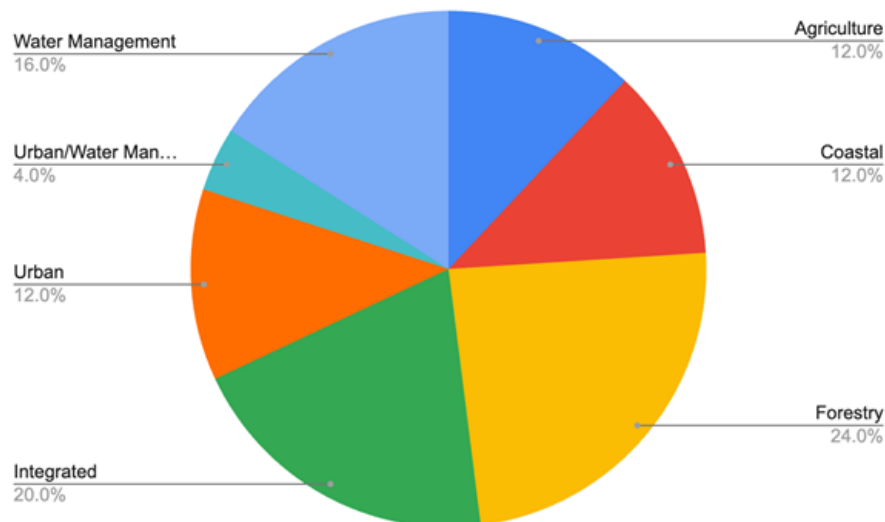


Figure 4: NBS-related economic activity

Figure 4 shows that respondents come from a broad range of NBS-related economic activities relevant to rural (agriculture, forestry), urban and coastal domains. In 20% of cases, NBEs cover more than one domain (integrated). These interviews are part of a series which is still underway, in this section we present preliminary anecdotal evidence from interviews conducted to date.

Methods of acquisition of knowledge

While many of the NBE respondents were highly qualified (Masters or PhD level), they were generally qualified in a specific discipline and lacked multi-disciplinary knowledge or experiential knowledge on how to apply technical knowledge in relation to a relatively new concept such as NBS. This led to a lot of experiential ‘on-the-job’ learning.

“How we learn? We learn by doing projects, like when we do a project or get commissioned to do a report or whatever, we come out the other side of that just knowing more and being better. Projects are great for acquiring new knowledge, which then speed-feeds into practice.” (Forestry NBE)

Preferred mode of learning of NBEs

While in general, NBEs expressed a preference for industry specific learning, the preferred modes of learning varied widely. Some preferred learning via tacit experiential learning approaches while others expressed that online platforms could be very helpful in a rapidly changing knowledge environment.

“When it comes to some general understanding of, let's say, sustainable marine tourism, if we're working on a project like that, there's never a platform that I can just point everyone in the same direction. And then make sure or even my team, for example, just to kind of test that we're all on the same level, and then move forward together. So some sort of training on getting everybody and also this NBS sphere is always moving. And as I said, we move from sustainable tourism to now regenerative tourism, and then you know, we all kind of ad hoc

catch up with the latest term, but no one puts enough time into it. Because we know by next year, there's going to be another term that we need to adapt and work on too. So it's kind of a moving target.” (Marine conservation NBE)

c. Vocational

Adult learning and CPD NBS education landscape

Courses range from 6 lower priced (€90-230) to 5 pricier ones (£850-3,200), with some of the latter cases offering lower rates for students, those based in lower-income nations, or public sector workers. Two courses did not indicate the price. Of all cases, the development of 8 is co-funded or supported by the EU, but of these only 5 are free.

Our search limited to six languages resulted in majority of courses conducted in English (22), few in Spanish (3) or in several languages, such as English together with Spanish, French or Portuguese (4), and the remainder in English with several options for (automated) subtitles.

The length of the courses ranged from 2 to 50 hours. One outlying case is an in-person course on green building amounting to over 200 hours; however, NBS are the focus of only one of its many modules. The median length of the courses is 16 hours, and the majority are delivered throughout 4-6 weeks, with several hour workload required weekly.

There is a skew towards NBS in the urban setting, with 16 courses explicitly teaching NBS in cities. Another 4 courses focus on coastal areas, one on NBS in the rural environment, and the rest of 16 touch on multiple. This proportion is also reflected in the thematic scope of the courses, with the most popular theme to teach being **urban regeneration**. The 13 cases that we identified can be further broken down into several subthemes. Courses on green infrastructure and urban planning and design target urban designers, planners, engineers, and mobility and transportation professionals (3) as well as, additionally, policymakers and stakeholders from the private sector (3). Other courses teach on urban green economy (3), sustainable communities and climate resilience (2), ecosystem restoration and rewilding directed at citizens (1), and on health and well-being (1).

Second most popular theme is **water management** with 9 courses offered. Subthemes include general understanding of NBS for water management (2), engineering (2), and one course each specialising in urban water systems, coastal cities, marine ecosystems and water related climate hazards. Majority of these courses targeted professionals already working with water management, such as hydraulic engineers, marine ecologists, those working with coastal/river flood protection, water resources management, wastewater treatment and pollution prevention, and other. In one case a course was meant for the public sector officials and professionals based in coastal areas.

Climate resilience was the main theme in 5 courses, covering use and design of NBS for adaptation, climate action, and resilience to hazards. The primary audience for these courses were engineering and environmental students and professionals, project managers, landscape architects, and policymakers with one course being directly intended for the latter.

Five courses focus on **governance and participatory planning**, including themes of climate resilience planning (2), and one each relating to NBS policy landscape, co-creation and co-

implementation processes of NBS, and integrated spatial planning. These courses primarily target civil servants, regulators, NGO staff, and environmental policy and urban planning professionals.

Another 4 courses offered a more general and broad **understanding of NBS**, and were not linked to any one specific theme. The covered material included NBS links to sustainable development, climate change, and different types and examples of NBS, and were targeted at a non-specialised general audience. Lastly, only one course was on **Entrepreneurship and NBEs**, targeted at social entrepreneurs, NGO staff, NBEs and Sustainability managers.

Considering the twelve NBS societal challenge areas identified by the European Commission (2021), the ones least addressed thematically are social justice and cohesion, air quality, biodiversity enhancement, and land management, although to some extent they may figure across all the courses.

Most courses were introductory (presenting the concept of NBS), closely followed with number of intermediate (targeted at a more specialised audience, e.g., engineers, policymakers or urban planners), and very few advanced (highly specialised). Of the courses that identified their level of difficulty, 12 were introductory, 8 intermediate, and 2 advanced. Based on the descriptions of the rest of the courses, there seems to be a relatively even distribution between courses that are open to a broad audience with little to no prior understanding of NBS, and more intermediate level courses that require professional experience applied to knowledge on NBS implementation, design and governance.

Overall, just under half of the courses rely solely on transmissive, theoretical teaching style, that is followed up by short quizzes that are often required to complete for receiving certification. We identified 14 of such transmissive pedagogy courses, and most of them also offer a self-paced learning experience. Almost half of the courses include an element of peer-learning, either through discussions, debates, or peer-reviewing. Few of the courses (6) specified relying on inquiry-based learning, namely using case studies to teach. Less than half of the courses made note of readings and activities that went beyond videos as the core learning material. Noteworthy is one course that described its major outcome as setting up a local context adapted NBS project, including its co-design, implementation and benefit assessment, and the entrepreneurship course resulting in a business plan for an NB enterprise. The two in-person courses also include field trips and experiential learning. With regards to assessment, the vast majority of the courses relied on quizzes, most often in the form of multiple-choice tests. The in-person and the more expensive paid courses all included additional forms of assessment, like group projects, attendance, and individual presentations.

With regards to skills and competences, overall, the courses offer a variety of specialised and more technical skills: ecological design skills, hydraulic engineering and design process, performing preliminary calculations for dimensioning infrastructures, using tools to assess environmental impacts of climate hazards, methodological competences to value NBI. Some of the identified transversal skills include collaboration, active citizenship, critical thinking, systems thinking and relational thinking. Several courses included skills going beyond design and initial planning of NBS for ensuring their success. For example, identifying trade-offs of NBS in different contexts, the barriers and enablers for their successful implementation, ability to describe NBS to technical and non-technical audiences.

In addition to these discussed courses, we found three cases of CPD for teachers on NBS education: the online MOOC '[Exploring Nature-Based Solutions in Your Classroom \(2023\)](#)' by NBS EduWORLD with the support of Scientix and Trane Technologies, its predecessor MOOC "[Exploring Nature-Based Solutions in Your Classroom](#)" (both of which funded by the European Commission and coordinated by European Schoolnet on the European Schoolnet Academy platform), and an in-person training in Ireland delivered by Second You Consultancy.

4. Higher Education Principles

Higher level NBS education involves incorporating principles that connect students with nature, promote sustainable practices, and foster an understanding of the environment. Based on our research here are five principles for designing NBS education for higher levels:

1. Demonstrate Impact

A major challenge of using NBS is demonstrating impact and value. Producing a clear quantitative measure of value is often challenging and this may cause issue for traditional decision makers with financial back grounds used to standardised approaches. The education approach must include an element of measurement, standards, and frameworks to demonstrate the impact NBS can have across economic, social, and environmental areas.

2. Practical Application

The importance of practical implementation of NBS was stressed for enabling students to apply theoretical knowledge in real world situations. For higher education this will necessitate case studies, field trips and hands on research projects be included in NBS curricula design.

3. Interdisciplinary Approach

Integrating NBS into different educational levels and disciplines was discussed. Encouraging collaboration among different universities and disciplines, embedding NBS into various courses beyond environmental sciences, and addressing gaps in understanding when and how NBS is taught were highlighted.

4. Global Context and Local Action

Connecting NBS to both local and global contexts. Highlight local case studies and environmental issues, making the curriculum relevant to students' immediate surroundings. Additionally, exploring global challenges and solutions to foster a sense of responsibility and awareness of broader environmental issues. Once an understanding of the global context has been developed students can be encouraged to actively engage with local communities and stakeholders. Collaborating on projects that address community needs using NBS: This not only enhances the learning experience but also instils a sense of social responsibility and community involvement.

5. Critical Thinking

Developing critical thinking skills by presenting students with real-world environmental challenges. Encouraging them to analyse, evaluate, and propose innovative NBS. This approach fosters problem-solving skills and encourages students to think critically about the implications of their decisions on the environment.

a. Competence guidelines for sustainability education

As part of our analysis we reviewed the competence frameworks in relation to higher education. The classic work on sustainability education is the key competencies framework published by Wiek et al in 2011. This framework derived from detailed literature review systems thinking, anticipatory, normative, strategic, and interpersonal competences. The Wiek et al framework underpinned the UNESCO Eight Competencies for Sustainability (2017, which added three more competences: critical thinking, self-awareness, and integrated problem solving, though these could be seen as being embodied in various ways within Wiek et al. For example, integrated problem-solving is seen as a ‘sum of the five’ competence, and critical thinking is regarded as a competence that should be found in all excellent academic programmes rather than being specific to sustainability. We found in our interviews with key educators that Wiek et al serves as the reference framework for educators at third level who are working to design institution wide programs of sustainability education.

The Wiek et al framework also overlaps very significantly with GreenComp (2022), the European sustainability competencies framework. There is one critical exception. While GreenComp makes explicit reference to nature within the competency framework, Wiek et al does not. Table 3 illustrates the competencies in each framework and colour codes them to show the areas of overlap and difference between them. The ‘Promoting Nature’ competence specified within GreenComp is unique to the GreenComp competency framework.

A possible implication of the absence of explicit reference to nature within the most widely used competence framework was Wiek et al’s decision to exclude any competences that could be classified as value orientations (even though a ‘normative’ competence is central to the framework) while the UNESCO frame does not exclude value orientation, it does not explicitly reference nature. Within GreenComp, the nature competence is positioned within the category of embodying sustainability values. Whereas Wiek et al eschewed value orientations, GreenComp positions them as foundational. The competences of valuing sustainability, supporting fairness, and promoting nature underpin the other nine.

GreenComp positions nature within the set of competencies relating to the embodiment of sustainability value. Specifically, Competence 1.3, Promoting Nature, identifies as a core competence the capacity to “acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems.”

Table 3: Competency Frameworks Compared

Wiek et al Key Competences in Sustainability (2011)	UNESCO Sustainability Competencies (2017)	GreenComp (2022)
1. Systems Thinking	1. Systems thinking	1. Systems thinking
2. Normative	2. Normative	2. Valuing sustainability 3. Supporting fairness
3. Anticipatory	3. Anticipatory 4. Integrated problem-solving	4. Futures literacy 5. Problem framing
4. Strategic	5. Strategic	6. Adaptability 7. Political agency

5. Interpersonal	6. Collaboration	8. Exploratory thinking 9. Collective Action
	7. Critical thinking	10. Critical thinking
	8. Self-awareness	11. Individual initiative
		12. Promoting Nature

This gap in the competencies frameworks prior to GreenComp creates both an opportunity and a challenge for NBS EduWORLD. There is an opportunity for NBS EduWORLD to make a very significant contribution to the mainstream body of sustainability higher education in addressing the gap created by the exclusion of an explicit nature focus in competence frameworks. The challenge is the obverse of this opportunity: given the exclusion of nature, there is much work to be done in orienting stakeholders to the value of NBS, given that nature is poorly framed within sustainability education frameworks.

Positioning NBS EduWORLD Principles for designing NBS Higher Education within the Competency Frameworks

In Section 4 we identified five principles for designing NBS higher education. Of these, Interdisciplinary approach and critical thinking are well reflected within the competency framework. Demonstrating impact encompasses the competences of impact assessment and measurement, but these are only tangentially related to the core competencies of the existing frameworks. Practical application and Global context / Local action are not competencies but contexts. The three may all be related to the GreenComp competency category of Promoting nature.

We tentatively conclude that the emphasis in higher education on impact, practical application, and global context / local action reflect the limited attention to nature in sustainability competency frameworks to date. Stakeholders need rich illustrative examples, and a vocabulary for communicating the ‘value added’ from investment in NBS. We will explore this further in the workshops in early 2024.

5. Challenges & Gaps

Implementing NBS in higher education presents a unique set of challenges that require careful consideration and strategic planning. While the integration of NBS aligns with sustainability goals and offers numerous benefits, several gaps and obstacles hinder its seamless adoption in higher education offerings:

1. Standardisation

One primary challenge is the lack of standardised frameworks and guidelines for incorporating NBS into academic curricula. Higher education institutions struggle to develop comprehensive programs that seamlessly integrate NBS across various disciplines. The absence of clear methodologies and pedagogical approaches makes it challenging for educators to incorporate NBS into existing courses or create dedicated programs. Addressing this gap requires collaborative efforts among academics, environmental experts, and curriculum designers to establish a cohesive framework that aligns with diverse educational objectives.

2. Culture

This also raises a question around the culture of the institution and whether the key decision makers are open to incorporating NBS teaching. This may involve a lack of awareness and understanding among key stakeholders, including administrators, faculty, and students, regarding the potential benefits of NBS. Without a widespread appreciation for the ecological and educational advantages of NBS, garnering support for their implementation becomes an uphill battle. Initiatives such as awareness campaigns, workshops, and seminars are necessary to educate the university community and foster a collective commitment to the incorporation of NBS.

The 3rd level interviews and focus groups highlighted the challenge the language of NBS may have particularly where English is not the native language. There is a proliferation of terminology by people who are familiar with NBS which may not translate meaningfully to those who are less familiar with the area.

3. Impact

A key to delivering cultural change is demonstrating the impact NBS can have. Many NBE expressed concerns about both the challenges in measuring impact but also the lack of demand for, and knowledge about, how to measure impact among end users in the public and private sector.

“We monitor internally (our own impacts), but no one's asking us to, we're doing it for our own impact reports for our own knowledge, some sort of tracking mechanisms, ...public sector, we all know, when these EU projects finish, maybe they'll catch up with you in a couple of years, but maybe you'll never hear from them. Same thing with development banks, they'll have their missions that they want to help certain countries in 5-10 years, and then they go on to the next regional development.” (Marine conservation NBE)

Others suggested that this picture is changing with greenwashing leading to increasing demand for impact measurement but a lack of consistency in approaches on how to do it.

4. Interdisciplinary Teaching

In addition to a lack of NBS awareness, the 3rd level interviews highlighted the challenges faced in popularizing interdisciplinary modules, noting variations in compliance across different schools and faculties. Efforts are being made to develop common modules and collaborate with various disciplines for mainstreaming sustainable development. However, challenges around streaming and staff workload are pressing.

Furthermore, the lack of interdisciplinary collaboration presents a hurdle to the holistic implementation of NBS in higher education. NBS often require input from diverse fields, including environmental science, architecture, urban planning, and social sciences. Breaking down disciplinary silos and fostering collaborative research and teaching initiatives is essential for a comprehensive and effective integration of NBS into higher education. This is particularly challenging where students wish for their modules to contribute to a particular stream and align with other modules, NBS should not be viewed as a stand-alone or separate knowledge area so, clarity is needed on how NBS contributes to traditional disciplines.

5. Financial Constraints

Financial constraints pose another significant hurdle for the implementation of NBS in higher education. Establishing green infrastructure, creating outdoor learning spaces, or developing research initiatives centered around NBS often demands substantial financial investments. Many institutions, businesses and local authorities already grappling with budgetary constraints, may find it challenging to allocate resources to NBS initiatives. This challenge may also be extended to the availability of staff to undertake additional teaching or administrative responsibilities associated with new topics. Similarly, for NBEs, while there is an interest in learning more about new sources of financing, there is also awareness and concerns about some financial instruments.

"I think it's a bit dangerous to monetize everything that has to do with nature's technologies. Because then you have this carbon market, which is a nightmare. I was totally against whatever has to do with sustainability. But somehow I would like to know a bit more about that. It's financing and business model." (NBE in water management)

In conclusion, while NBS offer immense potential for enhancing sustainability and providing unique learning experiences, the implementation of these solutions in higher education faces several challenges. Standardising frameworks, securing funding, raising awareness, overcoming infrastructure limitations, and promoting interdisciplinary collaboration are critical steps to bridge the gaps and pave the way for the successful incorporation of NBS into higher education. Addressing these challenges requires a concerted effort from educators, administrators, and policymakers to create a more sustainable and environmentally conscious higher education landscape.

6. Research-Based Priorities Going Forward

1. Interdisciplinary Programs

Develop interdisciplinary programs that integrate various fields of study, such as environmental science, biology, geography, business, engineering, and social sciences. This approach fosters a holistic understanding of NBS and encourages collaboration among students and faculty from different disciplines.

Integrate NBS into existing curricula across various disciplines. This ensures that students in different majors gain an understanding of the importance of NBS and their role in addressing global environmental issues. This will allow for the incorporation of NBS into existing learning streams.

2. Hands-on Learning

Implement hands-on and experiential learning opportunities, such as fieldwork, internships, and community-based projects. These experiences allow students to directly engage with NBS gaining practical skills and insights into their effectiveness.

3. Community Engagement

Foster collaboration with local communities to identify and implement NBS that address local environmental challenges. Engaging with communities provides students with real-world experiences and helps build partnerships for sustainable projects. This will also benefit students through demonstrable impact of their work.

4. Impact

Integrate impact assessment and modelling into curriculum design. This is a real priority for vocational and entrepreneurial education where the financial analysis of NBS is critical for both project and integrating the concept into organisations.

5. Policy and Advocacy Training

Provide education on policy, and advocacy related to NBS. Equip students and entrepreneurs with the knowledge and skills to advocate for sustainable practices, influence policy decisions, and contribute to positive environmental change. It is important to note that this includes education on how to incorporate NBS into existing policy.

This approach includes working toward green competences based on a unified framework.

6. Engage with Nature

Develop programs to raise awareness among students and the broader community about the importance of NBS. Education should include engaging in outreach activities, such as workshops, seminars, and public lectures, to disseminate knowledge and promote a broader understanding of sustainable practices. This may require further research into how students connect with nature in their day-to-day lives.

By addressing these priorities, higher education institutions can play a pivotal role in preparing the next generation of leaders and professionals with the knowledge and skills needed to contribute to a more sustainable and resilient future.

7. Conclusion

Higher education in NBS stands as a key stone in the pursuit of a sustainable and resilient future. From vocational training to entrepreneurial education and tertiary research, this multifaceted approach ensures a comprehensive and holistic response to the pressing environmental challenges of our time. By investing in education that aligns with the principles of NBS, we not only prepare individuals for meaningful careers but also nurture a generation capable of safeguarding the delicate balance between human development and the natural world. This report serves as an initial overview of the current higher-level education approaches for NBS. Research was carried out on (1) current EU wide course offerings; (2) interviews with 3rd level experts and stakeholders on NBS education approaches; (3) interviews with NBEs into their needs; and (4) focus groups with tier 1 partners inclusive of stakeholder mapping.

Implementing NBS in higher education faces significant challenges requiring careful consideration. The absence of standardised frameworks and guidelines for integrating NBS

into curricula presents a primary obstacle, demanding collaborative efforts for cohesive approaches. Cultural barriers including a lack of awareness and language complexities among key stakeholders, hinder the acceptance of NBS teaching. Demonstrating the impact of NBS for cultural change is essential but concerns about measuring impact and a lack of demand for such assessments pose obstacles. NBS education design must be mindful of financial constraints, both in higher education institutions and among NBEs. These challenges underscore the complexity of integrating NBS into higher education and the necessity for comprehensive strategies to address them effectively.

The report details with research-based priorities for NBS in higher education and discusses competence guidelines for sustainability education, referencing frameworks by Wiek et al (2011), UNESCO (2017), and GreenComp (2022). Research priorities include interdisciplinary programs, hands-on learning, community engagement, curriculum integration, policy and advocacy training, and public awareness. Competence frameworks reveal a significant gap in addressing nature, with GreenComp explicitly incorporating it. The report recognises the opportunity and challenge in positioning NBS EduWORLD to promote the use of comprehensive green competences in sustainability teaching and fill the gap in nature-focused competencies in the Higher education sector and suggests that stakeholders need illustrative examples and a vocabulary for understanding the value added by investing in NBS.

The report advocates for the integration of NBS into higher education through a multifaceted approach: NBS education requires exemplars, place-based learning and replicability for long-term success. The lessons drawn here show that NBS require multiple disciplines for their design, diversity (of settings) for co-creation and recognition of the place-based transformative potential of NBS as 'superior' to grey infrastructure. The development of interdisciplinary programs is emphasised as a means to cultivate a holistic understanding of NBS. The importance of impact assessment and real world examples in curriculum design, particularly for vocational and entrepreneurial education are also highlighted. Overall, the report asserts that by addressing these priorities, higher education can play a pivotal role in preparing future leaders with the knowledge and skills needed for a more sustainable and resilient future.

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9. Appendix

Appendix 1: NBE Survey Questions

(i) Through what networks do you keep informed about current and emerging trends in your sector(s)?

- Political/Policy
- Academic
- Industry/Professional
- Community
- Individual initiative

(ii) How does your organisation acquire different types of knowledge? You can select more than one option per type of knowledge

	Institutional e.g. third level accredited	Industry e.g. professional training/CPD, events,	In-house e.g. knowledge transfer between skilled	N/A
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	courses	networking, webinars	colleagues, learning-by- doing	
Technical Knowledge				
Sales & Marketing Knowledge				
Financing Knowledge				
Other business functions (legal, HR, admin, etc.)				

(iii) Where would you like to see more support in terms of capacity building and skills development for your organisation? 1 = most important, 5 = least important.

- Measuring impact
- Technical knowledge
- Financing and business models
- Communication and marketing skills
- Business and market acumen

(iv) What is the average level of education in your organisation?

- Second level
- Third level - degree
- Third level - post-graduate degree/Masters
- Third level - PhD
- Vocational
- Other (please specify)

(v) How would you rate the current level of training and education on nature-based solutions for practitioners?

- Scale of 1 - 10

(vi) How would you rate your knowledge on nature-based solutions?

- High level of knowledge
- Good level of knowledge

- Some knowledge
- Low level of knowledge
- No knowledge
- Comment/Other



NBS
EduWORLD