European Space University for Earth and Humanity

UNIVERSEH is an alliance of five European universities established to develop a new way of collaboration in the field of Space, within the "European Universities" initiative.

The alliance aims to create new higher education interactive experiences for the university community, teachers and students, and for the benefit of society as a whole. Such initiatives will enable broadminded, informed and conscientious European citizens to capture and create new knowledge and become smart actors of European innovation, valorisation and societal dissemination within the Space sector, from science, engineering, liberal arts to culture.

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1

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Table of content

UNIVERSEH – European Space University for Earth and Humanity is an alliance of

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1   Introduction

This document deals with re-usable micro-contents production in the context of UNIVERSEH project.

ADN stands for "Aerospace Digital Nuggets". It is a micro-content aimed at pedagogical performances and optimizing re-utilization across various pedagogical use cases and platforms. The object of ADNs is to provide knowledge about a specific notion, used individually or as a basic component for a larger training program. To promote their reusability, these objects are constrained by technical and digital learning specifications.

ADN are small reusable chunks of aerospace knowledge. It is integrating high-quality interactive multimedia contributions. The content is deliberately limited, it covers usually just one learning objective, then inducing only a short learning time (e.g., less than 30 min). It requires also interactions for auto-evaluation purposes and learner engagement.

No social (human) interaction or any form of contextualized information is present in ADN. All these contents and activities may be deported, if needed, to the learning platforms such as LMS – Learning Management Systems implemented larger courses towards specific learners.

The ADN notion has been early developed at ISAE-SUPAERO that has already created several of these micro-contents. The focus of this document is to share more details about the ADN approach, the methodology to produce them, and the ecosystem that supports their creation, management, publication, and display. Ideas about how to use them in various pedagogical situations are also proposed.

More specifically, this deliverable aims at providing guidelines to define a production process, considering the ADN's requirements in terms of technical and pedagogical requirements, but also to optimize the production process and make it easier to deploy. This production engineering considers both the technical constraints allowing optimal exploitation, and the pedagogical openness with a user-centered approach: particularly for learners and teachers. In conjunction with UNIVERSEH/WP3, several ADN in the context of space engineering will be carried out to provide inspiring examples aligned with the thematic context of Space. Finally, use cases of ADN in the various pedagogical situation will be listed.

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The document is structured as follows. In section 2, background about ADN micro-contents is presented. The following section will introduce the concepts, their implementation with H5P format, and underlying contents. Section 6 lists actors and their responsibility and competencies in the ADN development process. Section 7 proposes the ADN collaborative development workflow and gives details on each step. Section 8 focuses on the ADN implementation, management, and publication with the underlying Nuggets author platform. Finally, section 9 gives various ideas about the use of ADN in various pedagogical situations.

2   ADN Background

2.1   Towards re-usable micro-contents

Many Universities initiated their digital learning strategy with the development of digital products. Since 2011, MOOCs (Massive Online Open Courses) have been available on international platforms. Beyond the objectives of open education and communication, these distance learning products have been a fantastic opportunity to engage higher education institutions in content production engineering and explore the challenges of digital learning.

In addition to the development of these MOOCs, pedagogical efforts lead to the emergence of complementary experiments, in particular:

- **Illustrated classes**: the development of content and/or the use of digital services (EdTech) used in face-to-face teaching to improve the understanding, the commitment of students according to the notion taught
- **Flipped Classrooms**: approaches consisting of offering pre-recorded educational content that can be accessed autonomously before the physical meeting with the teacher.
- **(Blended) SPOC** (Small Private Open Course) involves producing and executing specialized training courses for small groups of learners in continuing education in the context of distant or hybrid learning.

These various experiences lead to remarkable success and innovative ways to teach but also several difficulties. One of the main difficulties remains the necessary production time of digital content, with busy teachers/researchers. These are long-term projects, requiring a significant investment on the part of the teacher, even if a team specialized in digital learning may support part of the process.

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The creation of a MOOC or any digital learning products could also then be viewed as an opportunity to develop quality content that could be reused in other contexts. To achieve that, special care must be taken in the creation of the content.

The issue of access and reuse of digital resources for educational purposes remains problematic and of interest to the community seeking to make their resources more usable and profitable. In the central perspective of reusing digital content in various educational situations, the idea of implementing a service-oriented micro-content ecosystem has been recently proposed by ISAE-SUPAERO.

The definition of micro-contents given by Karll and Defelice[1] is "an instructional unit that provides a short engagement in an activity intentionally designed to elicit a specific outcome from participant"

Based on this definition, we build specific learning objects, based on decontextualized and qualified re-usable micro-contents, integrating high-quality interactive multimedia pedagogical contributions. Once produced, these objects will be centralized in a specialized warehouse, simplifying the integration into any learning platforms that get sufficient access rights.

These micro-contents are intended to be used in a variety of ways: lifelong, initial or continuing education, on-campus, distance, or hybrid learning in asynchronous or synchronous delivery. This is a premium value for UNIVERSEH aiming at teaching courses in a distributed European University. They are primarily integrated into courses, whether they are offered in synchronous or asynchronous ways. Task 8 of WP4 intends with MLEARN[2] to setup also a "micro-learning" approach, offering learners the possibility of direct access to micro-contents, offering a way to upgrade their level of competencies on a specific domain revising course notions or supporting project-based approaches.

2.2 What is an ADN?

Based on the definition of OER (i.e., Open Educational Resources) and Karll and Defelice microcontent definition[1], ISAE-SUPAERO introduced the concept of ADN (Aerospace Digital Nuggets) called also "Digital Nuggets" or simply "Nuggets".

ADN aims at exposing one specific course concept in the context of one specific learning outcome. The object of the nuggets is thus to propose a certified basic

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[1] Karl M. Kapp, Robyn A. Defelice, Microlearning short and sweet, ATD Press, 2019
[2] See https://MLEARN.universeh.eu

6

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knowledge associated with a notion as a basic puzzle piece of knowledge. To promote their reusability, these objects are constrained by precise specifications. The main characteristics of nuggets are decontextualized content, short time to use, and online accessibility by different means. To enhance their digital processing, a metadata description is proposed and stored across the learning content.

More specifically, nuggets are defined by the following elements:

- A content including a pedagogical intention for a specific target notion.
- A unitary, indivisible pedagogical component of limited duration: 30 minutes maximum for learning time.
- A content integrating pedagogical interactions, completed by means for the learners to evaluate their level of understanding of the notion (formative evaluation).
- A decontextualized content, without reference to time or prerequisites (i.e., which may exist, but which are not specifically expressed in the content other than by metadata).
- Content that can be accessed anywhere, anytime, on any device (ATAWAD - Any Time, Anywhere, Any Device).
- Content built with a defined set of tools, based on mastered standards to ensure accessibility and appropriate integration.
- Content documented with metadata (e.g., title, author(s), keywords, summaries, type, micro-competencies in complementary repositories, prerequisites, learner time, etc.) for easy management and retrieval.
- Content-based on one or more pedagogically linked resources and learning activities.
- Content that strictly respects the technical constraints of the Web, HTML5 format, and all standard Web associated technologies, allowing a display in a modern web browser and on any terminal: computer, tablet, mobile.
- A content whose learning uses by learners are traced and whose traces may be made available to stakeholders, in compliance with the GPDR constraints.
- Content that can be dynamically integrated into learning platforms (i.e., LMS platforms, microlearning web platforms, etc.).

Each nugget is characterized by a set of data (or metadata) allowing to describe it with standardized information. It allows an automated treatment such as content search. The use of this metadata is particularly helping for ADN presentation, searching,

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sorting, filtering, classifying, usages statistics, pedagogical performance and interoperability and automated processing.

The ADN re-usable micro-content creation strategy is illustrated in the context of UNIVERSEH in the following figure.
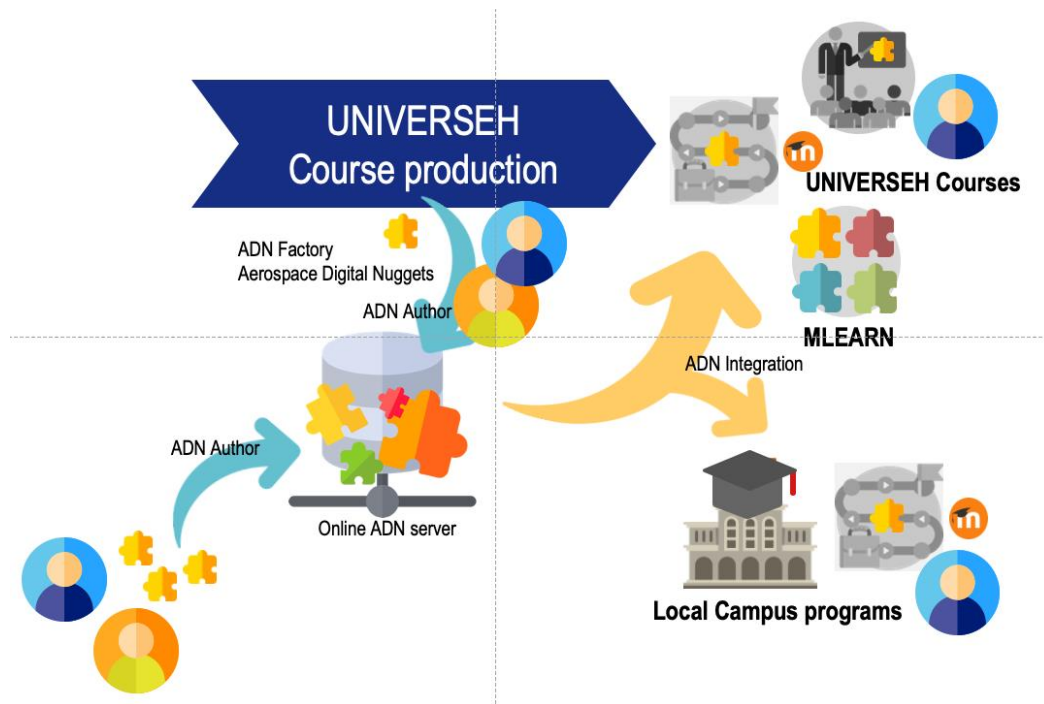
The UNIVERSEH course implementation is a good opportunity to implement re-usable ADN reusable micro-contents. The course development team should think, in the early phase of the course development, about what part of this course could have a chance to be reused elsewhere.

This reuse could be implemented e.g., in the various instantiations of this course in UNIVERSEH: one for physical campus students, one for remote learners. At the bottom of the figure, it is illustrated that it may be also useful to create ADN which are not directly linked to an official UNIVERSEH course. We could make ADN with e.g., professors or experts that do not want to propose a classical course but just light onto a specific topic.

Once created, the ADN stands in the online ADN server (i.e., see NaaS server part in next sections), ready to be integrated into learning platforms. These platforms may be the UNIVERSEH LMS Moodle platform, but also as already stated into the MLEARN

8

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platform to provide direct access to ADN to UNIVERSEH learners. The author may also want to use ADN for its own purpose, e.g., the courses it teaches to the students University. The integration is also possible to its own University LMS. Depending on the author and its producer choices (i.e., the University he depends on), it will be possible to push the ADN to a larger diffusion area, such as a group of partner Universities or even made publicly available through open education licenses.

2.3 ADN characteristics

Khan[3] proposed an E-Learning framework to analyze the eight dimensions of an organization's training/learning culture: pedagogical, technological, interface design, evaluation, management, resource support, ethical and institutional. The framework allows the stakeholders to review an organization's existing learning environment from the perspective of what works, what doesn't.

In this context, the framework serves as a refining filter for identifying learning solutions. The next figure presents the framework visualized through the lens of Aerospace Digital Nuggets. The outer octagon represents the eight dimensions of the framework while the inner green octagon list ADN's representative specificities of the corresponding dimension.

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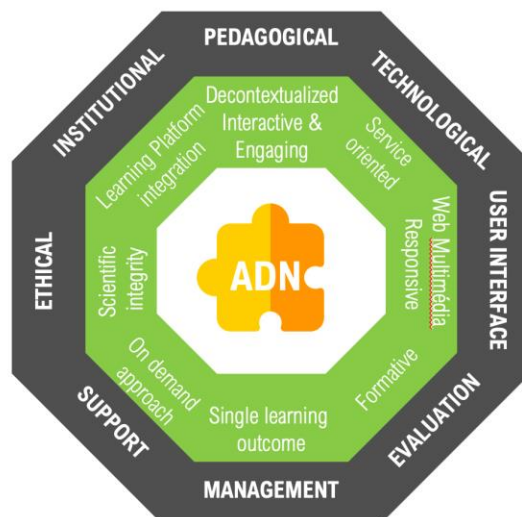
[3] Khan, B. H. (2001) A framework for Web-Based Learning, E

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From the learning framework point of view, the ADN approach can be characterized:

- **Pedagogical**: the main aspects that guide the ADN production remain the decontextualized nature in such a way to enhance re-use, and the interactive and engaging nature of ADN.
- **Technological**: the 24/7 access with service-oriented approach ease integrations, maintenance, and mastering content dissemination.
- **User interface**: ADN is implemented using H5P allowing web multimedia responsive design with learner interaction.
- **Evaluation**: the ADN only implements formative evaluation with interaction, exercise, or labs.
- **Management**: the ADN is short time with focus content on a single learning outcome
- **Resource support**: ADN assist in providing just-in-time and on-demand resources support
- **Ethical:** ADN is produced by experts and digital learning teams from universities providing high-quality content and scientific integrity.
- **Institutional:** the online approach and the possible integration in various learning platforms create the opportunity to capitalize educational contents

The ADN approach not only has an interest in the efficient production of contents but also tends to ensure its reuse by framing its design from both a pedagogical and technical point of view, inducing maximum acceptability and integration. The main potential advantages of the ADN approach are:

- **Short to produce** due to the limited scope of learning outcomes they contain.
- **Entirely instrumented**, from authoring to mastered dissemination.
- **Easy of re-use** in various pedagogical situations on various learning platforms
- Based the open extensible **H5P**[4] format.
- **Easy to maintain and to deploy new releases** on the learning platforms where they are integrated.
- **A versioning management** supported by NaaS infrastructure (see next section)
- **Mastering the dissemination** of the digital learning content

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[4] See https://h5p.org/

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- **Manage the Intellectual property**
- **Pedagogical performance** for learners
- **Responsive design** and compatibility with smartphone tablet and PC
- **Capacity to build innovative learning platforms** using a programmatic interface
- **Standardized learning analytics** and learning usage analysis
- **Ready for adaptive & personal learning** innovations
- **Institutional approach** Institutions can disseminate ADN knowledge though their LMS and innovative micro-learning platforms.

2.4   Technical infrastructure with NaaS

NaaS[5] (*Nuggets as a Service*) is the underlying service-oriented ecosystem aimed at optimizing ADN implementation. It focuses on easing the management and the re-use of digital content in the context of education. It is the underlying technical infrastructure that supports ADN. Associated with digital production engineering, it makes it possible to produce ADN micro-contents, then to store, share, integrate, present, and monitor their pedagogical uses.

As illustrated in the following figure, there are several components in this ecosystem.

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[5] See https://www.naas-edu.eu

Digital Nugget Factory Methodology
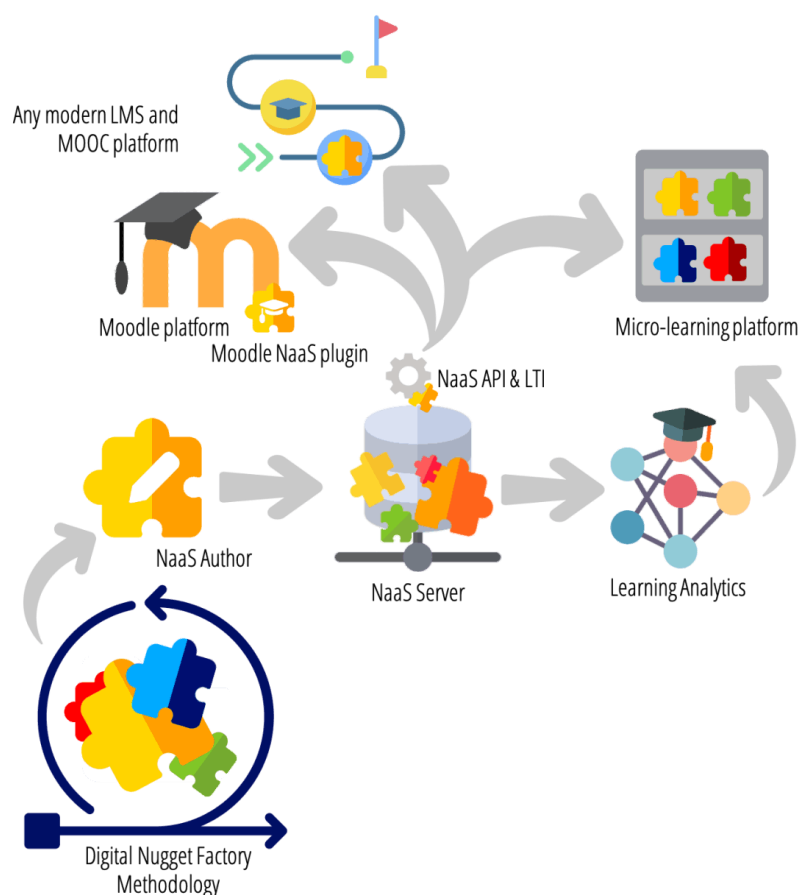
The Digital Nuggets Factory is a methodology supporting the design of nuggets and its implementation with the Nuggets Author (or NaaS Author) platform. This platform offers the means to edit nuggets based on H5P technology, but also to manage versions and to share the creation between several people. It is the gateway to the NaaS server which stores and distributes Nuggets in a very efficient and scalable way. They are dynamically integrated into various kinds of digital learning platforms such as Moodle or any other LMS, or even handcrafted platforms such as Micro-Learning platforms such as MLEARN[6]. Learning analytics will feed the consumer platform in such a way to provide e.g., suggestions toward adaptive learning.

3   ADN Production

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[6] See https://MLEARN.universeh.eu

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Creating an ADN should remain a short-term agile mini-project that requires various expertise, mainly associated to both the targeted domain and the digital learning multimedia production.

A mastered process in terms of time planning and resources and must be compliant with quality requirements. A basic workflow where different actors are involved to ease the organization and enhance the quality of the produced ADNs.

3.1 Agile Production process

The workflow associated with the development of ADN is based on four main steps, basically Preparation, Implementation, Validation, and Publication. Once the ADN creation is requested, the process is started through the preparation step. This first step intends to define the overall scope of the ADN, the elements and structure that will allow the production step. The implementation step is associated with the media creation and integration into a single ADN. The validation requires a strong quality check both on the topic and pedagogical quality of the ADN. Finally, the publication step pushes the ADN onto the server making it available for use in learning courses.

This process involves three specific roles defined to complete the various tasks, as illustrated in the following figure.

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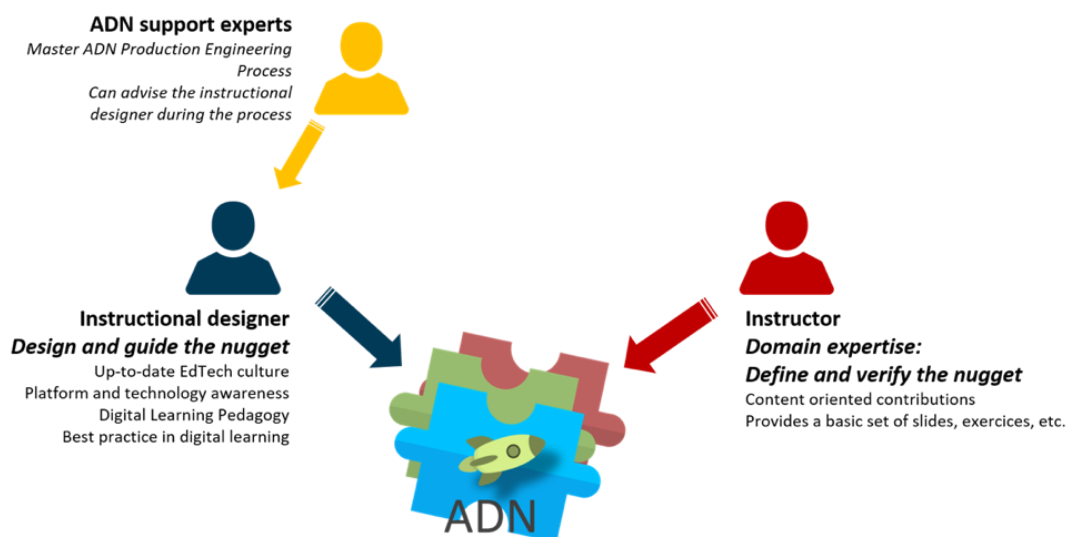
More specifically, the various defined actors are:

– **Instructor:** a member of the faculty team, the instructor is the domain expert authoring the ADN content. It is writing the content and may participate in the video shooting, verifying, and validating the ADN. The domain expert gets strong competencies in the, it is usually a University Professor that fulfills this role, it may also be an industry expert. He or she also provides the support material (for example a basic set of slides and exercises). The instructor contributions are mainly content-oriented. The instructor is, at least, involved in the ADN preparation and validation phases.

– **Instructional designer:** a member of the local digital learning team, the instructional designer proposes support to the instructor to build the AND. He helps the instructor (if needed) with pedagogical designs and guides the nugget specification. He has up-to-date knowledge about Digital pedagogy and EdTech. He may implement multimedia content and organize video shooting and production with the instructor. He masters the overall ADN production implementation process. He suggests and guides the instructor in the pedagogical choices and is responsible for the global ADN standardized format implementation. The instructional designer is involved all along the process to advise and/or coordinate.

– **ADN experts:** Member of the ADN infrastructure team, the ADN experts centralize support and provide expertise for UNIVERSEH ADN Factory both about production engineering and NaaS technical infrastructure. They teach methods, tools and provide support and advice if needed to local instructional designers for ADN creation. At the very beginning of the ADN creation project, the ADN support experts can organize training for ADN creation to ensure the quality of the production.

Considering these actors and with concerns of necessary agility for this micro-project, we propose to implement ADN through a methodology that copes with possible changes of requirements and the need to explore technologies that represent an

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invariant reality in digital learning developments. This methodology is inspired by the "yPBL" methodology defined in active learning-based methodology[7].

We define a process where incremental and iterative phases, communication, and deliverable are planned and defined to facilitate the continuous interaction between the digital learning team (i.e., instructional designer) and the faculty team. within the ADN project team, the instructional designer and instructor work together playing different roles to build the targeted ADN. To perform these interactions, actors involved in the process need to work on ADN development through various phases as presented in the following figure.
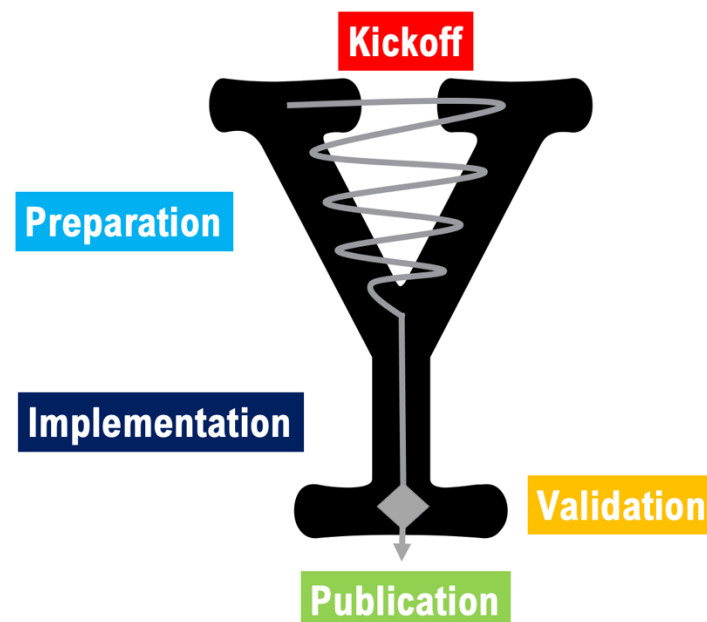
As illustrated by the graphical "Y" representation, it differentiates 2 tracks under a unified process. The first (left) track of the "Y" refers to the pedagogical aspects of the

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[7] E. Exposito, yPBL methodology: A problem-based learning method applied to software engineering, May 2010, DOI:10.1109/EDUCON.2010.5492424 in Conference: Education Engineering (EDUCON), 2010 IEEE

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ADN topic to be proposed and the second (right) track the more technical aspects (e.g., what content types, external web platforms for exercises, etc.). This separation helps the instructor to concentrate on discovering and specifying the pedagogical requirements that need to be satisfied (left track) while allowing them to explore and select the available technologies that could be used to build the content.

Once the pedagogical and technical requirements have been identified and specified, the two tracks can be merged to go to the implementation phase, illustrated by the vertical track of the "Y". From this point, the ADN can be developed using the corresponding technology. It will be validated by the stakeholders and published for use.

The next figure illustrates a more classical sequential view of the overall ADN factory process, and the necessary minimum checkpoints the team should implement. It is recommended to start the process by a formal kickoff (that may concern one or several related ADN development).
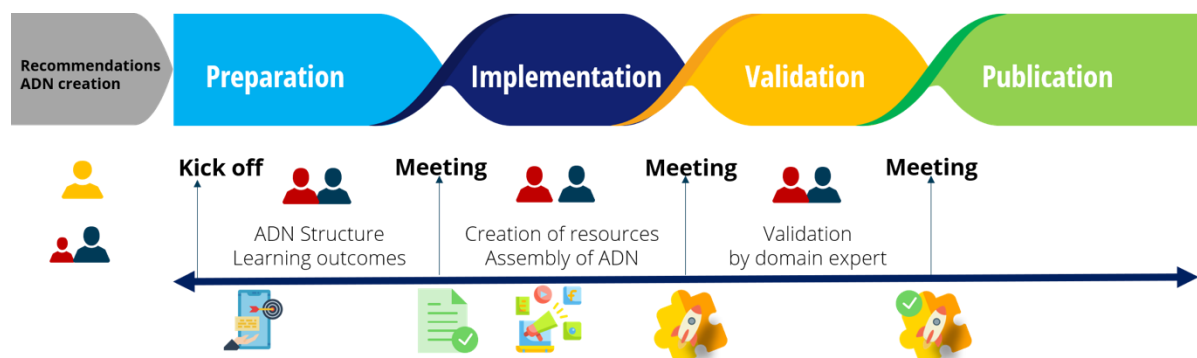
3.2 ADN Preparation

The objective of this step is to define a global specification of the ADN. The very first step to preparing an ADN is to define the scope of this ADN. A good approach to do this is to define the metadata which characterize the nugget, and which constitute a sort of ADN "identity card". This is to be done by the instructor (the domain expert) with the assistance of the instructional designer.

More specifically, the following information should be gathered:

- The topic of the ADN and its perimeter.
- The ADN title.

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- The author, co-author, the producer (i.e., the University that support the author, etc.).
- The main language used in the ADN
- The learning income(s) or prerequisite(s) to the ADN
- The learning outcome of the ADN (there are usually only one per ADN)
- The ADN abstracts
- The level of complexity of the ADN (Beginner, Intermediate, Expert that depends on the topic and the prerequisites)
- The list of available resources and sources
- The intellectual Property of the content

At this step, it could be useful to also specify some special requests or any constraints the ADN should implement for any reason (e.g., no video, no voice, the use of a special external platform, etc.). An exchange between the Instructional Designer, the Instructor, and the ADN expert team may be necessary.

TIP: ADN content

An ADN presents interactive pedagogical resources and at least one formative evaluation. Pedagogical resources can include text, images, videos, slides, or any media that may be integrated into the H5P content types that must be known by the instructional designer to help the instructor. Keep also in mind here, is that an ADN is intended to be used in various educational programs and must be associated to a single concept.

Once the ADN learning incomes and outcomes are clearly defined, it is time to build the ADN structure. It is the path, the pedagogical scenario that defines various steps between learning incomes and outcomes.

This gives the ADN breakdown, the type of activities, and their aim in the path. It could be specified as a learning script, defining the various steps and ideas on how to implement them (e.g., type of media to be used/created, the sources already , if any).

ADN Title : Airplane Components
At the end of this ADN the learner is able to name the different components of an aircraft and to explain the role of each

17

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Step	Objective of the activity	Type of activity (text, images video, quiz, simulator, etc.)	What the learner is supposed to do	Duration of the activity	Media to be created (Yes/ No)	Available resources (Type, name, author ...)	Special request (for example no video,
1	Present ADN learning objective and structure	Short text	Read	1 min	Yes	See ADN meta data	NA
2	Focus on the differences in shape and size of aircraft.	Text	Read	3 min	Yes	NA	NA
3	Name each component of an aircraft and explain the main functions	Interactive video	Watch	< 5 min	Yes	NA	If possible, use drone to record the video to show all components of an airplane
4	Assess the knowledge of learner on the names of the components	Drag and drop	Drag and drop the caption to the correct place	3 min	No	Image already exists. Provided by author	NA
5	Explain the function of the flight controls surfaces of an aircraft	Video	Watch	< 5 min	Yes	NA	The video will need to show controls in the cockpit and outsides components at the same time
6	Check if the learner understands the actions of the pilots on control surfaces	3 questions Quiz	Select the correct statement	5 min	Yes	NA	NA

Example of ADN structure

The instructional designer guides the instructor to build the ADN pedagogical scenario. It is important to distinguish the "out the box" content type H5P proposes, the possible multimedia implementation the local environment may propose (e.g., high-cost chromakey video, lightboard, or just basic webcam production), and also the external learning EdTech platform that can be used e.g., for specific interactions.[8] For example, the IREAL⌷ platform which is part of another UNIVERSEH/WP4 task could be used

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[8] See https://ireal.isae-supaero.fr

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to support a lab into the targeted ADN. The objective is finally to specify the best "time-to-cost" solution to present the notion in the context of this online self-paced learning.

We recommend building basic ADN according to the following basic structure:

- Starts with a small text to describe shortly the topic and the purpose of the ADN.
- Presents one or few resources to teach the theoretical inputs. It may be video, but also texts, images, or any needed content types.
- Finally, provides a formative evaluation associated to the theoretical input to check the learner get the knowledge. This could be completed by external tools such as IREAL to support the work and get the evaluation answers.

At the end of this phase, a formal milestone will validate the scope and specification of the ADN and will start the organization of the next step: implementation.

3.3   ADN Implementation

In the ADN Implementation phase, all the necessary raw components that will compose the ADN have to be created or at least prepared. It may mean the development or the adaptation of the slides that need to remain lightweight and pedagogically efficient, to shoot video with the instructor, to implement interaction during or after the video, or formative quiz. It could also be much development works if a brand new IREAL experiment should have been to be digitalized or a web software simulator to be developed.

The phase may start by collecting and reviewing the support material That already exists. Then the raw content (e.g., video, pictures, texts, etc.) is adapted and/or created, according to the quality requirements. We suggest setting up a collaborative drive share between the whole team to help the ADN development.

When the raw components bricks are ready to be integrated, it is time to use the Nugget Editor platform, also called Author[9].

To create an ADN, several types of resources and exercises are possible, depending on the underlying H5P technology used in the Nugget Editor tool: texts, slides, documents, quizzes, drag and drop, interactive videos, etc. The work to create the multimedia resources (presentation, articles, videos, podcast, quiz, simulation, etc.) is a collaborative work between the ADN Factory process actors.

Resources intellectual property check

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[9] See https://author.naas-edu.eu

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It is mandatory to check the Intellectual property of each resource that will be used in the ADN and be sure to have the proper right to use them before uploading them into the ADN authoring tool.

To create resources, adopt the following basics rules:

– Distinguish the need to know from the nice to know information (nice to know information may be added in an additional document (e.g., article or reference) or even outside to the ADN, e.g., in the Moodle LMS course space as contextualized information.)

– Keep it simple

– Use charts, icons, images in a coherent way (but make sure to have rights to use them).

– Special case for chromakey video creation with the instructor integration:
  - The material to illustrate the video - including graphic design, using support material provided by domain expert must be probably adapted for video integration: keep a sufficient space to integrate the speaker, as much as possible add illustrations, and keep keywords according to the speech.
  - The instructor must write down the script of the video before shooting in such a way as to speed up to shooting phase. The usage of a text prompter is highly recommended in this context.

The various elements will be finally integrated into the Nugget Editor platform that integrates H5P content-type editions.

3.4 ADN Validation

This third phase is a check-out point to make sure the ADN complies with the technical and pedagogical specification and is also that is technically correct:

– The instructor remains the responsible of the overall ADN.
– The instructor must validate the content of ADN.
– The instructional designer will validate the learning journey and experience.
– It could be interesting here to propose the ADN to a group of beta-testers (for example students, Ph.D. students, other domain experts).
– If expectations are not met the ADN must be corrected in the Implementation phase.

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3.5 ADN Publication

The ADN publication uses the Nugget Editor tool and becomes available to learners via a micro-learning platform or can be integrated into courses (e.g., in a Moodle LMS platform).

3.6 Synthesis

This checklist helps to monitor the quality of the ADN to be produced.

1. **ADN Kick off with Domain expert and Digital learning expert.**

2. **Preparation**.

   – Write the ID card of the ADN.
   – Detailed structure and ADN synopsis.

      - The ADN syllabus must include at least one knowledge content and one formative evaluation.

      - Specification validated by the Domain expert.

3. **ADN implementation.**

   – Content development.
   – ADN integration with H5P using Nuggets Editor.

4. **ADN Validation.**

   – CHECK: components validated by instructor.
   – CHECK: components quality validated by instructional designer expert.

5. **ADN publication using Nuggets Editor**

4   ADN Implementation using NaaS Ecosystem

The previous section has described the workflow for ADN production. The implementation of ADN is a process that includes several important steps and the use of external tools (p.ex., PowerPoint slideshow, video camera, video editing, etc.). This creation process includes both to the production of content, which may include different media, and to the use of the ADN editor tool, the Nugget Editor, which allows for ADN implementation, H5P support, version management and deployment.

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4.1 The H5P open format

4.1.1 H5P: Why and what for?

H5P technologies[10] is open-source software (MIT license) for creating interactive content, based on HTML5 and JavaScript. It has been developed since 2014. H5P content can be developed through editing platforms such as Moodle LMS or CMS like Drupal or WordPress. It is nowadays part of the Moodle core distribution.

H5P features an intuitive content editor that allows easy generation of interactive content although the interface is only in English. The content created can use H5P servers to be created and served but are more often created from an H5P compatible Web platform like Moodle, Drupal, WordPress or any platform implementing H5P interface. It is also possible to implement H5P content with a locally installed application such as Lumi[11]. H5P is based on standard HTML5, rather than on proprietary technology such as Adobe Flash or Microsoft Silverlight. The advantage of this is openness and interoperability with other open systems. It is likely to remain so in the future, as modern browsers are built around HTML5. **So, H5P is considered a perennial solution**.

4.1.2 H5P basics

H5P makes it easy to create interactive content by providing a range of content types for various pedagogical needs.

H5P has a real interest for an effective educational scenario:

− **Ergonomics of design** consists of considering the results of fundamental research to create resources that improve the quality of learning. Five rules are essential for designing and effective digital resource:
  - Ensure readability of information.
  - Limit the amount of information and avoid cognitive overload.
  - Structure the resource.
  - Focus participants' attention on the point at hand.
  - Make it easy for listeners to take notes.
− **Accessibility:** ADN designers must consider the access needs of students from the design of the resources, taking advantage of the possibilities offered by the technologies used in the editing process of these resources. H5P offers the

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[10] See https://h5p.org/
[11] See https://lumi.education/

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possibility of inserting different alternatives (e.g., text, audio, or video) according to the needs. The navigation can be thought of in a very structured way. But once again, ADN designers will have to be attentive to these issues when scripting their resources.

– **Cognitive performance**: Several types of H5P activities use mechanisms that promote active memorization. The possibility of inserting tests with immediate feedback, flashcards, or other interactions that can be configured in a very relevant way will promote the memorization of the concepts covered.

Instructional designers have at their disposal an infinite creative reservoir conducive to engagement, motivation, and therefore learning.

4.1.3   H5P main content types

A very large set of possibilities are offered by H5P to create interactive (or not) content. Some of them are very easy to use, some need more knowledge and implications. That is the reason why it is very important to think about the contents of the ADN and the way to motivate the students.

Some content types are really made for the purpose of the course (e.g., interactive video, timeline, virtual tour, course presentation, book) and some are more dedicated for the summative evaluations (e.g., Multiple choice, Image pairing, Drag and drop, fill in blanks, find the hotspot).

What it is important to keep in mind in the choice of the content type is that learners are working alone. The ADN content must be rigorous, engaging, and attractive.

Each activity has its own interface. All H5P content types and documentation are available online on the H5P website and particularly https://h5p.org/content-types-and-applications. But overall, H5P is quite clear, and you can easily understand how to create an activity. The H5P website offers many tutorials and documents that explain very well how to use the different content types.

H5P integrates basically media and adds interaction with it. These media may be mainly text, pictures, videos. To ensure the quality and consistency of the ADN created in the UNIVERSEH project we propose some general guidelines.

4.1.4   Support material and Slides

The slides used to create an ADN may be often re-designed. Pictures or icons may be needed, text can be reduced to the main keywords or ideas. We recommend using

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a white background, your logo and/or UNIVERSEH logo can be included using a very simple pattern.

4.1.5 Texts

In order to ensure that learners are immediately engaged in their learning, a few rules should be observed when writing texts: short sentences, selected words, accessible wording. Important points should be highlighted by bolding the text, not coloring it to be more accessible.

The mathematical formulas can be written using the Latex notations. For more information on writing in Latex, see LaTeX website[12] and Matjax Web implementation[13].

The mathematical formulas can be written in LaTeX syntax[14] using the Matjax[15] web library. For more information on writing in LaTeX, Wikipedia page[16] about this text preparation system can be a useful resource for instructional designers.

4.1.6 Pictures

When using pictures in ADN creation always make sure you have the proper usage rights to do it. As a rule, always specified the author and copyright.

If you are not sure, do not hesitate to contact the author to ask specific rights, they usually agree on usage for training.

Regarding image format, make sure the quality of the picture is good enough. Limit the size of an image to 1920x1080 and the file format is appropriate (i.e., jpeg for pictures, png for graphics and icons).

There are some online libraries for images and icons, some are free of charge, or you can subscribe for any usage (For example: see Unsplash.com).

Icons are also a good way to illustrate support materials, there are also online icon libraries, some are free others need to subscribe (For example: see Flaticon.com).

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[12] https://www.latex-project.org

[13] https://www.mathjax.org

[14] https://www.latex-project.org/

[15] https://www.mathjax.org/

[16] https://en.wikipedia.org/wiki/Help:Displaying_a_formula

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4.1.7 Video production

We recommend producing videos only when it brings a real added value and to provide instructor presence in some part of the content.

The videos must be recorded in HD format (1920x1080) and then stored and serve on a professional video server. This is important to ensure the quality of the ADN and to make sure that, whatever the media used by the learner and the quality of his/her network, he/she can work on the ADN without difficulty. For example, you can store the videos on YouTube or Vimeo. We recommend using "unlisted" privacy property when using these public platforms. Then the link only will be added in H5P.

There are several types of videos are classically included into ADN.

1. **Computer screencast**: A screencast is a record of a computer screen and /or the sound of the microphone. They are well adapted, for example, to tutorials, course presentations, (voiceover slides) or common question answers.

2. **Simple audiovisual slideshow with PowerPoint:** it's an easy way to use PowerPoint to record a slideshow with your voiceover or even the speaker video. We recommend you prepare your ideas or even, the text for each slide before starting recording and you prepare slides according to the recommendations above.

3. **High-quality chromakey video production**: Chromakey is a post-production technique to create a video composed of two layers: the video of a speaker recorded in front of a green (or blue) screen which is replaced by background. This background can be images or videos. For example, this technique is used to create a video of a teacher telling the course with the images of the course presentation in the background. See the next pictures as examples.

The result of this kind of videos is more qualitative and engaging for students.

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Tips

When creating the slides of the course presentation do not forget to keep a blank space in the slides, to integrate the teacher. Videos can be used to create branching scenario, an H5P content type that allows to display media according to the choices made by the user.

4. **Lightboard:** A lightboard is a transparent board on which the teacher writes its course as on a blackboard. The video is then flipped. This kind of support is powerful for equations, correction of exercises or courses needed several schemas. The advantage for a teacher is that this method does not differ from the normal way of giving lecture on a blackboard.
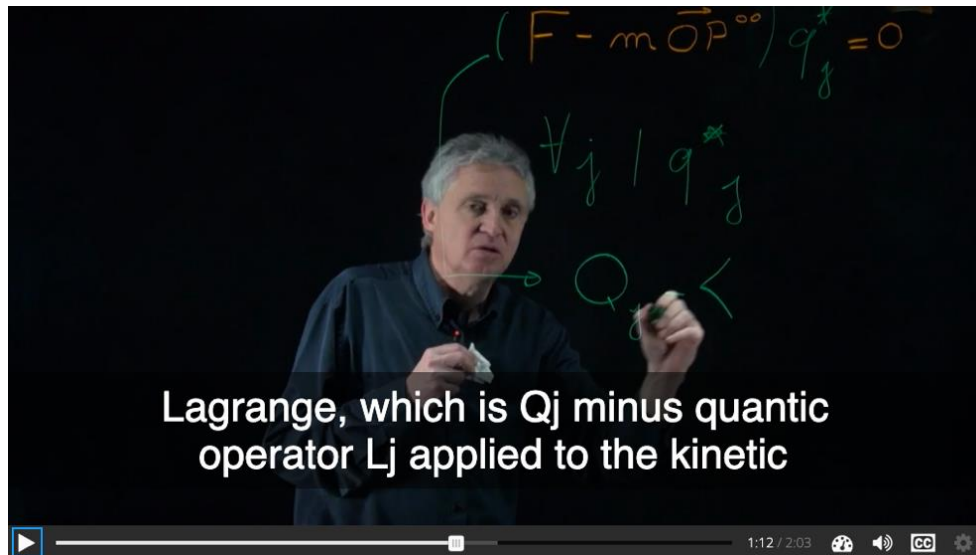
5. **Artificial voices:** Sometimes teachers don't want to get recorded, or don't have time, or are not available at the right place. In this event, artificial voices may be used. The teacher just must write the text of his speech and provide it to the instructional designer who will implement it in the "text to speech" generation tool he will have chosen. We strongly recommend checking the quality of the artificial voices which differs a lot from one provider to another.

Tips:

ISAE-SUPAERO has tested and has chosen Google voices. Do not hesitate to contact the UNIVERSEH ADN experts about the text2speech process.

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6. **Subtitling videos**: Subtitling a video is a very important element to ensure maximum accessibility of the ADN. In addition, some learners have a more visual than auditory memory. Subtitles will then help them in their learning. In case of sound problems or the inability to activate the sound of the video, subtitling will also be highly appreciated. The video must be subtitled at least in English.

Note

Several subtitle types are supported by H5P.

4.1.8 Other medias

Other types of media may be interesting to include in the ADN content. Among them, we can think of simulations or digitized experiments. Two examples are proposed here:

4.1.8.1 Simulations: example with Geogebra.

GeoGebra[17] is a dynamic mathematics software for all levels of education, covering all aspects of mathematics: geometry, algebra, spreadsheets, graphics, statistics. GeoGebra is a growing community with millions of users in almost every country. It is an easy-to-use interface, but with many powerful features, a tool for creating interactive learning resources in the form of web pages. And most importantly, it's open-source software available for free.

An example of ISAE-SUPAERO made GeoGebra is proposed in the next snapshot.

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[17] https://www.geogebra.org/

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Heinrich Heine
Universität
Düsseldorf

For this simulation, no torque is applied around the Δ axis, but we give the rotor and the blades an initial speed.

$a = 1$
$b = 2$
$C_m = 0$

$\theta(0) = 0$
$\theta_1(0) = 0$
$\theta_2(0) = 0$

$\dot{\theta}(0) = 0.5$
$\dot{\theta}_1(0) = -0.25$
$\dot{\theta}_2(0) = 0.25$

4.1.8.2 Remote experimentation with IREAL

The IREAL platform[18] allows building labs for higher education, based on digitalized scientific experiments set up that will be easily accessed by any number of learners from anywhere, at any time, with any device.

The platform focuses on a deferred approach for experiment setup usages. The principle is simple: the lab team has firstly to digitalize the experiment setup, to record all facets of the tests achieved with an experimental setup. This recording may include audio and video from several points of view, but also any digital measures that could be done during the tests. The platform provides a way to synchronize all these data into a test repository. Then it provides a realistic interface allowing the learner to access the recorded tests depending on the parameters he/she sets. Then the experimental test is played as if the learner would have the experiment in front of she/him. The

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[18] https://ireal.isae-supaero.fr

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learner can observe, record visual measurements, or sometimes get a data pack associated with the test.

The platform tends as much as possible to put the student in the same experimental environment as during the practical work in the laboratories.

The IREAL experiments can be easily integrated into an ADN.

4.2   ADN integration into the Nugget Editor

The Nugget Editor platform allow to edit, manage and publish the ADN.

Access to the Nugget Editor tool requires UNIVERSEH credentials and proper rights to access to the Nuggets Editors as an author.

An account manager is a tool that enables UNIVERSEH's participants who need to be authenticated within the UNIVERSEH information system to create an account. Contact ADN expert from WP4.7 for getting more information.

WARNING:

The nuggets editor platform, and more generally the nugget as a service ecosystem remains in early version. There are still many development activities; the description of the interface in the following sections may evolve in the future.

The ADN edition step remains on two main different sections. The first one is about metadata and information about the nugget, the second is the H5P learning content. Each of which must be completed in a rigorous manner to guarantee the quality of the published ADN and ease of use, either in a course or on third-party platforms.

4.2.1   The ABOUT section

In the ABOUT section, several fields are suggested. **Some of them are mandatory to publish the ADN[19]. This list may evolve in future version.**

1. **Title**: it's the title of the ADN. This title will appear in all platforms (MLEARN, LMS, etc.). The maximum size is sixty (60) characters.

2. **Description**: this short text introduces the ADN. It should be very specific and should encourage student engagement. It might be interesting here to list the learning incomes and outcomes in few words.

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[19] The fieds may evolve in the future version of ADN support

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3. **Banner**: it's the picture to illustrate the ADN. This picture must of course be free of copyright. The main object must be in the center of the image.

4. **Creator**: it's the author of the ADN (teacher or another person). It is possible to add several names here.

5. **Contributors**: it's the instructional designer (or another person working on the project) who implements the ADN in the Nugget Editor. It is possible to add several names here.

6. **Level**: the level of the ADN. From Beginner to Advanced, depending on the knowledge, the prerequisites, etc.

7. **Learning time**: it is the time needed to complete the ADN by learners.

8. **Tags**: it can be useful to add some keywords in order to facilitate the search of the ADNs in the different platforms.

9. **Discipline**: it's the main discipline of the ADN. Some suggestions are offered if they already exist in another ADNs.

Tip: Meta data

Make sure that these metadata are properly filled in order to increase the proper processing of the ADN content.

4.2.2 The "CONTENT" Section

This is the place to edit the ADN using H5P contents. You can add multiple items, as many as necessary to create the ADN.

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WARNING:

At this stage, the ADN is still not accessible to learners on the learning platforms such as LMS or microlearning. It must be published in order to be integrated.

4.3 ADN Authorizations

The nugget editor allows to manage the properties and the extent of ADN sharing.

In the AUTHORIZATION tab of a nugget:

1. You will define the producer of the nuggets, the producer is the Institute which manages the nugget creation, for example ISAE-SUPAERO.

You define also on which perimeter the ADN will be available, for example, the UNIVERSEH consumers will allow publishing the nuggets on Learning Platforms associated with UNIVERSEH, i.e., the MLEARN and in courses of the LMS EDU platforms.

The perimeter OPEN EDUCATION will allow the nugget to be publicly available, in any learning platform that wants to show it.

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You can find the LTI information needed for LTI integration of the nugget in other platforms. Click the show button to display the LTI information needed for integration. (I.e., Tool URL, LTI key, LTI secret).

4.4 ADN publication

The **Versions tab allow saving a new version of the nugget**. A table displaying the new nugget version will appear.

Click on the empty box in the Published column.

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Click on the empty box in the Published column.

Information

The ADN is now available on the learning platforms associated to the authorization you setup, such as MLEARN and can be integrated in a course with the Moodle plugin or using the LTI protocol.

4.5 Versioning and publishing

A feature allows the publication of several versions of the same nugget in learning platforms.

The Version tab provides a history of the ADN version, and each version may be integrated independently of each other. You can see the different versions of a nugget and the published one in the Versions tab. It is possible to publish multiple versions of the same nugget in different platforms. To do this, you will have to check several boxes in the Version tab.

33

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Version	Creation date	Published	Default version	Actions	Publication date
v1	04/11/2021 14:01:26	☐	☆	👁↺🗑	
v2	26/11/2021 12:58:09	☐	☆	👁↺🗑	
v3	11/01/2022 10:46:26	☑	★	👁↺🗑	11/01/2022 10:46:45

4.6 ADN Maintenance

It will undoubtedly be necessary to make changes to the ADN (e.g., minor corrections such as text errors or image adjustments, or more substantial work such as changing a video for example).

In the list of nuggets click on the pen icon next to the nugget you want to edit.

Title	Actions
ADN - the basics	👁✏☰
ADN for methodology	👁✏☰
Beam	👁✏☰
How efficiency can reduce aviation CO2 emissions?	👁✏☰
Lagrange's parameters for/in Lagrange's Equation	👁✏☰

Warning:

The ADN must be republished in order to be used. Follow the previous step.

Tip: Listing your nuggets

Click on the "My nuggets" actions menu item. This menu lists the nuggets already created or on which the person has modification rights.

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5   ADN integration into learning platforms

One of the main ADN concepts is the capacity to be reused across various educational contexts. We show in this section how they can be integrated into learning platforms.

The UNIVERSEH project considers this element, and several methods are proposed to integrate ADN in these learning platforms.

5.1   Integration into the Moodle LMS or other pedagogical platform

To use an ADN in a course, it is necessary to integrate it into a platform (e.g., Moodle). This integration means more than a simple hypertext link, it must also include learner authentication, the right management, and the learning traces. For this, two possibilities are offered by the NaaS ecosystem: the LTI standardized protocol or the use of the specially developed Moodle plugin.

5.1.1   Integration into a LTI LMS

LTI is a protocol that allows users of an LTI-enabled LMS such as Moodle, Canvas, Open EDX, Coursera, any LMS able to integrate content provided by a third-party web application simply and securely. In this document, the example will be given with Moodle.

LTI works by setting up a secret shared link between an LTI client platform (an LMS like Moodle) and the LTI provider (Nugget Editor). LTI allows the user to view external content (such as a hyperlink or iframe) but also manages the security of the integration (who is this user? a learner? does the user have the right to view this content?).

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As shown in the previous figure, some elements characterizing the nugget are required:

- The secure launch URL of the nugget
- The shared secret linked to the nugget and provided by the provider (Nugget editor)
- The client key identifying the platform that integrates

Tip: LTI in the Nugget Editor

In the Nugget Editor, these elements can be found in the Authorizations tab.

5.1.2 Moodle plugin

As part of the UNIVERSEH project, a Moodle platform named EDU[20] has been implemented to host the courses and provide students with all the necessary educational resources. A simple interface between NaaS and Moodle LMS like EDU has been installed to ease the ADN integration.

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[20] https://edu.universeh.eu

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In the targeted course, to add one or more ADN, simply add a new resource to the right place in the course. The specially developed plugin will be filed with the other resources (e.g., Folder, File, Label) and is called Nugget.

Remarks

It is also possible to use this plugin in the any Moodle LMS of universities that gets access to the targeted ADN.

In the activity configuration page, the search for ADN is facilitated. A text field allows you to search for the ADN by keywords. Once the proposed ADNs are displayed, you just have to select the right ADN.
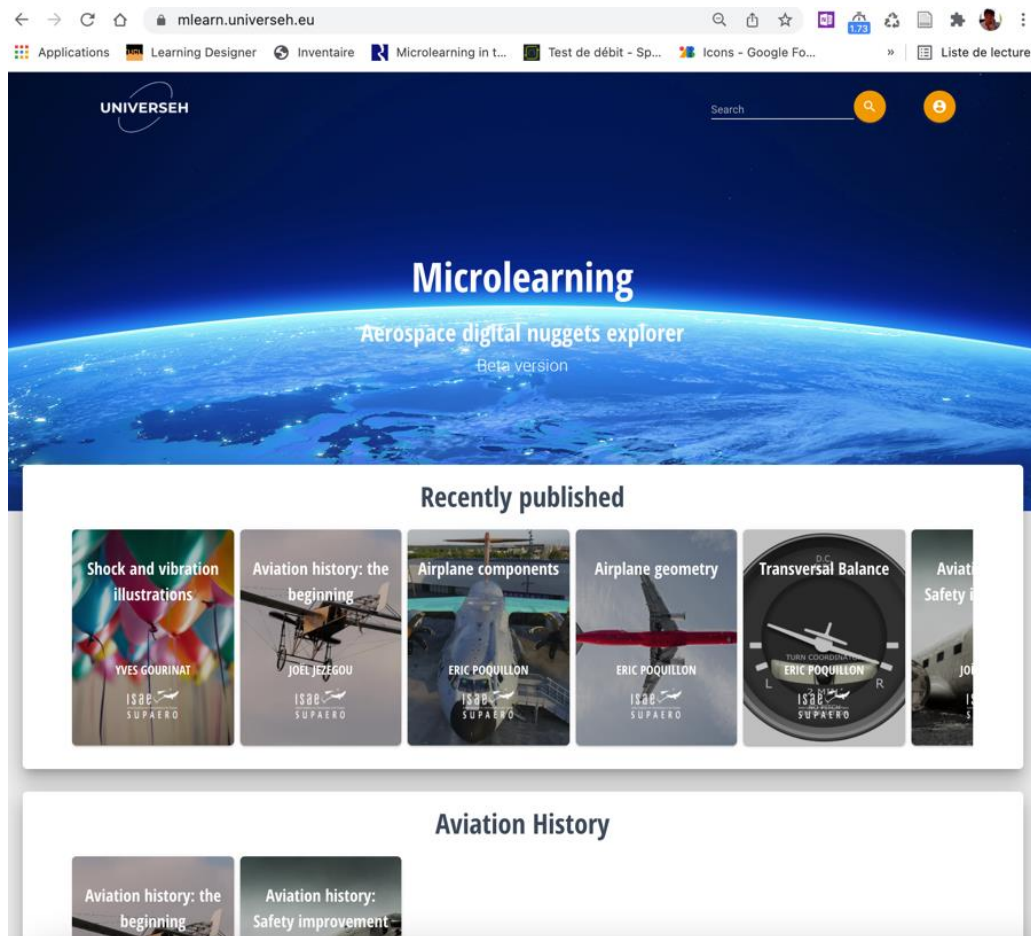
The rest of the activity settings are identical to all other Moodle resources (availability date, restricted access, activity completion, etc.).

The ADN will then appear as new activity on the course page (currently the Nugget activity icon is a puzzle piece). The student will then simply click on the resource to see the content of the ADN and work on the theme.

5.1.3 NaaS API

ADNs can be consumed directly from a tailored learning platform through the NaaS API. This is the case of MLEARN[21] micro-learning platform that makes intensive use of the programmatic NaaS API to present ADN to UNIVERSEH.

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[21] https://mlearn.universeh.eu

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All published ADN within the UNIVERSEH perimeter appear in the MLEARN platform.

6   ADN use cases

ADNs may be used in a wide variety of educational situations.

Whatever the use case, nuggets can be done as many times as needed by students. A few use cases are listed below:

6.1   ADN, as refresher to update student level

It is sometimes useful for some students to review concepts, or even to refresh themselves on some prerequisites. Access to digital nuggets can be a great help for students. Three examples of ways to do it:

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- a refresh section can be created in the course and a selection of nuggets can be integrated.
- the list of nuggets can be provided to the students, just like a bibliography, and students can go directly onto the MLEARN platform to find the nuggets and refresh themselves.
- the students are used to use the MLEARN platform, and they check themselves the refresher they need.

6.2   ADN in a MOOC for self-paced teaching

Digital nuggets are directly integrable into MOOC platforms compatible with LTI. It is then possible to insert a digital nugget into any MOOC and then avoid systematically building-specific content.

6.3   ADN in online learning integrated into a LMS online scenario

A distance learning course consists in building a pedagogical scenario aiming at learners to develop the identified skills. The digital nuggets can be integrated within a course alongside more specific content linked to the course or to the learners' profile.

For example, a course can be composed of several nuggets, some documents, webinars, formative evaluation, and summative evaluation dedicated to the context of the course and the students.

6.4   ADN in a flipped classroom

The idea here is to offer digital resources as part of a course offered in reverse. Students access the generic resources in autonomy for example on the LMS and acquire the basics of the subject. Then Students meet physically (or online via a web conference) the teacher.

Teachers will use this synchronous class for Q&A session, exercises and discussions, practical examples.

6.5   ADN for campus teaching

It can be useful during a lecture to show an excerpt from a video or a specific exercise statement. This use case of digital nuggets allows you to support your course with ready-made content and encourage students to go further with this content.

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6.6 ADN for Project Based Learning as an on-demand resource

Project and problem-based instruction all focus on each student's capacity to build understanding. The MLEARN platform offers many certified educational micro-resources in which students could come and find the appropriate content to carry out their projects. Thanks to the micro-learning platform, they could either find the basic content of the courses, but also more specific and complementary micro-contents.

6.7 ADN as additional resources provided through the learning platform

The various lectures proposed on the campus do not allow for detailed coverage of all the concepts that students might need.

Digital Nuggets are a good way to provide additional material for:

- students interested in topics not covered by their courses.
- students on Internship do get updated refresh on topics.
- to arouse the curiosity of the most motivated students.

6.8 ADN to implement hybrid learning scenario.

Hybrid approaches make it possible to vary teaching methods optimizing synchronous moments and dedicating them to the teacher's high value-added tasks. For example, a course can start with a physical session to set up the big picture of the topics and explain the course objective. Then the students can take ADN and some Q&A sessions can be organized to check the student's understanding and keep the commitment of students.

7 Conclusion

In this report, we provide an ADN as a pedagogical micro-content object with high added value because of its possible multiple uses, its potential for involvement in learning, and its collective power since it can be integrated into pedagogical devices by people who did not participate in its production. We describe an entire ecosystem aiming at managing the ADN and method to produce them.

UNIVERSEH courses can design and integrate one or several ADN that may also appear in dedicated microlearning platforms such as MLEARN. We finally provide an idea of ADN use though various examples.

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