



Report WP3: A2

Core textbook

content preparation:

Support tools for the ontology
schema implementation



Result

The support tools for the ontology schema implementation

Related to

WP3-A2: Support tools for the ontology schema implementation

Statement of originality

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Table of contents

1. Introduction.....	3
2. WP3-A2: Ontology schema implementation	6
2.1 WP3-A2 Results: The CONALI 3.0	6
2.2 WP3-A2 Results: The template for CONALI 3.0	10
References.....	13

1. Introduction

WP3 is divided into 4 main Activities (A1-A4). This report comprises the information associated with the work done for the second activity A2, namely the “**WP3-A2: Tools for the ontology schema implementation**”.

The University of Pisa (UNIPi) is the leading organization and coordinator for this work package.

The report is focused on design and developing the new version of CONALI 3.0 using Protegè, and starting from the CONALI .owl file. For the simplicity of material collection and initial drafting, a Word template aligned with the input required for CONALI 3.0 was created. The results of this activity are the CONALI 3.0 (.owl file) and the template for material collection.

The following Table 1 summarizes the main acronyms in alphabetical order, full name and short description.

Table 1: Acronyms, full name, and short descriptions

Acronym	Full name	Short description
ATs	Assessment Tasks	In the Constructive Alignment framework, assessment tasks are not isolated evaluations but are purposefully linked to the specified Intended Learning Outcomes (ILOs). They serve as a means to verify whether students have successfully achieved the learning objectives set forth in the curriculum.
CA	Constructive Alignment	Constructive Alignment (CA) is a pedagogical theory and framework developed by John Biggs that emphasizes the importance of alignment in the design and delivery of educational experiences. The key components of constructive alignment include Intended Learning Outcomes (ILOs), Teaching and Learning Activities (TLA), and Assessment Tasks (ATs). The theory posits that for effective learning to occur, these three components must be closely aligned to ensure coherence and transparency in the educational process.

CONALI	Constructive Alignment Ontology	The CONstructiveALignment (CONALI) ontology, is a recent application of ontologies in education, specifically in the context of Constructive Alignment (CA). Developed using the Ontology Web Language (OWL), CONALI provides a framework to represent the body of knowledge related to CA, encompassing semantic relationships in a computer-readable format. The last version is CONALI 2.0.
EdU	Educational Units	Low level granularity distinct modules or components within an educational program or curriculum. These units are designed to cover specific topics, themes, or skills, and they serve as the building blocks of the overall educational experience.
EGV	Educational Goal Verb	An Educational Goal Verb refers to a verb that articulates the specific actions or behaviors that students are expected to demonstrate as part of achieving educational goals. By incorporating precise verbs into ILOs, educators can better communicate the intended depth and complexity of learning, facilitating the alignment between ILOs, Teaching and Learning Activities (TLA), and Assessment Tasks (ATs) as per the principles of constructive alignment.
HE	Higher Education	Education that takes place at universities, colleges, and other institutions that award academic degrees. It typically follows the completion of secondary education (high school) and offers more advanced and specialized instruction. Higher education includes undergraduate and postgraduate programs, leading to degrees such as associate's, bachelor's, master's, and doctoral degrees.
ILOs	Intended Learning Outcomes	These are clear, specific, and measurable statements that articulate what students are expected to know, understand, and be able to do by the end of a course or educational program. ILOs serve as the starting point for instructional design and guide the selection of teaching strategies and assessment methods. These are made by EGV, context and content.
OWL	Ontology Web Language	Web Ontology Language is a powerful and expressive language used for representing and sharing ontologies on the World Wide Web. An ontology is a formal representation of knowledge, typically describing the relationships between entities within a specific domain. OWL is particularly designed to support the development of ontologies that enable machines to reason about

		information and enhance interoperability between applications.
SOLO	Structure of Observed Learning Outcome	The Structure of Observed Learning Outcome (SOLO) taxonomy is an educational framework designed to assess the levels of understanding and learning outcomes in students. SOLO taxonomy categorizes learning outcomes into different levels of complexity, providing a way to measure the depth of understanding a student has reached.
TLA	Teaching and Learning Activities	Methods, strategies, and activities employed by educators to facilitate student learning. In constructive alignment, TLAs are carefully chosen and designed to directly support the achievement of the intended learning outcomes, according to the selected EGV. The aim is to create engaging and relevant learning experiences that guide students toward the desired understanding and skills.
TET	The Evolving Textbook	Current project: development of a platform for engineering EdU representation, focusing on CA. The platform of TET requires to be built on educational ontology presenting scalability, and with alignment in content to allow collaborative update of the material.

2. WP3-A2: Ontology schema implementation

This activity addresses the gap highlighted in the previous activity WP3-A1: i.e., the lack of ready to use CA-based ontologies for education that support collaborative effort. Starting from the CONALI ontology 2.0 the consortium has reshaped the taxonomy and related semantic to match the requirements for the representation of EdU in TET using Protegè and starting from CONALI2.0 OWL file. In addition to that the ontology was expanded also to include a recent contribution in literature that helped mapping and characterizing TLA and AT based on the Bloom taxonomy level they serve: [1]. Finally, the need for indexing the content and context of the ILO was made explicit through the inclusion of specific keywords. The second result of this activity is the template developed in accordance with the new CONALI 3.0 for material collection.

2.1 WP3-A2 Results: The CONALI 3.0

The CONALI 3.0 ontology was modified by (i.e., adding/removing classes, data properties, data object and individuals). As main modification for ILOs class we added: short description, Bloom Verb level, Content (keywords), Context (keywords), and for TLA we added: Course moment, Weekday date and time slot, Location, course material, link to material, keywords. During the ontology restructuring, SOLO taxonomy, functional and declarative knowledge were removed.

In more detail, we removed:

- the class *StructureofObservedLearningOutcome* and the related subclasses *ExtendedAbstractLevelOfUnderstanding*, *Multi-StructuralLevelOfUnderstanding*, *Pre-StructuralLevelOfUnderstanding*, *RelationalLevelOfUnderstanding*, *Uni-StructuralLevelOfUnderstanding*
- the class *KindOfKnowledge* and the related subclasses *DeclarativeKnowledge* and *FunctioningKnowledge*
- the subclasses *ATForDeclarativeKnowledge*, *ATForFunctioningKnowledge* from the class *AssessmentTask*
- the subclasses *TLAForDeclarativeKnowledge*, *TLAForFunctioningKnowledge* from the class *TeachingAndLearningActivities*
- the class *SecondCycleProfile*
- the class *Teacher*

- the class *Programme*

All the related object properties and data properties of the removed classes and subclasses were removed as well. All the ILO and Course instances of CONALI 2.0 were removed. On the other hand, we added:

- data types
 - Short description, string for the ILO
 - ILO_ID, positive integer for the ILO
 - ContentKeyword, string for the content
 - ContextKeyword, string for the context
 - TLAKeywords, string for the TLA
 - TLAMaterialLink, string for the TLA
 - Course_moment, string for the TLA
 - Weekday date and time slot, string for the TLA
 - Location, string for the TLA
- specific sub-classes of AT and TLA classes as identified in the paper recently published. The sub-classes of TLA inherits the father class relation for the EGVs as follows in the object property below.

`<TeachingAndLearningActivity><enactsEducationalGoalVerbOf><EducationalGoalVerb>
<EducationalGoalVerb><isEnactedByTLA><TeachingAndLearningActivity>;`

For the existing *TLA* class we added:

- *TLAlevel1*: individuals (lecture, Reading material)
- *TLAlevel2*: individuals (Mind map, Think-pair-share, Discussion, Reflection, Fishbowl)
- *TLAlevel3*: individuals (Case study in real-life situation, Problem-solving tasks, Roleplay, Group work, Laboratory)
- *TLAlevel4*: individuals (Debates, Class discussion, Jigsaw method, Think-pair-share, Fishbowl, Laboratory)
- *TLAlevel5*: individuals (Journal, Debates, Mind map, Peer evaluation)
- *TLAlevel6*: individuals (Brainstorm, Design a presentation, Create a new report, Construct a roleplay)

For the existing *AT* class we added:

- *ATLevel1*: individuals (Multiple choice, quiz/test, question banks, take-home examinations)
- *ATLevel2*: individuals (Mind maps, interview, debate, problem sheet, minutes, forum posts, open-book, individual presentation, group presentation, viva-voce)
- *ATLevel3*: individuals (Abstract, case study, problem-solving tasks, roleplay, group work, portfolio, workbook, project)
- *ATLevel4*: individuals (Thesis, annotated bibliography, literature review, debates, class discussion, jigsaw method, think-pair-share, fishbowl, laboratory)
- *ATLevel5*: individuals (Report, reflection, journal, debates, mind map, peer evaluation, group work, teamwork)
- *ATLevel6*: individuals (project, thesis, article, essay, creative work, demonstration, performance, roleplay)
- *BloomTaxonomyLevel* class and related sub-classes for each of the six levels: *BTLevel1*, *BTLevel2*, *BTLevel3*, *BTLevel4*, *BTLevel5*, *BTLevel6* taking as reference. The adopted approach for object properties is to link each *BTLevel* subclass to each EGV subclass. Then the following object properties were defined.

```
< BTLevel1> <hasRememberingVerb> <RememberingVerb>
<RememberingVerb> <BelongsToBTLevel1> < BTLevel1>;
< BTLevel2> <hasUnderstandingVerb> < UnderstandingVerb>
<UnderstandingVerb> <BelongsToBTLevel2> < BTLevel2>;
< BTLevel3> < hasApplyingVerb> <ApplyingVerb>
<ApplyingVerb> <BelongsToBTLevel3> < BTLevel3>;
< BTLevel4> <hasAnalysingVerb> <AnalysingVerb>
<AnalysingVerb> <BelongsToBTLevel4> < BTLevel4>;
< BTLevel5> <hasEvaluatingVerb> <EvaluatingVerb>
< EvaluatingVerb > <BelongsToBTLevel5> < BTLevel5>;
< BTLevel6> <hasCreatingVerb> <CreatingVerb>
<CreatingVerb> <BelongsToBTLevel6> < BTLevel6>;
```

Figure 2 and 3 depict the classes and relations according to the modifications for the TLA/AT and BTLevel, respectively. The CONALI 3.0 ontology in the OWL format is publicly available¹.

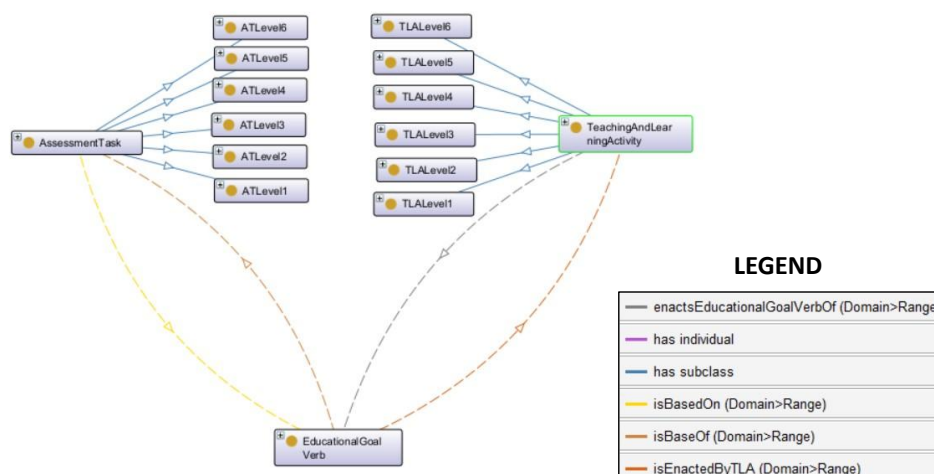


Fig. 2. CONALI 3.0 ontology AT and TLA classes and subclasses and relations

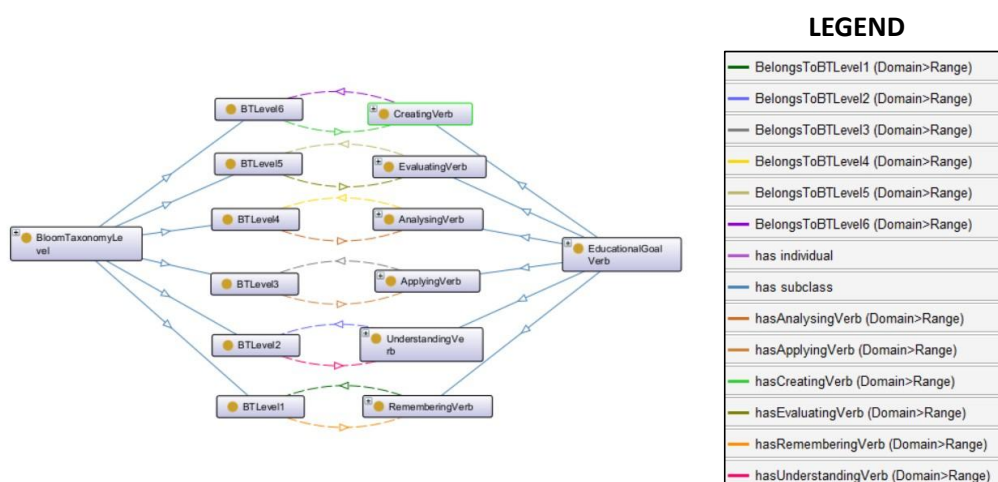


Fig. 3. CONALI 3.0 ontology BTlevl classes and subclasses and relations

¹https://unilj.sharepoint.com/:u:/r/sites/ErasmusTETproject/Shared%20Documents/WP3-Core-Textbook-Content-Preparation/Report/V2_Ontology_CONALI_3.0?csf=1&web=1&e=JO10c3

2.2 WP3-A2 Results: The template for CONALI 3.0

The base to collect the educational material was the template format developed in accordance with the CONALI 3.0 developed in WP3-A1. The template is attached in the following and can be accessed online ².

Intended Learning Outcomes (ILOs)

The template for the formulation of the ILO is emphasizing the student perspective. All the ILO are formulated to address directly what is expected from the learner after following the related educational unit. Three are the key elements:

- **Short description:** ILOs has in general from 150 to 250 characters.
- **Bloom Verb Level:** detailing the action expected and referring to the expected level of understanding as expressed in the well-known Bloom taxonomy¹ selecting one of the following level:
 - o Level1_Recall facts and basic concepts "Remember": (define, duplicate, list, memorize, repeat, state)
 - o Level2_ Explain ideas or concepts "Understand": (classify, describe, discuss, explain, identify, locate, recognize)
 - o Level3_ Use information in new situations "Apply": (execute, implement, solve, use, demonstrate, interpret, operate)
 - o Level4_ Draw connections among ideas "Analyse": (differentiate, organize, relate, compare, distinguish, examine, test, analyze)
 - o Level5_ Justify a stand or decision "Evaluate": (appraise, argue, defend, judge, select, support, value, critique, weigh)
 - o Level 6_ Produce new or original work "Create": (design, assemble, construct, conjecture, formulate, author, investigate)
- **Content** to which the action indicated by the verb refer to and keywords enclosed in parentheses and in italics
- **Context** where the action for the related content must be applied and keywords enclosed in parentheses and in italics

Table 1: ILOs for the CourseXX, Partner: XX

	Short description	Bloom Verb level	Content (keywords)	Context (keywords)
ILO1				
ILO n				

¹ For more info refer to: <https://doi.org/10.3390/educsci12070438>.

1

² https://unilj.sharepoint.com/:w:/r/sites/ErasmusTETproject/Shared%20Documents/WP3-Core-Textbook-Content-Preparation/WP3-A3%20Preparation%20of%20core%20textbook%20content/EduMaterialDataBase_Template.docx?d=wa869b399b6fe42c5a2c33f24903b86d2&csf=1&web=1&e=VMQ2F

Teaching and Learning Activities (TLA)

The template for the formulation of the TLA is emphasizing the following dimensions:

- What is the teacher supposed to do to enact the underlying ILO
- What is the learner supposed to do to enact the underlying ILO
- How does the suggested activity relate to good teaching practices as expressed in the 7 principles of good learning²

Table 2.1: TLAs for the Course: XX, Partner: XX

ILO reference (Highlight the Verb that need be aligned)	Teaching Activity (What the teachers do)	Learning Activity (What the students do)	How does this use the 7 Principles of good learning
ILO1	TA 1.1 TA1.2	LA1.1 LA1.2	
ILOn			

Table 2.2: TAs for the Course: XX, Partner: XX

Course moment ¹	Weekday, date and time slot ⁴	LA Type ⁵	Location ⁶	ILO Code	TLA Code ⁷	Course material ⁸	Keywords	Link to the material

² 7 principles of good learning:

- encourages contact between students and faculty,
- develops reciprocity and cooperation among students,
- encourages active learning,
- gives prompt feedback,
- emphasizes time on task,
- communicates high expectations
- respects diverse talents and ways of learning

Arthur W. Chickering and Zelda F. Gamson (1987)

³ Can be physical meeting or homework or any other kind of activity that need to be done in the course (e.g., visit). It shows the chronological flow of the course.

⁴ It helps understanding relative positioning and duration of different course moments.

⁵ referring to column 3 of the Table 3 (can be one of the listed examples). For more info refer to <https://doi.org/10.3390/educsci12070438>.

⁶ Class, home, lab, company

⁷ Follow the code of the previous template Table 2.1 (TA)

⁸ Material supporting each course moment. Can be: 3d models, www page, note, quizz, code, video lecture, book, chapter, task, video, slides, peer work

2

Table 3: Learning activities examples (column 3)

Bloom Taxonomy	EGV	Learning Activities (Examples)
Remember	arrange, define, list, identify	Lecture, Reading materials
Comprehension	classify, discuss, present, rewrite	Mind map, Think-pair-share, Discussion, Reflection, Fishbowl
Apply	solve, calculate, demonstrate, organize, use	Case study in real-life situation, Problem-solving tasks, Roleplay, Group work, Laboratory
Analyze	categorize, contrast, compare, debate, inspect	Debates, Class discussion, Jigsaw method, Think-pair-share, Fishbowl, Laboratory
Evaluate	assess, conclude, justify, measure	Journal, Debates, Mind map, Peer evaluation
Create	design, develop, revise, formulate	Brainstorm, Design a presentation, Create a new report, Construct a roleplay

Assessment Task

The template for the formulation of the AT is emphasizing different assessment strategies for different verbs and different learning style.

Table 4: TAs for the Course: Manufacturing processes, Partner; Unipi

ILO reference (Highlight the Verb)	Assessment task 1	Assessment task 2	Assessment task n
ILO 1	Bloom level: Type***: Short description:		

Table 5: AT examples

Bloom Taxonomy	EGV	Assessment Task (Examples)
Remember	arrange, define, list, identify	Multiple choice, quiz/test, question banks, take-home examinations
Comprehension	classify, discuss, present, rewrite	Concept/mind maps, interview, debate, problem sheet, minutes, forum posts, open-book, individual presentation, group presentation, viva-voce
Apply	solve, calculate, demonstrate, organize, use	Abstract, case study, problem-solving tasks, roleplay, group work, portfolio, workbook, project
Analyze	categorize, contrast, compare, debate, inspect	Thesis, annotated bibliography, literature review, debates, class discussion, jigsaw method, think-pair-share, fishbowl, laboratory Report, reflection, journal, debates, mind map, peer evaluation, group work, teamwork
Evaluate	assess, conclude, justify, measure	Project, thesis, article, essay, creative work, demonstration, performance, roleplay, recorded/rendered creative work,
Create	design, develop, revise, formulate	

References

- [1] A. Maffei, E. Boffa, F. Lupi, M. Lanzetta, On the Design of Constructively Aligned Educational Unit, *Educ Sci (Basel)*. 12 (2022) 438. <https://doi.org/10.3390/educsci12070438>.



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