

Aligning Assessment with Learning Outcomes in Outcome-based Education

Raquel M. Crespo¹, Jad Najjar², Michael Derntl³, Derick Leony¹, Susanne Neumann⁴,
Petra Oberhuemer⁴, Michael Totschnig², Bernd Simon², Israel Gutiérrez¹, Carlos Delgado Kloos¹

¹ Departamento de Ingeniería Telemática, Universidad Carlos III de Madrid, Leganés –Madrid– (Spain)

² Institute for Information Systems and New Media, Wirtschaftsuniversität Wien, Vienna (Austria)

³ Computer Science Didactics & Learning Research Center, University of Vienna, Vienna (Austria)

⁴ Center for Teaching and Learning, University of Vienna, Vienna (Austria)

Abstract— In outcome based learning, learning outcomes (knowledge, skills and competences) to be achieved by learners are in the focal point of the learning process. All educational activities and resources need to be related to the intended learning outcomes of a learning module or course, in order to assist the learners in successfully achieving the intended learning outcomes at the end of the learning experience.

Outcome based assessment means that the assessment process must be aligned with the learning outcomes. This means that it should support the learners in their progress (formative assessment) and validate the achievement of the intended learning outcomes at the end of the process (summative assessment). It also means that the assessment process should be adapted depending on the kind of outcomes that it is aimed to appraise.

This paper presents an insight into the current state of outcome based learning within Europe and proposes a unified conceptual model for outcome based assessment, shaping a theoretical framework for the integration of learning outcomes, assessment and units of learning as key concepts. An application scenario is finally described to illustrate the application of the model.

Keywords- learning assessment, learning outcomes, unit of learning.

I. INTRODUCTION

The European Qualification Framework [1] is proposed to act as a translation mechanism across the different National Qualifications Frameworks (NQFs) in the European countries. Its implementation should help higher educational institutions and workplace organizations across Europe to exchange and compare learning outcomes presented by individuals. The primary goal of the EQF is to improve mobility of learners across European countries and educational systems. Currently, higher education institutions have not yet adopted standards for learning outcome definitions, resulting in inefficiencies for both outcome-based learning design and outcome-based discovery, access and re-use of units of learning [2].

In this paper, the ICOPER¹ project approach for developing outcome-based assessment and units of learning is presented. The alignment of assessment items to learning outcomes to be achieved by learners is discussed in a novel theoretical framework and reference model for assessment in outcome-based educational environments.

II. KEY CONCEPTS IN OUTCOME BASED EDUCATION

A. Learning Outcomes

Learning outcome means statements of what a learner knows, understands and is able to do on completion of a learning process. It covers knowledge, skills and personal, social and/or methodological abilities that a learner should attain when successfully having finished a unit of learning:

- **knowledge** means the *outcome of the assimilation of information* through learning [1]. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. Example: “*learners are able to enumerate and explain the eight golden rules of interface design.*”
- **skill** means the *ability to apply knowledge* and use know-how to complete tasks and solve problems [1]. Example: “*learners are able to design an interactive website that complies with Web Accessibility Guidelines.*” – Note that in order to achieve this skill, learners will need to assimilate knowledge in web programming and web usability. They will be able to do something by applying knowledge, therefore it is a skill.
- **competence** means the proven *ability to use knowledge and skills* in work or study situations and in professional and personal development [1]. One key aspect of a competence is the degree of autonomy and responsibility with which learners are able to apply knowledge and skills. Example: “*learners are able to review the design and usability of a given system and formulate suggestions for improvement based on relevant design metrics and*

¹ <http://www.icoper.org>

guidelines with minimal supervision by a tutor.” – This learning outcome requires the ability to use knowledge and skills: it requires knowledge about user interface design and usability metrics; it requires the skills of being able to do a critical review, apply usability metrics, and suggest improvements to the model. It is a competence because it adds information about the degree of autonomy by stating that learners are able to do this with minimal supervision by a tutor.

IEEE RCD [3] is the only widely accepted standard for describing generic learning outcomes. IEEE RCD is a continuation (and replacement) of the early efforts on the development of IMS Reusable Definition of Competency or Educational Objective [4]. It provides a way to capture the key characteristics of a learning outcome, independently of its use in any particular context or target group (persons). This model should enable the storage, findability and exchange of learning outcomes across learning systems that deal with learning outcomes data.

B. Outcome Based Unit of Learning

Learners aim to achieve learning outcomes by successfully completing a **unit of learning**. Each unit of learning targets the acquisition of one or more assets of knowledge, skill or competence. We define a unit of learning as a contextualized, complete, self-contained unit of education or training that consists of a teaching method and associated content (adapted from [5] p. 25). A three-months distance course on the effects of global warming could be an example of a unit of learning. A one-hour face-to-face lecture on the basics of academic writing could also be an example of a unit of learning. Hence, units of learning may differ significantly for attributes like duration or complexity of activities.

This definition outlines two important properties of a unit of learning: *contextualized* means that the unit of learning is situated in a specific subject context; *complete* and *self-contained* mean that the unit of learning includes all information and resources required including objectives, content, assessment, description of learning and teaching activities, and so forth.

Well-designed units of learning typically follow a strategy or **teaching method**. We define a teaching method as a *learning outcome* oriented set of activities to be performed by learners and learning supporters. Examples of teaching methods are the lecture method, problem-based learning, and the think-pair-share method.

A pivotal piece of information to be included in a unit of learning or teaching method is the set of intended learning outcomes (see Section II.A) that learners are expected to attain upon successful completion of (a run of) the unit of learning. We define that learners have successfully attained a learning outcome if they successfully passed the associated assessment that is part of the unit of learning. Information on the learning outcomes to attain is linked to each unit of learning in the form of learning outcome definitions. As described in Section II.A, we differentiate between knowledge, skill, and competence types of learning outcomes.

Typically, teaching methods are *generic* descriptions of activities, independent of specific content or an application context. Therefore, a teaching method is not directly put into practice by teachers: it needs to be adapted to a specific application **context** that gives meaning to it (e.g. subject, target learner group, IT infrastructure). Teaching methods are thus realized in units of learning within a specific context and with associated content. One unit of learning may employ multiple teaching methods that aim at several learning outcomes.

Another important aspect to be considered for the design of units of learning is the **learning assessment**. The learning assessment specifies which assessment resources and methods are to be used during the learning provision process to assess the achievement of intended learning outcomes. While a generic teaching method typically makes general statements about the **assessment method** (e.g., multiple-choice test, peer assessment, learning contract, oral examination), the unit of learning needs to specify in detail how the assessment method is implemented with a concrete set of **assessment resources** (e.g. tests, test items, peer assessment forms).

There is a design-time view and a runtime view on units of learning. All required descriptive information (metadata) related to a specific teaching and learning process is specified at design time. A running instance of a unit of learning is called a *run*. While each run may involve different groups of learners in different environments, all runs of a unit of learning follow the design specified in the unit of learning. There are many different ways of representing units of learning. Some widely used formats include narrative texts, structured descriptions following a uniform template, or formal machine-readable descriptions using a specialized language (like IMS Learning Design [6]).

C. Outcome Based Learning in Europe

The European Union is confronted with the challenge to make Europe more responsive to the labour market's requirements. In other words, European graduates should be equipped with the appropriate knowledge, skills and competences required by the workplace to meet the challenges of globally increasing competition.

In 1999, education ministers from 29 European countries signed the Bologna Declaration [7] and so committed to establish the European Higher Education Area (EHEA) that should promote coherence in European higher education by 2010. The EHEA is not intended to represent a centralized European-wide system of higher education, but rather offers reference points for national policies and actions, and it guides the implementation of common key features in the respective national educational systems, such as national qualification frameworks. The re-structuring of the educational systems to meet the requirements of the EHEA resulted in a change of paradigm promoting the idea of putting the learner into the centre of the learning process and of concentrating on the intended learning outcomes of this process instead of what has been provided as input by teachers and instructors.

The Bologna process offers the instruments required to bring about the shift from a teacher centred to a more learner-oriented approach to education for formal study programs. That

includes the European Credit Transfer System (ECTS) [9] to express students' workload, the two/three cycles system (bachelor, master, PhD), the degree recognition to further the compatibility and portability of study programmes and the European Qualification Framework to make learning outcomes more transparent and comparable across Europe.

Of course, formal learning offerings (e.g. study programmes) cannot satisfy all the requirements of lifelong learners, therefore informal learning opportunities become crucially important. Anyway, integrated support for informal and formal learning is missing. Learning outcome development typically starts in the initial education context, which includes traditional school settings. But dynamic changes in the society and economy increasingly demand lifelong development of knowledge, skills and competences in the work context, encompassing both informal learning activities (i.e. intentional, but not accredited) as well as non-formal ones (i.e. as a side effect of other activities). A holistic picture of the educational process distinguishes its five phases: requirements analysis, design of learning strategy, development of learning offerings, provision of learning opportunities, and evaluation of learning offerings [8]. New approaches are needed to better map learning outcomes to units of learning, teaching methods, assessment methods and records, and context of study and work, analyse learning outcome gaps, and provide informal training to close these gaps. That is in addition to enabling exchange of graduates' learning outcome profiles between universities and workplace systems and between European universities.

In ICOPER, one key challenge will thus be to find ways that can effectively bring together educational achievements attained within formal as well as informal learning settings. That should result in evidence records (i.e. statements about the learner's attained learning outcomes based on assessment) of what a person knows and understands, and is able to do in terms of different application modes of knowledge and understanding at different levels of autonomy and responsibility.

III. TOWARDS A UNIFIED MODEL FOR OUTCOME BASED ASSESSMENT

The most significant precedent reference model for the assessment domain is FREMA (e-learning framework reference model for assessment) [10]. Since its development, the technology enhanced learning field has however experienced an important evolution, which requires a renovated model. The most significant contribution of the ICOPER model proposed here is its emphasis on learning outcomes orientation, which is in line with current European policies and recommendations framed by the Bologna Process and its efforts towards establishing the European Higher Education Area. An additional contribution is its integration into a global holistic reference model for technology enhanced learning rather than focusing on just one aspect –assessment– of the learning process.

A. Conceptual Framework and Content Space

The ICOPER reference model [11] aims to provide a conceptual framework for common understanding of the learning outcome based Technology Enhanced Learning (TEL) area as well as the interdependencies of its key concepts. The objective is to facilitate the work of stakeholders to design, develop, implement and improve TEL systems with a focus on re-use and outcome based learning. For the field of assessment, a reference model supports the development and implementation process of assessment-related tasks and systems.

The Open ICOPER Content Space (OICS) [12] aims to provide access to integrated educational content and services, and acts as a proof of concept for the reference model. Figure 1 represents the architecture for the OICS.

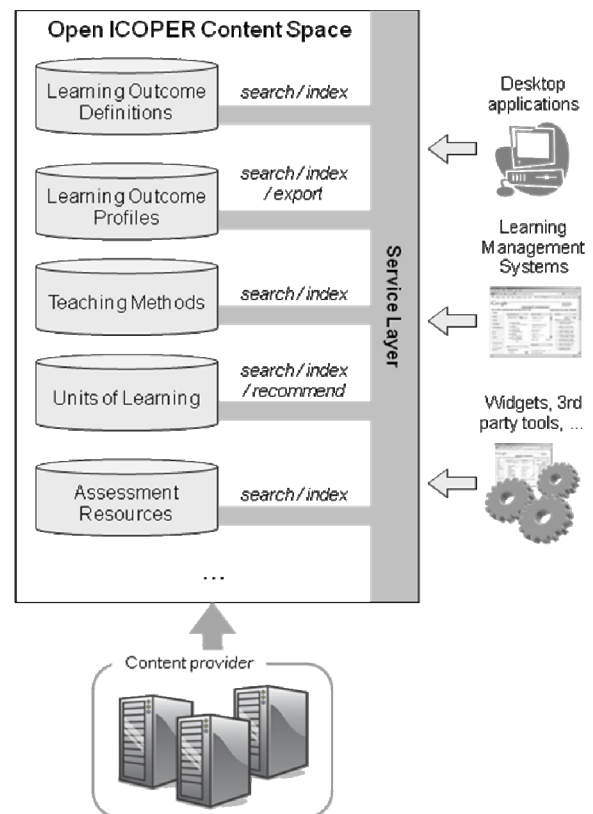


Figure 1. OICS architecture.

The OICS attempts to provide a service-based interface to access educational resources distributed among different content providers thus facilitating re-use. Accessibility of the resources relies on the use of metadata. Original metadata (as stored in the source repositories from content providers) are thus complemented with enriched metadata including complementary information associated to the resources according to the ICOPER reference model. The OICS implements a learning outcomes based approach to learning processes, providing access to the key educational resources defined in the ICOPER reference model: learning outcomes (including both learning outcome definitions as well as

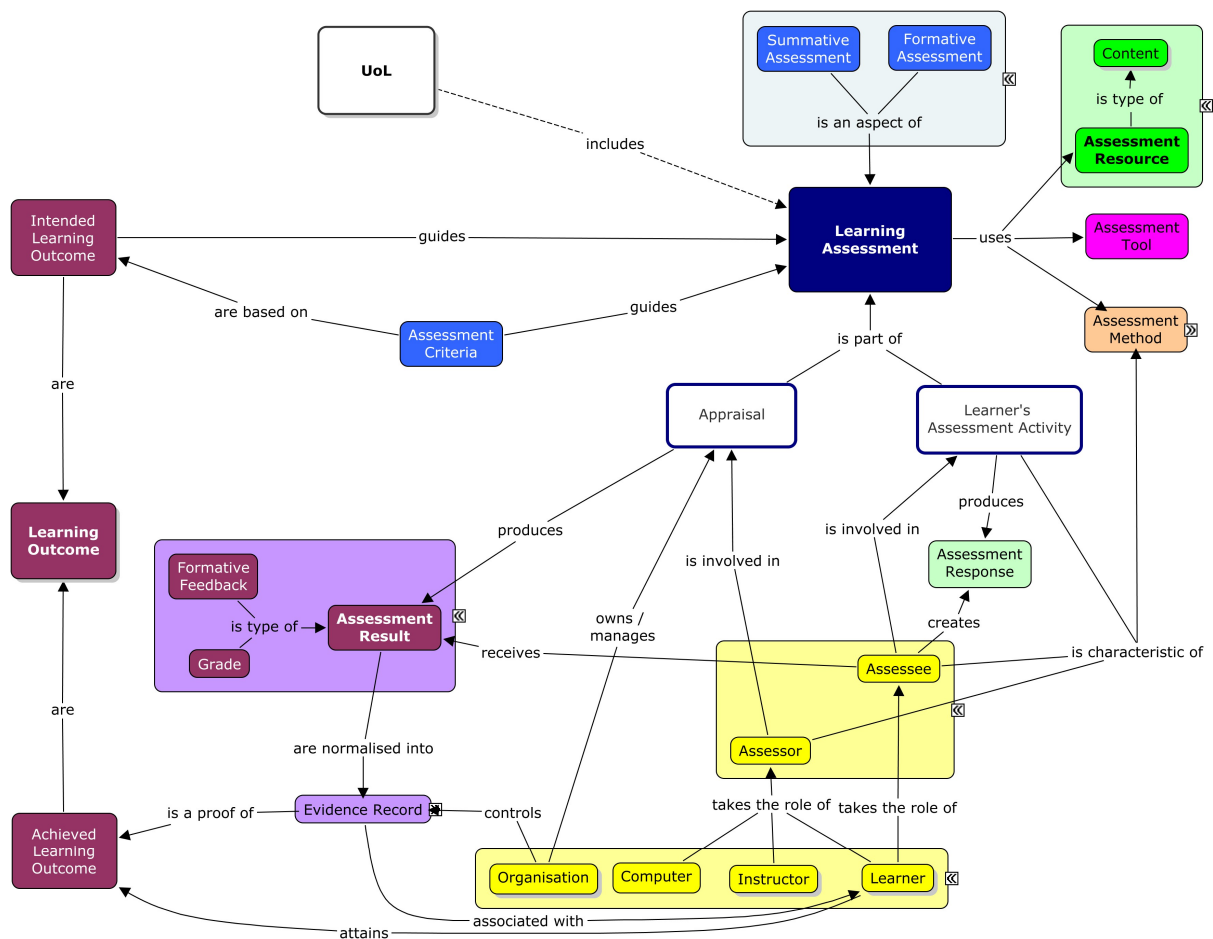


Figure 2 Conceptual map for learning assessment.

learning outcome profiles), units of learning and teaching methods, and assessment resources.

B. Unified Conceptual Map and Reference Model

There are two main concepts in any learning scenario: the learning outcomes that are intended to be achieved by the learner and the unit of learning as the means by which those can be achieved. In order to complete the picture, *learning assessment* appears as the process of testing the achievement of learning outcomes (knowledge, skills and/or competences) by an individual learner and providing the corresponding information reporting about the learner achievements and/or potential indications for improving them. It can be summarised as the process of identifying, collecting and preparing data to evaluate the achievement of the outcomes and educational objectives of a program [13]. Learning assessment is thus the binding process by which the intended learning outcomes defined by a unit of learning are accredited as actual learning outcomes acquired by a learner, transforming those learning outcomes from potential to factual.

The unit of learning makes use of the learning assessment process, in order to verify that the learner who participated in the unit of learning attains the intended learning outcomes. Learning assessment processes can be integrated into a unit of learning as activities which imply a response by the learner,

and also generate information about his/her performance as results.

Two representative cases can thus be considered [14]. On the one hand, a unit of learning which includes a final assessment process to check whether the learners have successfully accomplished the intended outcomes. That is, a summative assessment, which provides a measure of achievement or failure, made in respect of a learner's performance in relation to the intended learning outcomes of the program of study [15]. An example of such a case is an exam at the end of a course on Object Oriented Programming. The unit of learning is in this case the course itself, which includes a series of lectures, programming exercises in the laboratory, etc. In order to adequately cover the assessment of the expected learning outcomes, the exam would be composed of a theoretical part with multiple choice questions addressing knowledge outcomes of the course (*e.g. Explaining the concepts of Object and Class*); and a programming assignment for evaluating the student's programming skills (*e.g. Developing a software program which involves inheritance*). The learning assessment concept (cp. Figure 2) would comprise the whole process, including in this case both the activity of the learners taking the exam as well as the appraisal phase when the instructor gauges the learners' responses and awards them the corresponding grades.

On the other hand, a learning assessment process can be a learning activity itself, aiming to provide formative feedback to the learner about his/her performance and support their progress [16] [17]. An example of this case is a peer review activity integrated as part of the unit of learning. Following the previous example, the same course on Object Oriented Programming includes a peer review activity consisting of assessing a programming project developed by the learners organized in teams of four members. Such activity aims at generic learning outcomes such as team-working and critical evaluation, in addition to other domain specific outcomes. The learning assessment can again be subdivided into two sub-processes: the development of the project by the learner (learner's activity) and the reviewing (appraisal).

Further analysis of the relationship between learning outcomes, unit of learning and learning assessment requires the introduction of the key concepts related to the latter: assessment resource, roles (assessor and assessee), assessment results, etc. Figure 2 represents these key concepts as well as the relationships interconnecting them.

In a similar way that a unit of learning uses learning resources for supporting the learning process, an assessment process also makes use of specific content. An assessment resource is a special type of learning content, which is used for assessment purposes and it involves interaction with the learner. Examples of assessment resources would be the test in the first case, with the set of questions and the programming assignment instructions. And for the second case, the assessment resource is the project proposal together with the rubrics and questionnaires for the peer reviewing. Assessment resources should include additional information besides the textual instructions provided to the learners. For example, information about the correct answers for the multiple choice questions in the first case.

Such assessment resources are proposed to be represented using the IMS Question, Test & Interoperability (IMS QTI) specification [18] (considered nowadays a standard de facto for assessment resources) enriched with extended metadata. Such metadata includes information about the learning outcomes (knowledge, skills or competences) that are tested by the assessment resource.

Two roles are involved in the assessment process: the assessor (responsible of the appraisal) and the assessee (whose learning outcomes are appraised). They typically correspond to the learning supporter and the learner roles defined for the unit of learning, respectively.

As a product of the appraisal done by the assessor, the assessment results are generated, consisting of information about the performance of the assessee, his/her achievement of the learning outcomes and/or formative feedback for supporting the learner's progress. Usually, assessment results can correspond to specific learning outcomes and may need further post-processing to inform about more generic learning outcomes. For example, it may be necessary to combine results from several assessments to accredit the attainment of a certain learning outcome. On the contrary, it is also frequent that a given assessment process considers several different learning outcomes. Here there is a need for a normalization process that

transforms detailed assessment results into *evidence records*, which act as proof of the attainment of learning outcomes and can be included in the learner's *learning outcome profile*.

The evidence record acts henceforth as the binding between the learning outcomes that the learner can actually claim and the assessment process (when successfully completed). In order to be trusted and to provide complete information, evidence records should include data about the type of assessment performed as well as the responsible expert and institution that endorses this evaluation.

Finally, the description of the assessment process is formalized into the *assessment method* concept, which comprises the characteristics defining a certain assessment process (such as who plays the role of assessor, the type of activity posed to the assessee, the purpose of the process, the kind of results to be provided, etc.).

The assessment method is strongly influenced by the assessed learning outcomes. Different types of learning outcomes require different assessment methods. For example, knowledge-type learning outcomes can be assessed using multiple-choice tests while such kind of activity is less appropriate for assessing skills. Assessing the fluency and pronunciation skills of a learner in a course on English as a foreign language would imply the use of oral activity; whereas a written assignment may be used for assessing a learner's writing skills.

Different assessment methods can also be defined depending on the actors playing such roles. The assessor role can be played by the student him/herself, peer learners, the instructor or automatic assessment. Regarding the assessee role, learners can be assessed individually or in groups (collaboratively). Again, the learning outcomes can be determinant in the selection. Critical thinking is usually dealt with by self-assessment, and peer assessment is typically applied when evaluation skills are intended outcomes.

The assessment method is thus a concept that can be related to the teaching method defined for the unit of learning, as it plays an equivalent role for the learning assessment (namely, the generic description of the process) and can thus be considered an integral component of the teaching method. So the teaching method includes references to the assessment method(s) to be applied when learning assessment activities are included.

In the examples discussed above, different assessment methods are applied. In the final exam case, the assessment method consists of an individual, time-limited (duration: 2 hours), face-to-face written exam, combining a (constrained) multiple-choice test with a (constructed) development assignment; responsibility for appraising the learner responses corresponds to the instructor, who plays the assessor role; the purpose of the assessment is summative and grades are the only assessment results generated (no formative feedback is intended). Conversely, the assessment method in the second case (formative peer review activity) consists of a team project assignment (teams composed of four members), peer learners play the role of assessors and the purpose of the assessment is

formative, thus formative feedback is provided to the learners as assessment results.

Figure 3 shows the conceptual map for the proposed learning outcome based assessment model, abstracting the detailed concepts and focusing on interconnecting key ones.

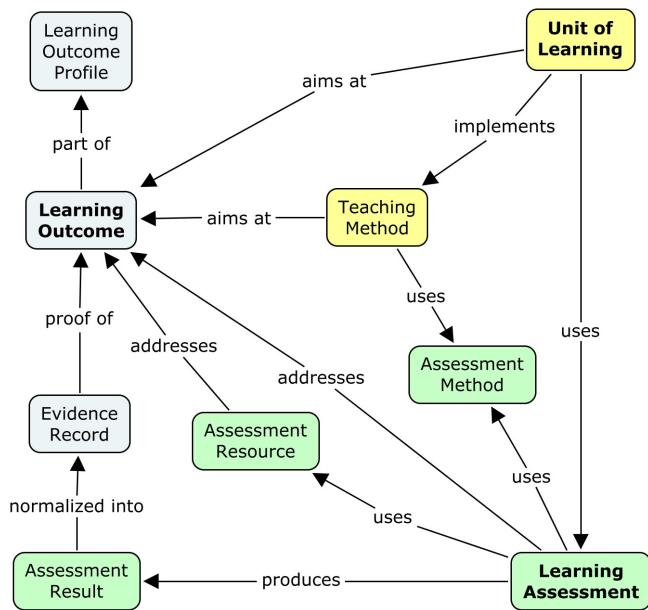


Figure 3 Concept map for learning outcomes-based assessment.

In summary, learning outcomes and assessment are connected in two ways:

- At design time: learning assessments are designed to evaluate the attainment of certain *intended* learning outcomes.
- At runtime (or provision time): learning assessments provide information about *actual* learning outcomes achieved by a learner; the assessment results are normalized into evidence records.

Typically, learning outcomes are acquired through participation in a unit of learning, and learning assessment can thus be integrated in such units of learning. Occasionally, learning assessment processes can stand independently, when aimed at just certifying the achievement of learning outcomes without an associated learning process.

C. Case Study

In this section a case study is discussed to illustrate the implementation of the unified model presented earlier. It aims at being a proof of concept for the model and to clarify the definition and connections of the key concepts. In summary, it consists of a basic English unit of learning composed of lectures, exercises, and a final assessment intended to evaluate the actual learning outcomes acquired by the learners.

During the design phase, the first step is to define the intended goals of the educational process, i.e., the intended learning outcomes. For this specific unit of learning, the learning outcome belonging to the skill category was specified as: “Applying English grammar rules in everyday situations”.

Following the definition of the learning outcomes addressed by the unit of learning, the next step is to define the process that will be used to assess the achievement of the learning outcomes. In this case, the assessment method will be one final exam, consisting of a multiple choice test, which is intended to be graded automatically by an assessment tool embedded within a Learning Management System (LMS).

Next, the teaching method to be applied needs to be defined. This sample course is taught using a series of lectures coupled with exercises that learners either perform individually or in pairs. A reference to the assessment method to be deployed (described above) is also required to be included in the teaching method description.

Once the structure of the course has been defined, the design process is completed with the selection of the learning resources (content) to be used, either creating new ones or re-using existing content. For the assessment process, such content would be the final exam used to evaluate the learners at the end of the course. In this example, this assessment resource is a multiple choice test on basic English grammar and vocabulary, consisting of a set of questions with the possible alternatives, including information about their correctness (to allow automatic grading).

Figure 4 shows the materialisation of the concepts defined in the proposed unified model for the case study discussed.

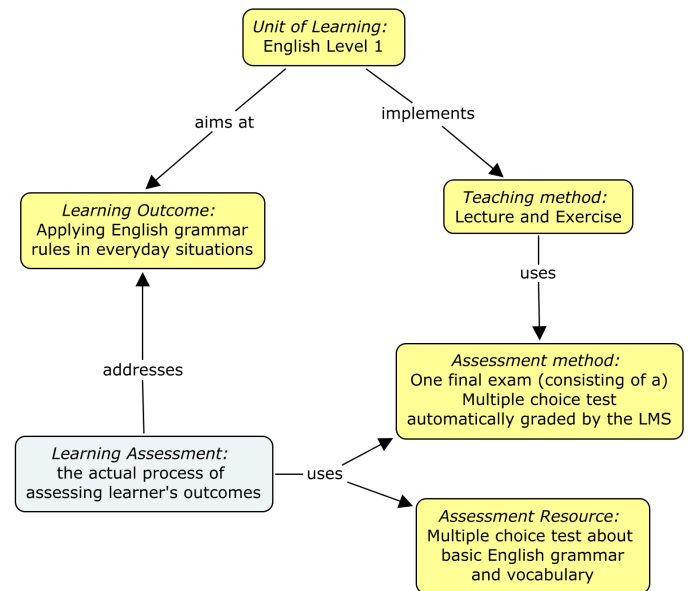


Figure 4 Outcome based assessment case study

IV. APPLICATION SCENARIO

The following application scenario illustrates the benefits of the proposed model for various stakeholders in the educational process both at design-time and runtime.

A. Context

A teacher is preparing a unit of learning about programming in the assembler language for the Pentium CPU. Intended learning outcomes at the end of the unit of learning comprise the following:

- *Knowledge*: being able to identify and name elements of the Intel Pentium CPU architecture
- *Knowledge*: being able to state the instructions of the assembler language
- *Skill*: being able to code a simple program in assembler including loops, conditional structures, and routines

B. Design time: preparing the learning activities

The teacher wants to provide the students with a formative assessment to be taken during the learning process, consisting of a test so that they can check their understanding of the basic concepts. The teacher, using a search functionality in an LMS that is connected to the Open ICOPER Content Space (OICS), searches and retrieves a test adequate for the domain, level and learning outcomes requirements.

The teacher also needs to include a final learning assessment which assesses if the students have successfully achieved the intended learning outcomes declared in the unit of learning. Thus, she searches the OICS for assessment resources adequate for the unit of learning (skill: being able to code a simple program in assembler). She finds a resource consisting on an assembler programming project (which should be developed by the students) accompanied by a rubric that will enable her to evaluate the validity and completeness of the coded program.

C. Runtime: updating the learners' leaning outcomes profiles

Once the unit of learning is completed, the learners' learning outcome profiles are automatically updated, for the learners who have successfully passed the learning assessment used in the unit of learning, to reflect the newly achieved learning outcomes with additional associated data like evidence records (e.g. certificate) and context (e.g. subject domain) of the unit of learning.

D. Conclusions

The scenario discussed above illustrates some of the advantages of the proposed unified model, which benefits a variety of stakeholders.

Authors and teachers can search for assessment resources adequate for appraising the achievement of the intended learning outcomes; either for supporting the learning process

(by detecting gaps between the intended learning outcomes and the actual ones achieved by the learner), or for certifying the final achievement of the learning outcomes at the end of the process. This facilitates the design process.

Learners also benefit as they are provided with quality material which supports their learning process for achieving the desired learning outcomes, as re-use is expected to help refining and improving such resources. Additionally, learners would also have a learning outcome profile which reflects their state of achievements and is kept up-to-date automatically and transparently.

Finally, *other stakeholders* such as companies or employers may also benefit from applications of this unified model. The learner's learning outcome profile would provide a potential employer the information required for assessing the applicant's suitability for a given position. Additionally, knowledge management programs aim to provide (among other objectives) specific training to the employees according to their actual knowledge, skills and competences and the requirements posed by their job positions. Learning outcomes-based assessment would allow searching for specific assessment resources in accordance with knowledge gaps and define tailored training programs. Learner's assessment is perhaps one of the areas where this combination is proving to turn into a richer symbiosis. Information and Communication Technology (ICT) strongly facilitates the management of the assessment process, leveraging the teaching burden associated to it [19]. But apart from the logistic support, ICT empowers potential benefits of the assessment process (for example, fostering immediacy of feedback) as well as open new scenarios for student evaluation.

V. CONCLUSIONS AND FUTURE WORK

Educational processes are shifting towards a learning outcomes based approach in the active learning model. Knowledge, skills and competences achieved by the learner play an increasingly important role as the professional life introduces new lifelong formative challenges. Learning assessment cannot be oblivious to this paradigm shift, either aiming at formative purposes in active learning or as a mechanism for accrediting the attainment of knowledge, skills and competences.

In this paper, a novel theoretical framework has thus been proposed for learning outcomes based assessment. The proposed ICOPER model captures the influence of learning outcomes in the learning assessment process, which determines appropriate assessment methods and resources to be used. Assessment plays a key role in acknowledging that a learner has attained the intended knowledge, skills and competences. This model is contextualised in the broader framework of outcome based learning, based on the unit of learning as the means by which the learners achieve such intended outcomes. Illustrative examples of scenarios and case studies are also provided to clarify the practical use of the model.

Future work includes the definition of a detailed taxonomy of assessment methods and an analysis of the appropriateness of the different assessment methods depending on the learning outcomes to be assessed. Also, ongoing work is aiming at developing a complete metadata model and binding that

enables implementation and interoperability of the concepts in the unified ICOPER model in educational resource repositories (such as the Open ICOPER Content Space). Such analysis will provide a best practices guideline for learning outcomes based assessment that facilitates the actual deployment of this approach.

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