Funded by the
Erasmus+ Programme
of the European Union

ODEdu
OPEN DATA EDUCATION

Deliverable 3.2: Open Data VET course for private and public sector employees

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Responsible Organisation:	**ODI**
Version-Status:	**V1 Final**
Submission date:	**30/06/2017**
Dissemination level:	**PU**

This project has been funded with the support of the **Erasmus+ programme** of the European Union

Deliverable factsheet

Project Number:	**562604-EPP-1-2015-1-EL-EPPKA2-KA**
Project Acronym:	**ODEdu**
Project Title:	**Innovative Open Data Education and Training based on PBL and Learning Analytics**

Title of Deliverable:	**D3.2 - Open Data VET course for private and public sector employees**
Work package:	**WP3 – Course models and platform development**
Due date according to contract:	**30/06/2017**

Editor(s):	**ODI**
Contributor(s):	**All Partners**
Reviewer(s):	**AcrossLimits**
Approved by:	**All Partners**

Abstract:	**This report presents an VET course model and example for delivery as part of the ODEdu project. Analysis of the curriculum outlined previously leads to the conclusion that a level 4 course on the European Qualifications Framework (EQF) is required introducing professionals in the public and private sectors to the essentials of working with open data. Applying the PBL model to such a course means that problems are required to be defined by the tutor. Beneficially this leads to the conclusion that the course can be delivered online in a short timeframe. An example course framework and outline is provided that can be used as reference in future work packages.**

Keyword List:	**Vocational Education and Training, VET, Problem based learning, open data, education**

Consortium

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Revision History

Version	Date	Revised by	Reason
0.1	08/06/2017	David Tarrant (ODI)	Initial report into template
0.2	09/06/2017	Emily Vacher (ODI)	Edited and updated figures and tables
0.3	21/06/2017	Angele Giuliano (AL)	Review version
0.4	26/06/2017	Emily Vacher (ODI)	Addressed comments from review
V1	30/06/2017	ODI, UOM	Final version ready for submission

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Disclaimer

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

The following table presents the acronyms used in the deliverable in alphabetical order.

Abbreviation	*Description*
EQF	European Qualifications Framework
OD	Open data
PBL	Problem based learning
VET	Vocational education and training
WP	Work package

Executive Summary

This document proposes a Problem Based Learning (PBL) course entitled Open Data Fundamentals that can be delivered online as a Vocational Education and Training course.

The course has been designed specifically to enable professionals in the public and private sectors to obtain the core knowledge and skills required to exploit open data.

The course proposes the coverage of 7 key areas of open data knowledge and skills including: culture, management, obtaining data, scrubbing data, analysing data, presenting data and data futures. These 7 key areas form the pillars of the course.

The course will see students capable of obtaining European Qualification Framework (EQF) level 4 knowledge and skills requiring them to generate solutions to specific problems set by the tutors of the course.

Over the 8-10 week period of the course, students will be set problems relating to 6 of the 7 pillars, testing their ability to put skills into practice and analyse the opportunities of using open data in the management and building of businesses.

Problems will all be focused on public services where there is an abundance of open data available. Additionally, public services will provide strong contextual connections to all students as everyone will have some experience of healthcare, transport and emergency services.

As the course develops, the problems will become more challenging and require students to apply all the knowledge learnt so far to solve each problem. The final problem sees students use live data to build a personalised travel planner and analyse the impact of open data on businesses in the transport sector.

1 Introduction

The aim of Work package 3 (WP3) of the ODEdu project is to develop an open data course model for university level education and an Open Data Vocational Education and Training (VET) course model for private and public sector employees. To this end, the work package will exploit the project results of WP1 and WP2 in order to produce multimodal and multilingual educational and training content based on the developed curriculum structure that will fit into the designed learning methods and processes.

This deliverable (D3.2) outlines the problem based learning course model on open data for vocational education and training. The course model will focus on employees in both private sector and the public sector.

In D2.2, the project consortium outlined a design pathway for creating Problem Based Learning (PBL) open data courses. There are six steps in the pathway:

1) Analysis
2) Inputs
3) Design
4) Development
5) Implementation
6) Reflection

The first stage that should be undertaken when developing a PBL course is the analysis: who are the stakeholders and what are their learning needs? In this project, D1.1 and D2.1 detail the extensive research done in identifying stakeholders and their learning needs, and then mapping these into a curriculum. The first section of this report starts by summarising the work carried out in WP1 to list the required open data related knowledge, skills and attitudes of various stakeholders. Using this list, a mapping is then done to establish those essential and less essential skills required for those in the professional and public sectors; the audience of the VET course. Finally, levels of attainment are then mapped against each key learning outcome. This allows for the analysis of the European Qualifications Framework (EQF), or equivalent level of attainment that will be achievable through the VET course.

D2.2 lists two types of inputs that need to be considered in this second stage: the tools that are going to be used in the course, and the design principles. Potential tools are discussed in D2.3, with further recommendations due in D3.3. The design principles of PBL models are explored in D2.1, and the recommendations discussed in section 4.4 of this report.

Using the design principles and tools repositories, the next step detailed in the design pathway is the design of the course. WP3 aims to design two PBL course models for open data; D3.1 for a university course and this report for a VET course. This report maps the outcomes to the various PBL models in order to make recommendations on both the approach as well as the methods, tools and design considerations for a VET course model.

The development and implementation of these courses is the next step in both the design pathway and in the project, and will be included in WP4. This report includes an example of a specific course Open Data Fundamentals, explored in section 6.2, which was developed using the VET PBL course model. As the project continues, this course, along with others that are developed using this model, will be run and rerun in different learning environments to test the VET course model.

The final stage outlined in the design pathway is reflection. Once the courses have been tried and tested in different settings, it will be important to reflect on their successes, and to critically analyse what needs to be done in order to improve the PBL model, the specific design of the course and the content. This is the aim of WP5 in the project, to provide evidence based recommendations for the future of PBL in open data.

This report is laid out at follows:

Section 2 performs a detailed curriculum analysis based upon the results from the demand analysis. This results in recommendations on which parts of the curriculum suit a course for professionals in the public and private section and at what level of attainment.

Section 3 provides an overview of Vocational Education and Training approaches that have been taken across Europe.

Section 4 analyses the PBL models as applied to the choices of curriculum and scope of a VET course and makes recommendations on the number and type of problems as well as the role of tutor and group.

With the core conditions set, section 5 looks at the potential delivery methods that would be available given the recommendations set out in previous sections. Knowing the range of options can then feed into the potential course models.

Section 6.1 presents the course model itself, reflecting the recommendations of all previous sections before section 6.2 gives an example course that fulfils all the key areas of coverage.

Finally, section 7 offers a number of concluding remarks and outlines any decisions that still needs to be made prior to implementation.

1.1 Scope

The presented document is the Deliverable 3.2 VET Course Model of the ODEdu project. The main objective of D3.2 is to select appropriate curriculum and tools (from WP1) and approaches (from WP2) to recommend and exemplify a Vocational Education and Training VET model for use in WP4.

1.2 Audience

The document is for:

- Any interested stakeholders from academia, business and the public sector that aim to get involved in PBL-based education and VET training.
- The project partners who will organise training activities
- The European Commission

1.3 Structure

The structure of the document is as follows:

- Section 2 provides a detailed analysis of the curriculum as appropriate for a VET course
- Section 3 provides an overview of VET courses
- Section 4 analyses and makes recommendations for appropriate PBL models for VET courses
- Section 5 discusses the delivery options for a VET course
- Section 6 recommends a VET course model for use in ODEdu and provides a sample course for use in WP4
- Section 7 concludes the document and Section 8 presents future work to be carried out.

2 Methodology

Extensive research has been carried out within the ODEdu project to identify the knowledge and skills required by learners (WP1) and the approaches through which this can delivered that conform to a Problem Based Learning methodology (WP2).

The curriculum skeleton designed in WP1 was built from existing literature and additional primary data collected as part of the project. The primary data was collected through interviews and focus groups with people who have experience with open data. A large number of stakeholders were surveyed in order to establish a list of open data related knowledge, skills and attitudes. This survey questions were designed to identify the open data knowledge and skills that university students, the private sector and public sector should obtain in order to enhance their open data competences and knowledge, entrepreneurship and innovation.

Analysis of these, once applied to a curriculum framework resulted in a common curriculum skeleton for ODEdu that consists of 5 categories: culture, management, business, open data skills and advanced technical skills.

These categories help to structure the 85 needs and 193 related skills or knowledge items identified that form the basis for the analysis carried out in this section of the report. Specifically, this section focuses on the needs, skills and knowledge required for the VET course.

As the ODEdu curriculum is extensive, we have selected the needs, skills and knowledge that will be most suitable for the different target groups of the VET course, appropriate for the design and structure of this type of course.

In the following section, we look at the mapping exercises performed in order to prioritise the 85 needs and 193 skills to those suitable for a VET course for private and public sector workers.

In this section, we look at a number of mapping exercises that have been performed in order to reduce the 85 needs and 193 skills down into a set that better suit a VET course for private and public sector workers.

2.1 Mapping - Curriculum and Learning Outcomes

In this section, we look at a number of mapping exercises that have been performed in order to reduce the 85 needs and 193 skills down into a set that better suit a VET course for private and public sector workers.

2.1.1 Methodology for mapping

D1.1 used the European Credit System for Vocational Education and Training (ECVET)[1] as guideline to build the curriculum structure. Following on from this activity were a series of recommendations in order to help build the correct course models, these recommendations consisted of 6 key steps.

2.1.1.1 Identify the competences

The competences need to reflect industry needs. "In the case that occupational standards have not been developed for the specific sector, it is highly recommended that meetings are set with the relevant industry and other important stakeholders to establish the key competences required."

2.1.1.2 Identify the level

D1.1. Stakeholders Needs Regarding Open Data. If no occupational standards are available, we propose level within the EQF framework (levels 1-8).

This step cannot be completed since we have not decided yet what the level of the training will be and there could be differences between the three target groups. This is discussed and referenced in the recommendations section of this report (Section 7) for further exploration in WP4.

2.1.1.3 Set course objectives

Set specific, measurable, achievable realistic and time bound objectives and consult key competences.

2.1.1.4 Establish learning outcomes

The learning outcomes are ideally based on the knowledge, skills and competences set in the standards.

2.1.1.5 Set learning activities

Establish total learning hours, credits and duration of course.

2.1.1.6 Set assessment of learning

The assessment methods used should be aligned to the learning outcomes. Different methods can be used.

[1] The European Credit system for Vocational Education and Training https://ec.europa.eu/education/policy/vocational-policy/ecvet_en

2.1.2 Application

This section of the report addresses the first four aspects of the aforementioned methodology in order to establish a list of learning outcomes that will guide the development of the VET course.

2.1.2.1 Identify the competences

In order to identify the competences required, we have presented the learning outcomes from Tables 6 and 7 of D1.1. The aim of this work is to build upon that done in D1.1 to identify the knowledge and skills that are in broad demand across all user groups.

First, each of the learning outcomes from Table 6 and 7 are combined such that each learning outcome had both a 'knowledge' or 'skills' mapping (noted as K or S) as well as related data about which group of users sought those skills. Where applicable, duplicated and very similar needs have been merged or removed leaving a total of 49 needs.

Finally, the table of needs has been ordered by level of learning outcome that need suggests. The level mapping uses Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) (Figure 1) to map needs such as "What is open data" to level 1 (Bloom Level – 'Remember'). This then allows the direct mapping of the levels in Bloom's taxonomy to the level of attainment in the proposed course and evaluate which levels the needs achieve as per Table 1.[2]

Table 1 - EQF level mapped to Bloom's Taxonomy

Bloom level	EQF level	EQF Description
1 - Remember	2	basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools
2 - Understand	3	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information
3 - Apply	4	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study

[2] Learning opportunities and qualifications in Europe https://ec.europa.eu/ploteus/en/compare

4 - Analyse	5	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems
5 - Evaluate	6	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study
6 - Create	7	specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields

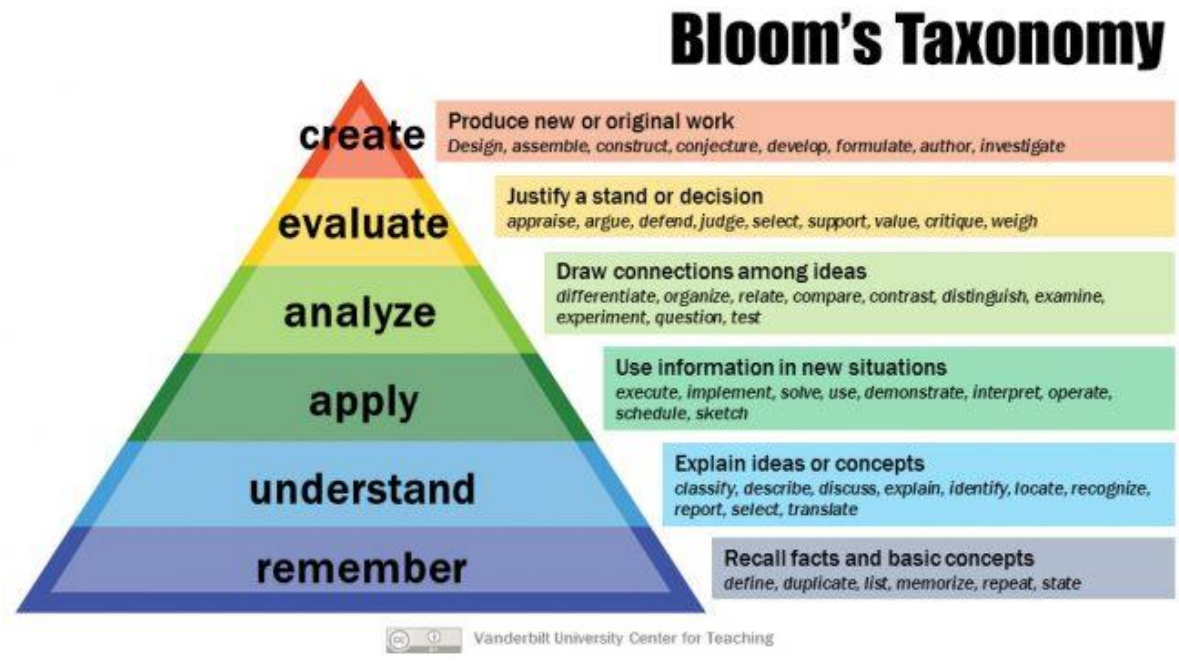

Figure 1 - Bloom's Taxonomy

It should be noted that not all learning outcomes and needs that use words like “Create” will map to the education levels as it also depends on the level of challenge. Primary school pupils are set “Create” tasks that are appropriate to their level, which would be far beneath degree level.

Table 2 shows the completed mapping with each need mapped to EQF level, knowledge or skill mapping (from Table 7 in D1.1) and also the requirement by each stakeholder.

Table 2 - Learning outcomes mapped to EQF level and stakeholder needs analysis

Outcome	EQF Level	Mandatory / Optional	Skill / Knowledge	Private sector	Public sector	IT student	Humanities student	Journalism student
what open data is	2	M	K	✓	✓		✓	✓
why open up data	2	M	K	✓	✓	✓		
why I would open up my research data	2	O	K	✓	✓	✓	✓	
how open data creates value	2	M	K	✓	✓	✓	✓	✓
what the value is of open data in the social sector	2	O	K				✓	
what the impact is of open data on society, business and public policy	2	O	K				✓	✓
which of my data are of value/needed/demanded	2	O	K	✓	✓			
what the opportunities are for the public sector	2	O	K		✓			
about open data licenses, why and how to apply those	2	M	K		✓	✓	✓	
which of my datasets can be used to solve a problem	3	O	K		✓			✓
what is considered sensitive / private data	3	M	K		✓	✓	✓	✓
how to annotate my data so that they are correctly understood	3	M	S		✓		✓	

more about data formats	3	M	S		✓		✓	
which data format is best for my users	3	O	K	✓	✓	✓		
how to convert from one format to another	3	M	S	✓	✓	✓	✓	
What is the connection between open data and open standards?	3	O	K	✓	✓			
about open data platforms	3	O	K		✓	✓		
where to find open data that could be useful for our own processes	3	M	S		✓		✓	
how to create a community around my data	3	O	K		✓			
how to download and explore a dataset	3	M	S				✓	✓
how to blend open data with our own	4	M	S	✓	✓	✓	✓	
how to engage with the (potential) data users in a sustainable way	4	O	K		✓	✓		
how to filter out sensitive data	4	O	S			✓		
how can I check the quality of my data	4	M	K	✓	✓	✓	✓	
how to clean data	4	M	S		✓	✓	✓	✓

how the users want to access the data (dump, API, interactive table, visualization, storytelling)	4	M	K		✓	✓		
which visualization is best for the type of data/user/problem addressed	4	M	K	✓	✓	✓	✓	✓
how to create a visualization	4	M	S	✓	✓		✓	✓
how to do storytelling based on data	4	O	K	✓			✓	✓
What are the known security issues when using open data?	4	M	K	✓				
how to provide feedback possibilities on the data	4	O	K			✓		
how to store and access / retrieve my annotated data	4	O	S			✓		
how to publish my open / linked data	4	O	S			✓		
how and where to find relevant and trusted data	4	O	K				✓	
how to analyse data	4	O	S			✓	✓	✓
how to refer correctly to data I found	4	O	K					✓
how to link / reconcile data with other data	4	O	S			✓		

how to interpret findings	4	O	K					✓
how to grow my business using open data	4	O	K	✓				
how to make my creation/product/service sustainable	4	O	K	✓				
how to start a business with open data	4	M	K	✓				
how to use open data to create or improve our products/services	4	O	K	✓				
how to use open data to increase our efficiency	4	O	K	✓				
Is it an advantage or disadvantage against my business competitors to open my data?	4	M	K					
how can I make money out of my creation	4	O	K			✓		
how to make my creation discoverable	4	O	K			✓		
how to collaborate with stakeholders	4	M	K			✓		
how to set up a business model	4	M	S			✓		
how can I contribute to the entrepreneurial sector by using open data	4	M	K			✓	✓	

Finally, in Table 2, a mandatory and optional column has been added based on the occurrence of that need over the different sectors. Thus, the more people requiring that need, the more mandatory it appears in what could be an essential part of open data course.

In summary, from this table there are 22 mandatory needs, consisting of 13 knowledge and 9 skills needs.

Table 3 shows the detailed breakdown of mandatory and optional needs at each EQF level also mapped to knowledge and skills. As Bloom level 1 is all about recall, only knowledge needs can exist here.

Table 3 - Mandatory and optional needs mapped to EQF level

EQF Level	Mandatory	Optional
2	Knowledge: 4 Skills: 0	Knowledge: 5 Skills: 0
3	Knowledge: 1 Skills: 5	Knowledge: 5 Skills: 0
4	Knowledge: 8 Skills: 4	Knowledge: 12 Skills: 5

It should be noted that Table 3 clearly shows that as the levels build so do the number of needs. Likewise, the needs do not progress beyond level 4 as the majority of them start with the phrase “How do I” which strongly suggests that people are looking to apply their knowledge and gain new skills to do so.

There are two exceptions to this which might be considered level 5 needs:

- *Is it an advantage or disadvantage against my business competitors to open my data?*
- *Which visualisation is best for the type of data/user/problem addressed*

However, as there were only two of this type of outcome it was felt more logical to include them in level 4 for the purpose of creating course reference materials.

2.1.2.2 Identify the level

From the mapping in Table 2, there is very little demand for skills acquisition above level 4 from the surveyed data in WP1. This presents an interesting challenge when developing a higher level VET or university-level course as part of this project.

The survey reinforces the needs that people have for education on open data at all levels of attainment. With open data being so closely coupled with digital skills this need for basic digital skills highlights the well-researched digital skills crisis taking hold in the UK (House of Commons Science and Technology Committee, 2016) as well as throughout the US and Europe (McKinsey Global Institute, 2011).

Many reports have talked about the need to enhance digital skills from school level and introduce coding and data work in place of the basic IT which appears ineffective.

Additionally, the demand for lower level skills provides the ODEdu project a unique opportunity to address many of the lower level skills with online learning and reference material which complements each of the PBL course models. This allows each of the PBL models to focus more on the application level and higher attainment.

2.1.2.3 Set course objectives

The course objectives will be decided on a per course basis. Having said that, Table 2 demonstrates a clear need to build from EQF level 2 to EQF levels 4 and 5. For a VET PBL course, the course objectives should reach EQF level 5 and be built towards throughout the course.

Take for example one of the level 5 needs identified in the section above:

Which visualisation is best for the type of data/user/problem addressed

There are several lower level needs and outcomes from Table 7 under “Visualise data” that build towards a whole visualisation syllabus e.g.

1. *Identify available technologies for creating visualisations*
2. *Use visualisation software*
3. *Navigate to a service that allows me to view a dataset*
4. *Identify the OD tools for visualisation*

The syllabus in D1.1 outlines 12 areas of focus for the curriculum:

- Open data culture
- Open data management

- Open data business
- Obtaining data
- Scrubbing data
- Exploring data
- Visualising data
- Modelling data
- Interpreting data
- Presenting data
- Programming skills
- Linked open data

It should be noted that advanced skills (programming and linked open data) were added in WP1 as a need of the University of Macedonia and public sector stakeholders in Greece. However, as shown in Table 5 in D1.1, these two categories were less in demand from other stakeholders. They are out of scope for use in a VET course.

This means that the overall course aim should target presenting data as the key problem space to work towards in activities.

Table 5 (D1.1): Overview interviews and focus groups per main category

	ODI: UK & private sector	Sepve: GR & private sector	AAU: DK & private sector	LOLA: BE & public sector	AAU: DK & public sector	UOM: GR & public sector	AAU: DK & academic sector	UOM: GR & academic sector
Culture	31%	21%	25%	15%	55%	9%	29%	12%
Management	25%	0%	8%	62%	45%	18%	12%	3%
Business	25%	40%	17%	0%	0%	0%	10%	6%
Basic skills	19%	40%	50%	17%	0%	11%	46%	39%
Advanced skills	0%	0%	0%	6%	0%	61%	2%	40%

As this course model is focusing on the VET course and therefore not the academic sector, we can remove data from the last two columns from this table. With the academic sector removed, the overall demand is distributed as portrayed in Figure 2.

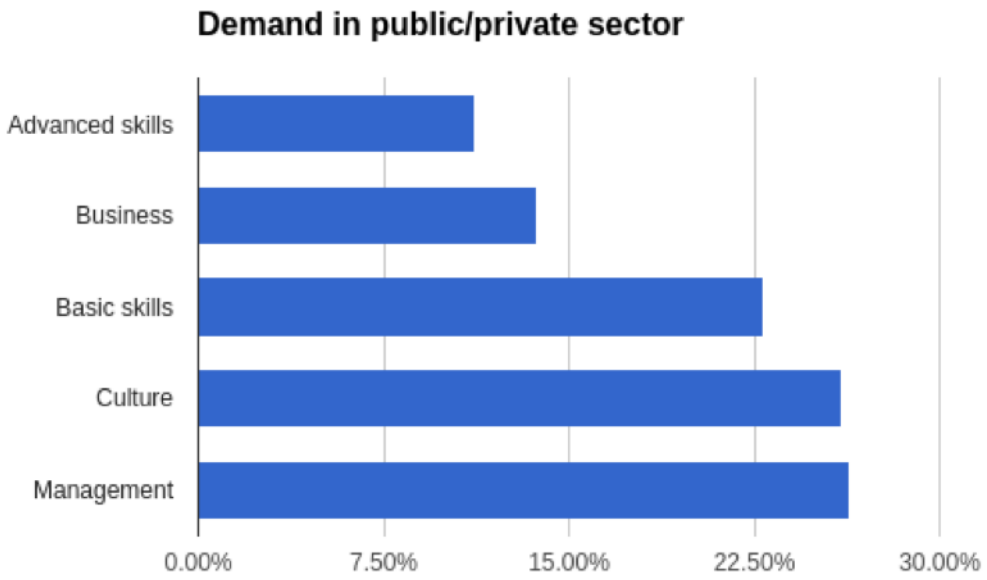

Figure 2 - Demand in public and private sector

Figure 2 suggests that the primary areas of focus are for management, culture and basic skills for open data. This covers a number of core topics that are summarised from Table 7 (in D1.1) and presented in Figure 3.

Whilst these curriculum areas have their basis in the curriculum outlined in D1.1, there are some key differences. Note that in Table 7 of D1.1 aspects such as data analysis are replicated in exploring and interpreting data, so here the basic skills have been reorganised into 5 curriculum areas. Similarly, we recognised the overlap between presenting data and visualising data, and so therefore combined the learning outcomes into the curriculum area presenting data. In addition, we added the curriculum area of data futures to Figure 3 in order to encompass learning outcomes that belonged to multiple curriculum areas. For example, D1.1 lists the learning outcome 'working with big datasets' in the curriculum area 'exploring data.' Big data is an area of study on its own and it has multiple implications on the way that data is made available (not normally via file download) the way it can be used and the way it is visualised. Therefore, we added the curriculum area of data futures to explore Big data, how it can be accessed (via APIs) and managed when it is delivered in

real time (live data). This set of learning outcomes is a logical fit in a category which allows those who are just starting with open data to understand the overlap between open and big data while also learning about different methods for accessing open data.

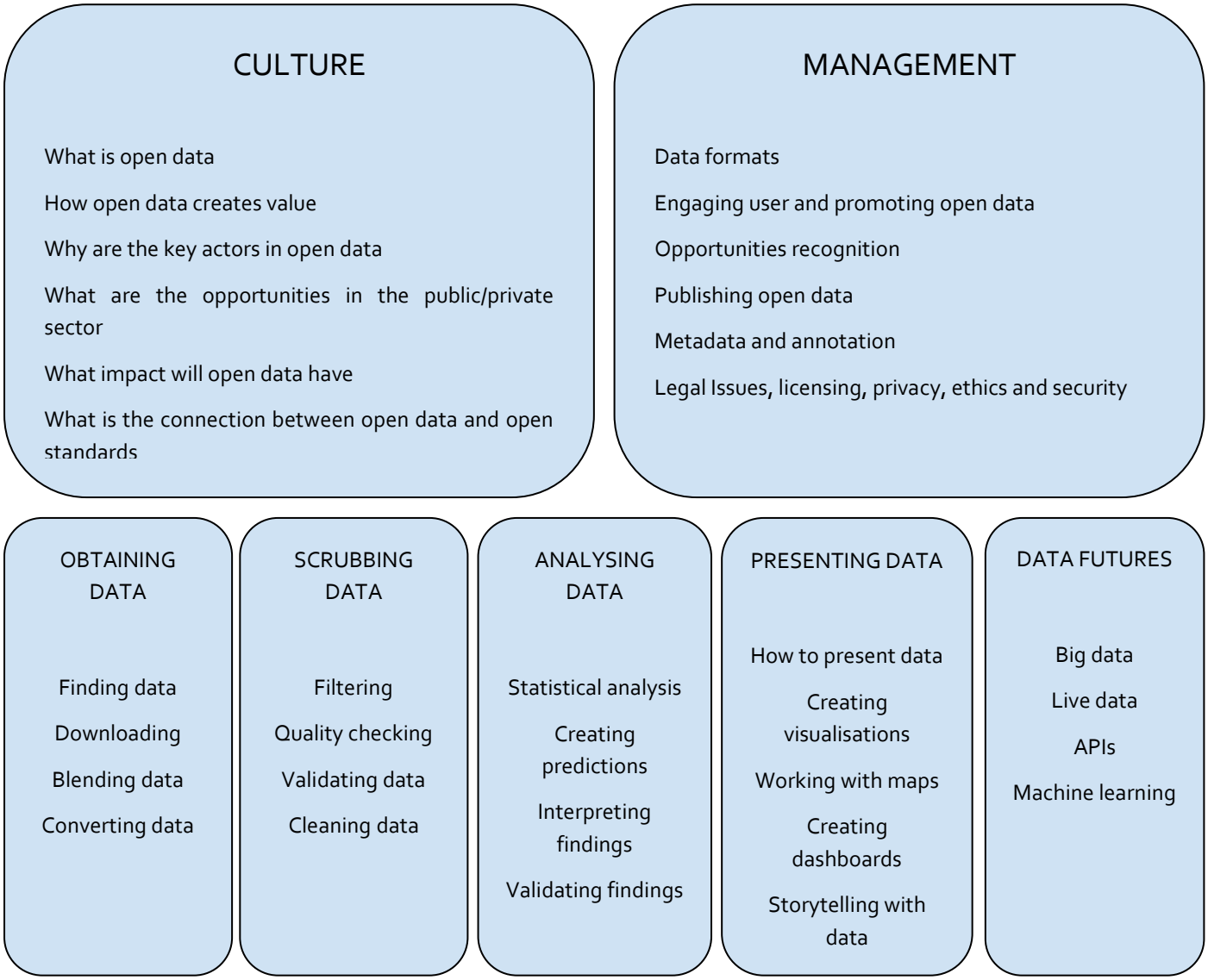

Figure 3 - Curriculum areas for VET courses

In the design of the course, application to business should be considered as part of the "Opportunities recognition" which forms part of the section on management.

Looking at these areas overall the aim of any course should be to:

Equip people with the knowledge and skills to work with open data.

Courses should look to cover the 7 key sections set out in the curriculum set out in Figure 3 above and approach this with a problem based methodology.

For example, a part of the course could require participants to perform some analysis on a dataset and validate these findings against an existing known outcome. Equally, participants could be asked to solve a problem that requires the use of some live data as part of the data futures section.

2.2 Levels of attainment

As discussed and outlined in the previous sections, the development of a VET course for professionals in the public and private sectors should focus on EQF level 4. This is equivalent to A-level in the United Kingdom, Matriculation Certificate in Malta, or the Baccalaureate in France. By the end of the course participants should have a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems.

This active application through a problem based technique would test the students understand of the core data skills. It would also help demonstrate how the curriculum is helping to provide more learners with the digital skills required to be effective data workers.

2.3 Recommendations

This section has performed a competency mapping that reduces the complete needs analysis of D1.1 down into a curriculum appropriate for a Vocational Education Training developed for professionals in the public and private sectors.

Mapping the curriculum and needs against the EQF framework reveals that the developed course should be a level 4 course focusing on students being able to apply a range of cognitive and practical skills to generate solutions to specific problems in a field of work or study.

Additionally, the course should focus on 7 key areas of open data knowledge and skills: Culture, management, obtaining data, scrubbing data, analysing data, presenting data and data futures.

Section 6 presents a potential course model for covering all parts of this curriculum. Section 6 will also continue the mapping methodology to cover the remaining aspects surrounding setting course objectives, learning outcomes and learning activities which will be aligned to the chosen PBL methodology which is presented in the following section.

3 Vocational Education and Training approach

3.1 Vocational Education and Training

VET courses can also play a key role in on the job training (Wollschlager & Guggenheim, 2004) and supporting career development or even career change. With the McKinsey report (McKinsey Global Institute, 2011) identifying a data skills gap upwards of 150,000 people in the US (with similar in Europe) and potential economic benefit running into the billions there is clearly a need to offer both higher education and on the job training to everyone in key data subjects, including open data. The European Union has identified Vocational Education and Training (VET) as an essential tool in its attempts to prepare young people for work in the modern economy (TNS Opinion and Social, 2011).

Vocational Education and Training (VET) is education that prepares people to work in a specific craft or vocation. Craft vocations are usually very physical in nature and take non-academic approaches that enable people to learn skills suited to a particular trade or occupation, for example, an electrician. Occupational vocations cover much broader areas such as engineering, accountancy and law and can involve a great number of transferable skills.

Vocational education can take place at secondary, post-secondary, further or higher education level. It often takes place at post-mandatory education level.

Vocational training is not a new thing in Europe and has routes that can be traced back to the 12th century when it was mostly under taken by guilds, many of which still exist today (Wollschlager & Guggenheim, 2004).

In the 18th and early 19th centuries, the guild system in Europe lost much of its importance as liberal economic doctrine and industrialisation took hold. Such training remained routed in the big industries of each country until mass transport started to see a convergence not just within countries but across Europe and in 1969, the vocational training act encouraged VET as a social good throughout Europe for all. Since the form of the European Union a key goal has been to build the most competitive and dynamic knowledge-based society in the world. The EU set three goals in Stockholm in 2000.[3]

- improving the quality and effectiveness of education and training systems in the European Union
- facilitating access for all to education and training systems
- opening up education

[3] Presidency conclusions, Lisbon European Council 23-24 March 2000, http://www.europarl.europa.eu/summits/lis1_en.htm

As technology improved it became an enabler to this vision and vocational qualifications could start to be offered to everyone, via the web.

A combination of everyone having access to the web as well as the ability to freely and affordably move around Europe has meant that vocational education and training still plays an important part in developing a knowledge-based society and many European Economic Area (EEA) member states have begun cooperation at a practical level on:

- A single framework for transparency of competences and qualifications,
- a system of credit transfer in vocational education and training,
- common criteria and principles for quality in vocational education and training,
- common principles for the validation of non-formal and informal learning
- lifelong guidance[4]

In a study by TNS Opinion and Social (TNS Opinion and Social, 2011) it was found that most people in the EU still regard VET as having a positive image in their country and there is still a very strong connection between employers needs and vocational training. TNS interviewed nearly 27,000 people aged 15+ in all member states and discovered that the primary motivator for taking a VET course was personal interest in the subject. Figure 4, taken from this report shows that cost is a very low consideration compared to aspects such as employment opportunity, type of teaching and length of study.

[4] Presidency conclusions, Lisbon European Council 23-24 March 2000 http://www.europarl.europa.eu/summits/lis1_en.htm

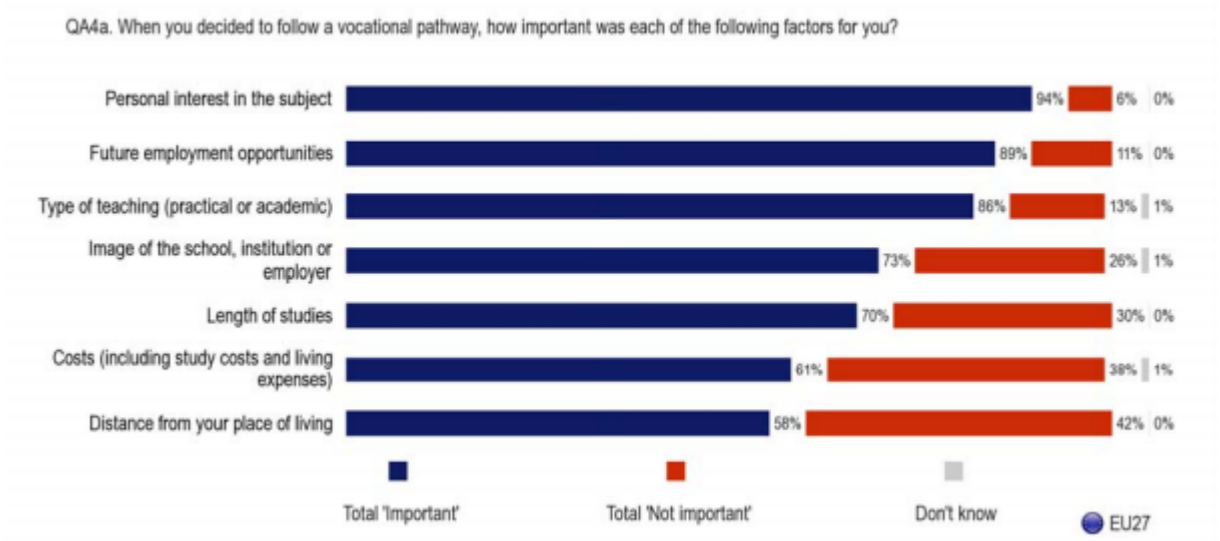

Figure 4 - From TNS Opinion and Social (2011)

When it comes to recommending the structure and length of a course, there is very little consensus. Generally, the length of a course should be appropriate given the field of study, the level of attainment and how long it takes to achieve your learning objectives[5].

Studies by Austin (Austin, 2006), Ferguson (Ferguson J., 2010) and Van Scyoc et al (Van Scyoc, 1993) find that the traditional 16-week length of taught semester courses at University does not always result in the best outcomes for learners. While Ferguson (Ferguson, 2010) and Van Scyoc (Van Scyoc, 1993) find no discernible difference in outcomes, Austin (Austin, 2006) shows that from over 45,000 observations, intensive courses can result in higher grades versus a 16-week course. Ferguson (Ferguson, 2010) discovers that intensive courses result in better student to student relationships however do present challenges to tutors in maintaining a focus on the intensive nature of the course when their work may require other activities.

One aspect not considered in the TNS report is the method of delivery; in person or online. Studies by Xu (Xu, 2013) show that attainment levels drop when courses are delivered online however this varies substantially based upon subject area. Both Xu (Xu, 2013) and Hiltz (Hiltz, 1997) find that attainment scores vary less in primarily digital subjects such as computer science, thus there are opportunities for both face-to-face and online modes of delivery to be used.

Perhaps most concerning is the finding by TNS (TNS Opinion and Social, 2011) that those see themselves as being low down on the social scale have less belief that VET can improve their job

[5] How long should my eLearning course be? http://blogs.articulate.com/rapid-elearning/how-long-e-learning-course/

prospects than people higher up the scale. This represents a major challenge: one of the EU's main objectives is to open up opportunities to disadvantaged groups, but these results show that these very groups, which have the lowest aspirations in general, have the least faith in the ability of vocational training to change and improve their circumstances. Thus, appealing to the widest possible audience may be more of a challenge to address the digital skills gap in Europe than any other consideration (McKinsey Global Institute, 2011).

3.2 Recommendations

The choice of length of course will need to be appropriate given the level of qualification, expectation of the student and availability of tutor.

Additionally, the level of challenge involved in problems will also need to be taken into consideration in allowing students enough time to complete any required activities between lessons.

Section 1 outlines a curriculum with 7 key areas. This suggests that the programme should have a minimum of 7 lessons, perhaps spread over 7 weeks in order to cover all the key areas with additional weeks allowed for introduction and reflection.

Finally, it is worth noting that, due to the digital nature of the course, both face-to-face and online methods of delivery can be considered. As such, Section 5 outlines the potential methods through which an online course could support PBL learning.

4 PBL course models

As part of the extensive research done as part of Work Package 2, it is clear that there are many PBL course models available. As indicated in D2.1, the main goal of PBL is not for students to learn specific content but rather to gain lifelong learning competencies and transferable skills. Problem based learning relies on a set of principles. The key principles of problem based learning outlined in D2.1 are collaborative learning, critical thinking, self-directed learning and reflection. Defining PBL as 'PBL learning principles' rather than a fixed structure allows for variation in PBL course models (Du, 2009) therefore enabling a tutor or facilitator to adapt the model for a given institution and setting. This can be equally applied to the components of problem based learning, of which there are three that must be considered before a PBL course model can be structured: the problem, the tutor or facilitator and the group. Each of these three components are explored in more detail below, and recommendations for the ODEdu VET course provided.

4.1 The problem

The main component of PBL is the problem. Effectively designing and implementing the problem is crucial to achieving goals and therefore to the process of learning. Factors to consider are who defines the problem, how many problems should be defined, and how the problem itself should be defined.

4.1.1 Who defines the problem

There are two main PBL processes for defining the problem as outlined by Arana-Arexolaleiba et al. (Arana-Arexolaleiba, 2013)

- Teacher or system directed
- Student directed.

In a teacher or system directed model, the students receive the problem ready formulated. In a student directed model, the students design the problem themselves within the theme of the course. Two PBL course models are presented in D2.1, from Aalborg and Maastricht. In the Aalborg model, the problem is usually defined by the students after a maximum of one month teaching. In some cases, the real-life problems from external partners are presented from which the students can select. In the Maastricht model, the problem is defined by staff at the university. Whilst it is recognised that there is value in student directed problem setting, a VET course for professionals is a different setting to an academic setting where students are in full time higher education. As has already been discussed in the previous section, the level of the VET course model should be at EQF level 4. As the notion of abstract problems is not introduced until EQF level 5, it would therefore be an unfair and unaligned expectation for students to research and formulate their own problem. In

addition, there is a practical element to be considered; as has already been noted, in the Aalborg model, students usually define the problem after one month of teaching. Given the nature of a VET course, it would be impractical for students to spend so long defining their own problem. For the PBL VET course model, it is recommended that the problem is teacher directed.

4.1.2 How many problems?

Another factor to consider when defining the PBL course model is whether to have one problem designed to incorporate all of the new knowledge and skills that students need to acquire in order to solve the problem and achieve the learning objectives, or whether to have multiple problems.

In the university setting, defining one problem that is followed throughout the course is usual practice. Both the Aalborg and Maastricht models explored in D2.1 use this model.

Setting a single, abstract problem for students to solve is done in order to increase the level of challenge and likewise attainment. With students having to select the single problem they address, it challenges their creativity from the start of the course, thus elevating the challenge up the levels of Bloom. This is the most realistic scenario for highly qualified individuals who are trained not just to apply technologies to solve an existing problem but to identify problems and opportunities in the first place.

For example, the Open Data Innovation course at the University of Southampton (COMP6214[6]) is a masters course that challenges students to identify an opportunity in the market where an open data innovation or product can help solve a problem. They are challenged to first identify this gap in the market, before developing and pitching a working prototype to a panel of judges. In this example, the students are required to first select the problem and then use their new skills to develop a solution where there might not already be one. Additional challenges can be faced if the students find that their problem either cannot be solved, or has already been solved. This approach also tests the student's research ability, preparing them for the next level of education where at the PhD level it is all about providing a novel contribution to science or philosophy.

This approach tests students at EQF level 7 “specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields.”[7]

As outlined above, for the VET course it is recommended that problems be set by the tutor. Additionally, in order to match the need of EQF level 4 around solutions to “specific” problems it may be necessary to define several closely scoped problems that focus on key areas from the curriculum and not try to combine all of them. Additionally, it may not be possible to define a

[6] Open Data Innovation http://www.southampton.ac.uk/courses/modules/comp6214.page
[7] Learning opportunities and qualifications in Europe https://ec.europa.eu/ploteus/en/compare

problem that combines many types of approaches to analysing data without being abstract, thus becoming a EQF level 5 course.

We therefore recommend for the ODEdu VET course that the tutor sets a number of specific problems, related to specific areas of the curriculum, that focus the students on applying their learning to generate solutions.

How to design the problems is discussed more in the next section.

4.1.3 Designing the problem

When designing a problem based learning course model, the problem that is set should consider the knowledge and skills that students need to acquire in the course (Moust, Van Berkel, & Schmidt, 2005). In other words, the problem should be designed in a way to enable the students to achieve the learning outcomes.

Dolmans & Snellen-Balendong (Dolmans, 2012) defined six types of problems used at Maastricht university that can guide learners towards different types of knowledge and skills:

Table 4 - Six types of problems (Dolmans and Snellen-Balendong 2012)

Type of problem	**Objective of problem type**
The explanation problem	Students explain and understand underlying structure and mechanisms in a problem
The discussion problem	Students critically reflect on topics connected with their professional sector
The strategy problem	Students learn rational reasoning and decision-making based on knowledge and understanding of underlying processes
The study problem	Students study independently
The application problem	Students use previously acquired knowledge to solve a problem
The multi-level problem	Students use detailed historical case notes to examine the problem on multiple levels.

D2.1 suggests that these problem types are a way to scaffold the PBL process for the novice PBL tutors or facilitators to ensure that the learning goals are achieved in the course. For the VET PBL course model, which is aligned to EQF level 4, it is recommended that the application problem be used. The application problem is where students use previously acquired knowledge to help them solve the problem. In the VET PBL course model structure, the students use the reference learning materials to help them solve the problems set each week by the tutor.

An additional course model to support PBL tutors or facilitators with the definition of the problem is the 3C3R model (Hung, 2006) presented in Figure 5.

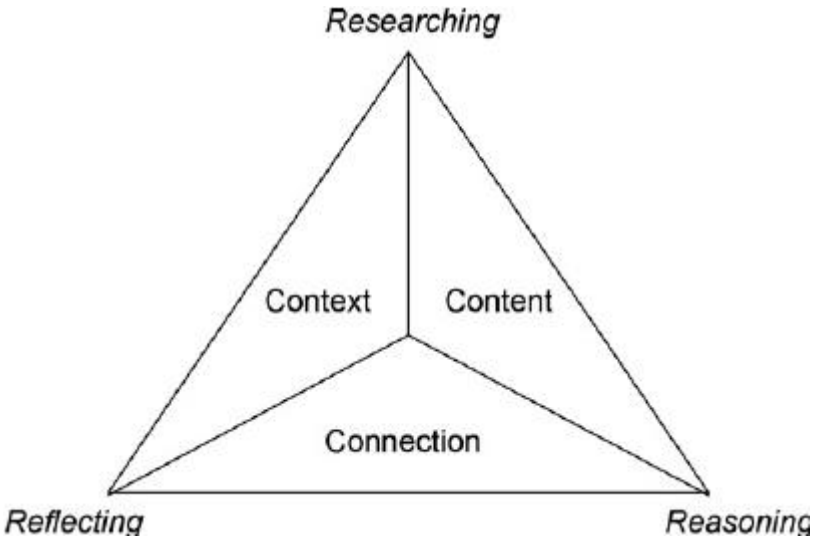

Figure 5- 3C3R model (Hung 2006)

Recommended in D2.1, the 3C3R model will help tutors to ensure that their problems included in their PBL course are useful and relevant to VET students. The 3Cs represent the three core components: content, context and connection. Providing students with a context and the ability to make connections between the problem and their own professional contexts is especially important in a VET course with students who want to make connections between their learning and their work. By making the content relevant, providing the context and enabling learners to make connections between the problem they are facing, and real life problems that they will face will help to enhance the learning experience of students on a VET PBL course. The 3Rs represent the processing components: researching, reasoning and reflecting. These support the students' cognitive process of developing problem solving competencies that are essential to the PBL course model.

The other major benefit of the 3C3R model is that it helps the tutor to ensure that their course caters for different learning styles. Honey and Mumford (Honey, 1986) identified four learning styles: the Theorist, the Reflector, the Activist and the Pragmatist. Whilst it is unlikely that an

individual will only show characteristics from one learning style, adult learners tend to show a preference for the pragmatist learning style. The Pragmatist is keen to see the relevancy and application to their work and tend to reject heavily theoretical concepts that are not realised in real-life cases, and so will favour the 3Cs in their learning. The 3Rs also help the tutor or facilitator ensure that the course also caters to the learning needs of the other three learning styles identified by Honey and Mumford: theorists, reflectors and activists. Research is a beneficial activity for the Theorist as it enables them to explore theoretical concepts as the detail they prefer; whereas reasoning and reflective tasks appeal to the Reflector, giving them think over and absorb new ideas; whilst the Activist will prefer applied research tasks, where they can apply the content and the context to discover what can be improved.

Using the 3C3R model to define and check the problems will help the tutor ensure that the problems are useful and relevant for the VET students. The model will also serve to maximise the students' learning, through the different learning styles that are addressed.

4.2 The tutor

The role of the tutor or facilitator is critical to the success of the PBL course. The exact nature of the tutor's role will depend on the PBL model that is followed, the level of attainment targeted, how the learning is delivered and the length and type of the activities.

It is the role of the tutor or facilitator to ensure that the key principles of PBL are incorporated into the course. Schmidt & Moust (Moust, Van Berkel, & Schmidt, 2005) present five roles of PBL tutors or facilitators:

1. engage learners in key concepts, issues and themes according to the lesson objectives
2. help learners reason effectively and develop deep understanding
3. help learners collaborate meaningfully with their peers
4. help learners be self-directed in their learning approach
5. help learners to be reflective about their learning process

The latter four of these roles directly link to the key principles of PBL as outlined in D2.1, namely critical thinking, collaborative learning, self-directed learning and reflection. The fifth, engaging learners in key concepts, issues and themes, is a role that is equally associated with traditional teaching, and is therefore less specific to the PBL model. Goh (Goh, 2014) presents typical actions a facilitator or tutor could do in a face to face setting in relation to the role of PBL tutors. These actions should serve as guidelines for ODEdu project trainers. Table 5 maps the role of the tutor or facilitator as presented by Schmidt & Moust (Moust, Van Berkel, & Schmidt, 2005) to the PBL principle as outlined in D2.1, and the potential actions suggested by Goh (Goh, 2014).

Table 5 - Facilitator role mapped to PBL principle

Role of facilitator or tutor	PBL principle	Actions a facilitator or tutor could take in a face to face setting.
engaging learners in key concepts, issues and themes according to the lesson objectives	-	Connect with learners' starting point and use appropriate scenario settings such as contexts or examples familiar to learners. Scaffold learning by making connections between prior and new knowledge in order to gradually help learners reach the next level of understanding. Use appropriate language, references, and analogies to help learners overcome the challenge of difficult terms
helping learners reason effectively and develop deep understanding	Critical thinking	Prompt learners to justify their claims and provide examples when explanations are vague or unconvincing. Encourage learners to critique ideas by considering their value and limitations within the context of the problem scenario. Comment on the quality of arguments presented.
helping learners collaborate meaningfully with their peers	Collaborative learning	Help learners build on one another's knowledge by modelling how feedback and constructive criticism are given. Include reticent or quieter learners in group discussions. Create opportunities for sharing meaning across groups.
helping learners be self-directed in their learning approach	Self-directed learning	Identify learning obstacles and suggest strategies to manage them.

		Sharpen learners' research and information management skills. Develop professional habits of working in learners such as agenda setting and action-planning.
helping learners to be reflective about their learning process	Reflection	Set clear criteria so that learners can evaluate themselves. Draw attention to blind-spots, misconceptions, and weak reasoning so that learners can address them. Give feedback regularly.

Regardless of a course being run face-to-face or online, the role of the tutor is to enable participants to learn. In a face-to-face setting, connection (one of the Cs) is easier to establish and the tutor will be able to visibly judge if connections to the context are being made and adjust the teaching to suit. In an online setting, even when talking directly to students it can be challenging to achieve the same level of interaction. Gupta (2017)[8] outlines how the quality of teacher is tied to the success of online courses, especially ones where there are low entry fees and lack of reason to stay engaged.

Later, section 5 discusses the different forms of online learning and how these can be applied to PBL and the role of the tutor in each.

4.3 The group

The group is the third component of PBL models. Problem solving in groups enables collaborative learning, but it also helps to nurture the other three key principles of PBL: critical thinking, self-directed learning and reflection.

Collaborative learning can take many guises and the exact role and nature of the group will depend on the PBL model. In some PBL models, students are entirely dependent on their peers to pass the course, whereas in others the role of the group is for inspiration and discussion of issues. The Aalborg model is an example of the former as the group must work together to solve the problem; whereas the Maastricht model, the role of the group is for discussion and inspiration and the

[8] Synchronous vs Asynchronous Learning in the Online World, http://edtechreview.in/e-learning/2773-synchronous-vs-asynchronous-learning

problem solving an individual task. In the Maastricht model this is still a form of collaborative learning, although it will depend on the framing from the tutor or facilitator.

D2.1 outlines different types of interactional dependencies which are useful to explore the role of the group in more detail. Dalsgaard & Paulsen (Dalsgaard & Paulsen, 2009) identify three interactional dependencies: individual learning, cooperative learning, collaborative learning which are presented in Figure 6.

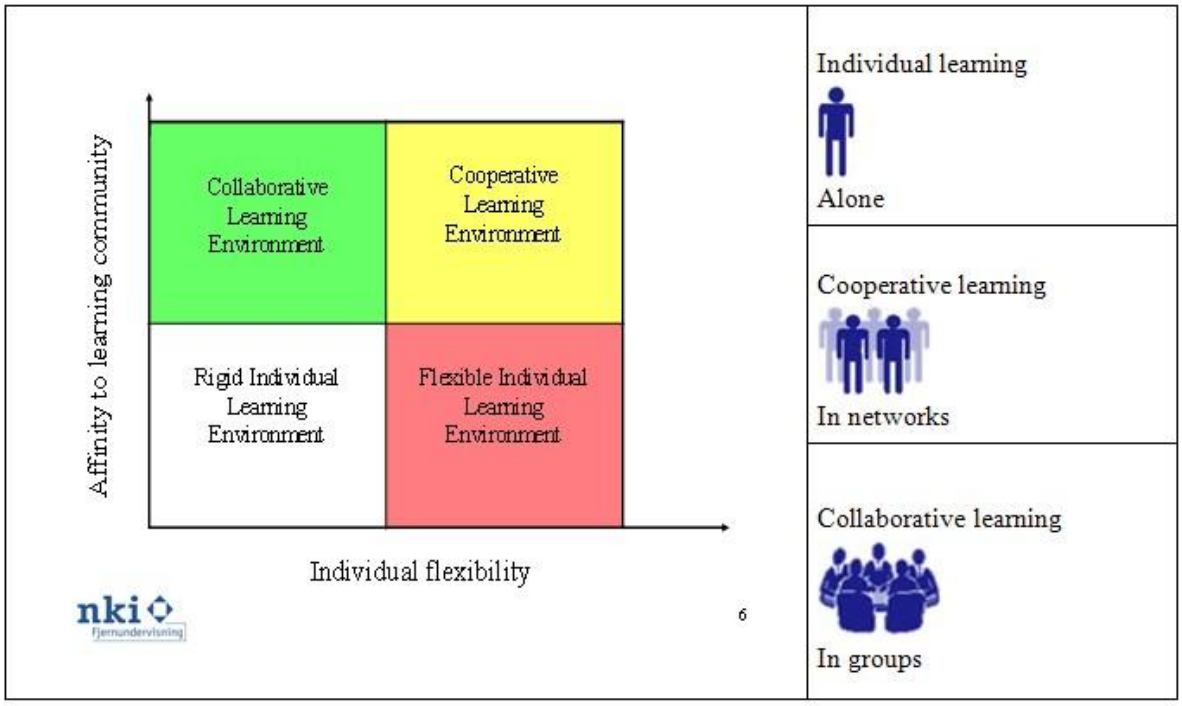

Figure 1. Individual, cooperative, and collaborative learning environments.

Figure 6 - Interactional dependencies (Dalsgaard & Paulsen (2009))

Individual learning has no interactional dependencies, cooperative learning has loosely tied dependencies in a network of learners who support and help each other and collaborative learning has strong dependencies. Of our two PBL models, the Maastricht Model is cooperative in nature, whereas the Aalborg Model is more collaborative. Both models also include elements of individual learning, where students work independently.

While it is recognised that collaborative learning identified in Dalsgaard & Paulsen's model, has been successful in the Aalborg PBL model, the question was how to design interactional dependencies in a PBL course model that would function in an online teaching environment. However, Dalsgaard and

Paulsen themselves state that cooperative learning 'thrives in virtual learning environments that emphasize individual freedom within online learning communities.'

Thus, it is recommended that the cooperative learning environment be used for an online PBL course model as the collaborative learning environment as defined by Dalsgaard & Paulsen is not practical for such individual learners who are unlikely to meet in person.

Cooperative learning techniques could take the form of discussions of the problems both inside and outside of the lesson, through dedicated forums or other online mechanisms.

4.4 Recommendations

The problem for the VET course model should be teacher directed because of the level of attainment that the VET course is aimed at. As an EQF level 4 course, it would not be appropriate to expect the students to develop their own problem. In addition, there is a practical element that needs to be considered: student-directed problems are often not formulated until four weeks into the teaching. For an online VET course, that timescale is impractical and as such would not maximise the students' learning.

It is recommended that the tutor define several closely scoped problems, related to specific areas of the curriculum, that focus the students on applying their learning to generate solutions. It is difficult, although not impossible, to define one problem that combines many types of approaches to analysing data without that problem then becoming abstract and thus a EQF level 5 course. To avoid this, it is recommended that multiple problems are presented for the students to solve throughout the course.

Problems should be applicable in nature so that students are required to use previously gained knowledge and skills to find solutions. In addition to their own experience, this previously gained knowledge and skills will come from the reference material taught by the teacher, online materials that the students can study at their own pace and, toward the end of the course, from solving the previous problems. Problems should also be developed using the 3C3R model to check their usefulness and relevancy to the VET students.

It is the role of the tutor to ensure that the four key principles of PBL are met: critical thinking, collaborative learning, self-directed learning and reflection. Whilst these will be included in the design of the course, the tutor must foster these principles throughout the lessons. They should also engage learners in key concepts, issues and themes according to the lesson objectives; and help learners to reason effectively and develop deep understanding, collaborate meaningfully with their peers, be self-directed in their learning approach and reflect on the learning process.

Finally, it is recommended that the VET PBL course model follows the cooperative learning model as this is more suited to the needs of the VET students. Cooperative learning works well in an online environment, whereas collaborative learning is unlikely to work outside of a face to face setting.

Successful cooperative learning may take some encouragement, so the tutor must make sure to foster a culture of cooperative learning throughout the course.

5 Delivery method

As outlined in section 3, digital focused courses can be delivered online or face-to-face with marginal differences in student attainment and learning experience. This section presents key theory regarding online delivery of a PBL course and present a potential model that can be used.

5.1 Online environments

Online environments can often be undirected. Even on courses that run over a weekly schedule, learners still have the flexibility to engage at a time of their choosing. This creates challenges for agenda setting for the learning itself. Using a problem based approach can help focus a student's learning to the point where engagement is required to solve the problem set.

There are also many methods through which online delivery can exist depending on where interaction takes place. Michael Moore first discussed the three most common forms of interaction in distance education: student-student, student-teacher, and student-content (Moore, 1989). Since this point the model has been expanded to the one by Anderson (Anderson, 2004) show in Figure 7:

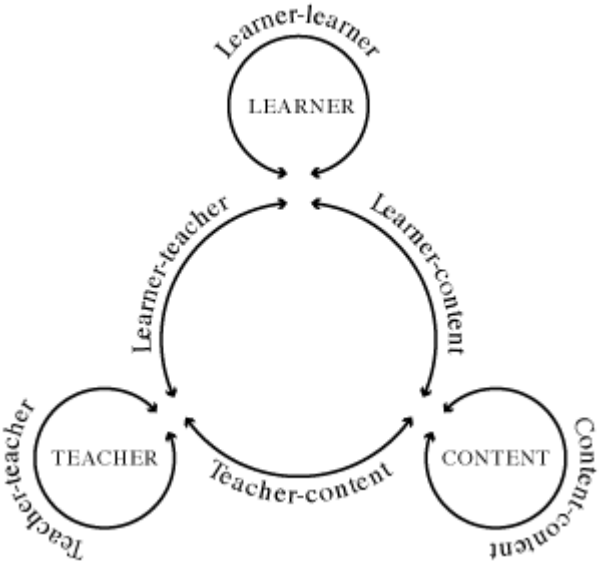

Figure 7 - Interaction in distance education (Anderson 2004)

Since publishing this paper in 2004, methods and opportunities for learning have moved on hugely. The first iPhone, which was revolutionary in terms of mobile technology development was not launched until three years later in 2007. Mobile learning opened up a new mode of delivery for learning which is still being developed today.

Gupta (2017)[9] looks at the concepts of synchronous and asynchronous learning and the advantages and disadvantages of each today. Synchronous learning should be used whenever there is a need for the educators to set the pace or tone, or when there is a need for a strong teacher-student engagement. Other synchronous learning journeys may be tied to specific real world events so can only take place at that time. Synchronous (or teacher directed) learning should always be used whenever there is a requirement for teachers or students to interact with each other at key points that are critical to the learning.

Asynchronous learning is where the students set their own pace and engage with the content as and when needed. This has the advantage of being very flexible for the learner and is suited for when learners are expected to self-educate on an individual basis. Normally on such courses there is little or no interaction with a teacher, however this does not have to be the case so long as engagements are limited in scope and applicable to all learners.

In relation to problem based learning, there is limited research on the application of PBL in an online environment. De Jong (De Jong, 2013) offer insights into a course that was taught both synchronously in a face-to-face setting to full time students compared to being taken (semi)-asynchronously by a set of part-time students. Their finding that there was no observed disadvantage of taking the course online. It should be noted that the publication states that the online learning was asynchronous, however this is only true for the student-content interaction as all other interactions were synchronous. It could therefore be argued that many students already choose to not attend lectures and instead engage with the content asynchronously, making a true comparison difficult.

King (King, 2010) applied a synchronous online PBL model to learning and found that ePBL can enable positive and novel forms of student interaction. However, focus needs to be on how students will be taking the course and are able to interact with other, be it online or offline at such high levels of interaction. King (King, 2010) makes a number of recommendations to help with the student-student and student-teacher interaction in a synchronous environment. Namely:

1. Test the technology thoroughly
2. Provide a hints and tips (and potentially acceptable practice) sheet to students and teachers for best use of the technology
3. Attempt to replicate a face-to-face ice breaker at the beginning of the course so that students can establish connection to each other (student-student)

[9] Synchronous vs Asynchronous Learning in the Online World, http://edtechreview.in/e-learning/2773-synchronous-vs-asynchronous-learning

In the 3C3R model (Hung, 2006) the connection is between context and content, however there is a need to connect to the community of learners to achieve the 3rd point above. Another key aspect of connection is to establish the relationships between students and the teacher and between the students.

In a synchronous online learning environment, the quality of the teacher is tied to the success of the program.[10] Establishing a good connection between the teacher and student is critical here however, students will still need to get comfortable with each other prior to engaging effectively in the course. Without this, some students may not be able to feel confident to engage in the course.

5.2 Recommendations

For the VET course, a semi-synchronous approach is recommended combining tutor led discussion with the projects online reference material which student can refer to as needed. Additionally, in such a model, both face-to-face and online delivery could be offered due to the similarity of the two models.

Tutors should set problems and then run review discussions before setting any subsequent problem and linking to reference materials that will help students solve the problem set. This is then similar to and building upon the successful model, run by King (King, 2010).

[10] Synchronous vs Asynchronous Learning in the Online World, http://edtechreview.in/e-learning/2773-synchronous-vs-asynchronous-learning

6 VET PBL course model for open data

In this section, we explore the VET course model that has been developed based upon the research and analysis presented in prior deliverables and in the previous sections of this report. After the theoretical VET course model, there is an example course that has been designed using the course model: Open Data Fundamentals. This is an example of a course to demonstrate how the VET course model can be employed. It is expected that more courses will be developed and implemented as part of WP4.

6.1 VET course model

For the VET course model, we have taken a semi-synchronous approach. This combines tutor led online discussion with online materials that students can refer to in their own time. The course is comprised of eight key lessons and five problems. Each lesson is designed to be two hours long, bringing the total contact time to sixteen hours. The recommended length for the VET course model is eight or sixteen weeks, depending on whether lessons are taught weekly or fortnightly.

The course model is designed to incorporate the key principle of problem based learning: collaborative learning, critical thinking, self-directed learning and reflection. As discussed in section 4.3, true collaborative learning as defined by Dalsgaard & Paulsen (Dalsgaard & Paulsen, 2009) is not appropriate for an online setting due to the limitations of an online course and the nature of VET learners. Instead, this course model takes a cooperative approach, where students are encouraged to communicate between lessons and to seek out guidance and support from their peers to solve the problems. Critical thinking is a key part of appropriate EQF level 4 courses and especially in problem based learning course models where students arrive at their own conclusions having considered the data available to them. This course is semi-synchronous and as such is designed to be taken at a specific time, week on week. However, the self-directed learning element is strong, as students are expected to work independently to solve the problems before a reflective discussion during the next lesson. This reflective element is the final key principle of problem based learning and is included throughout the course.

As outlined above, for the VET course model it is recommended that problems be set by the tutor. The VET course is designed to reach EQF level 4, so it would not be appropriate for students to have the additional challenge of researching and setting their own problem. Researching and setting the problem is also a key part of the group, and for the VET course model, the group will be cooperative in nature. Whilst it is possible to design one problem that continues throughout the course, it can be difficult to define a problem that combines many types of approaches to analysing data without being abstract and thus becoming a EQF level 5 course. Therefore, it is recommended, certainly for the novice PBL teacher, to define several closely scoped problems that focus on a few key areas from the curriculum and not try and combine all of them.

For the VET PBL course model, which is aligned to EQF level 4, it is recommended that problems are of the application problem type (Dolmans, 2012). Students should use previously acquired knowledge to help them solve the problem. In the VET PBL course model structure, the students use the reference learning materials to help them solve the problems set each week. As the course progresses, the students will be required to use skills that they have developed in previous weeks.

It is also recommended that tutors use the 3C3R model (Hung, 2006) when designing the problems. Identifying the content, context, connection of each problem, and designing activities so students need to research, reason and reflect will help tutors to ensure that the problems are useful, relevant and serve to maximise the students' learning. It is worth noting that the subject areas of the problems should be areas that the students can relate to. This is harder in an online course as the students will be more diverse than in a physical setting. Areas such as public services can be useful - for example access to education, hospital performance and managing budget cuts - as these are problems that are international. The other benefit of using public sector examples in an open data course is that the data from a is likely to be published openly by a range of countries, and certainly in the European context.

It is recommended that the tutor encourage the principles of PBL - critical thinking, collaborative learning, self-directed learning and reflection - for the students to maximise their learning. Often students can be shy in an online setting, particularly if they have not met any of their peers in real life, so the teacher must ensure that there are mechanisms for the students to communicate and work cooperatively to troubleshoot, compare progress and reflect. In addition, the technology must include these capabilities and have as few barriers as possible to learning.

As discussed above, Table 7 from D1.1 was adapted for the needs of the VET students in Figure 3. There are seven curriculum topics for the VET course:

1 culture
2 management
3 obtaining data
4 scrubbing data
5 analysing data
6 presenting data
7 data futures

For a comprehensive VET course model in open data, it is recommended that the tutor sets a problem for the key learning outcomes for each of the seven curriculum areas. As mentioned earlier, some problems may address more than one curriculum area, but there should be an obvious focus to ensure that the students' learning is clearly signposted.

The VET course model proposes that the first lesson serve two purposes: firstly, as an introduction to the course, and secondly as an introduction to open data. The exact nature of this taught content will depend on the needs of the learners, but in general it should align to the learning outcomes defined in the curriculum area 'culture'. There is no problem that is set in that first lesson, due to the importance of teaching the reference material that students will need throughout the course in order to solve the different problems. The purpose of the second lesson is also twofold: to recap the previous lesson, having giving students appropriate time for reflection and to set up the first problem, including teaching any specific reference material that the students will need to solve the first problem. In subsequent lessons, the first half of the lesson is devoted to discussing and reflecting upon the previous week's problem. The reflective element is especially important in this PBL course model as the problems set are application problems from Dolmans & Snellen-Balendong's (Dolmans, 2012) six problem types. The application problem is where students use previously acquired knowledge to solve a problem. The second half of the lesson is the set up for the next week's problem, which may also involve teaching some reference material. Some problems may take more than one lesson. In the example course Open Data Fundamentals, the fifth problem is two lessons in length, due to the complexity of the problem and the fact that the same problem can be examined from two perspectives and draws upon two of the curriculum areas: management and data futures. The eighth and final lesson is used as a reflection for the whole course, encouraging students to reflect on their experience, reinforce their learning and consider how they could use the digital skills they have learned to be effective data workers in their professional lives.

6.2 Example VET course: Open Data Fundamentals

Open Data Fundamentals is an example VET course that has been designed using the VET PBL course model. As outlined in the VET PBL course model, there are eight lessons in this course. Table 6 lists the lessons and the related problem. As discussed earlier in this deliverable, lessons one and eight have no related problem; lesson one is an introductory lesson and is an opportunity to teach reference material that the students will require to solve the problems, whereas lesson eight is designed to provide students with the opportunity to reflect on the course as a whole.

Table 6 - Lessons and problems in Open Data Fundamentals

Lesson number	Lesson	Problem

1	Introduction to open data	No problem, introduction and teaching session
2	Fire, fire! Obtaining emergency services data	How can we improve the performance of the London Fire Brigade?
3	Health check: Cleaning hospital data	How is that hospital performing?
4	Analysing data: do speed cameras improve travel time?	Do speed cameras improve travel times?
5	Equal opportunities: Visualising school data	Are all children in all parts of Africa getting equal access to education?
6	Rolling your own: building a business with open data	Building a personalised travel planner with live data (part one)
7	Rolling your own: the future of open data	Building a personalised travel planner with live data (part two)
8	Reflections	No problem, reflection session

Open Data Fundamentals has been designed to include each of the curriculum areas identified as relevant to VET learners (see Figure 3). Whilst each lesson includes learning outcomes from other curriculum area that are necessary for students to solve the problem, the lesson has a strong focus on one curriculum area above the others. Table 7 details each lesson, its principle curriculum area and other supporting curriculum areas.

Table 7 - Key and supporting curriculum areas for Open Data Fundamentals

Lesson	Key curriculum area	Supporting curriculum area
Introduction to open data	Culture	Management
Fire, fire! Obtaining emergency services data	Obtaining data	Culture

		Management Scrubbing data Analysing data
Health check: Cleaning hospital data	Scrubbing data	Culture Management Analysing data Presenting data
Analysing data: do speed cameras improve travel time?	Analysing data	Culture Management
Equal opportunities: Visualising school data	Visualising and communicating data	Culture Management Obtaining data Scrubbing data Analysing data
Rolling your own: building a business with open data	Management	Culture Obtaining data Data futures
Rolling your own: the future of open data	Data futures	Culture Management Presenting data
Reflections	-	Culture Management Obtaining data

		Scrubbing data Analysing data Presenting data Data futures

It should be noted that the problems are designed to become more complex as the course progresses, with students drawing on skills that they have learnt when solving previous week's problems.

6.2.1 Lesson 1 - introduction to open data

The main curriculum area that is taught in this first week is culture. The learning outcomes associated with this area are lower level, predominantly Bloom level 1 and 2 (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). They are also knowledge based, rather than skills based, therefore it was felt that it was more appropriate to teach this area of the curriculum in a more traditional sense, rather than through problem based methodologies. Therefore, there is no problem set for this curriculum area.

Table 8 details the curriculum areas that are drawn upon in this week, mapped to the learning outcomes identified in the needs analysis in D1.1 that are included in this lesson.

Table 8 - Learning outcomes for lesson one mapped to curriculum area

Curriculum area	Learning outcomes
Culture	State what makes data open Describe the basis of open data Recall open data examples Identify key impacts and benefits of opening up data Explain where open data creates value
Management	Set clear vision for open data use Identify different kinds of applications I can create with open data Identify other application areas where open data can be exploited List existing data portals

	Identify and evaluate data sources Explain licenses, decrees, basic law, European legislature Choose the right license Verify the license used allows for the re-use the company wants Recall legalities in relation to open data

6.2.2 Lesson 2 - Fire, fire! Finding emergency services data

This second week focuses on the curriculum area obtaining data. This is a logical step, as students need to be able to find the data before they can begin to clean, analyse or visualise it. The problem set in this week is 'how can we improve the performance of the London Fire Brigade?' This is a real problem that was facing London Fire Brigade in 2012[11] when they were forced to close up to a quarter of fire stations due to budget cuts; as the problem is taken from a real-life scenario it helps the students with the context and connections. Additionally, making budget decisions is something that is applicable to many jobs, and certainly something that students will be able to relate to.

Table 9 lists the different curriculum areas that are included in lesson two and maps them to the learning outcomes that were identified in D1.1

Table 9 - Learning outcomes for lesson two mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Recall examples and inspiration for public sector
Management	Discuss data driven decision making approaches
Obtaining data	Identify sources that open data can come from Search an open data portal Navigate an open data

[11] London Fire Brigade proposes closing a quarter of its stations, https://www.wsws.org/en/articles/2012/11/fire-n06.html

	Locate reliable data sources Identify and evaluate sources of data Download and explore a dataset
Scrubbing data	Explain the challenges of messy data Perform record deduplication and/or record merging Identify available tools to clean my data
Analysing data	Interpret data Explain what data means and its value Interpret findings

6.2.3 Lesson 3 - Health check: Cleaning hospital data

Week 3 focuses on the curriculum area scrubbing data. Scrubbing, or cleaning, data is an essential skill for all those who work with data, and must be covered before analysing or visualising data. For those who work with data, it is normal to expect to spend 80% of the data project preparing and cleaning the data and just 20% analysing, visualising and presenting that data.[12] In this week, the problem that is explored is 'how is that hospital performing?' with the aim of comparing health facility ratings and locations to find the best facility in the local area. Health is another topic that is easy to relate to, and the notion of finding the best health facility in the area will be familiar to students.

The majority of the curriculum areas are incorporated into this week's problem, as are detailed in Table 10, accompanied by the learning outcomes that should be achieved by students solving this problem.

Table 10 - Learning outcomes for lesson three mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Recall examples and inspiration for public sector

[12] The 80/20 Rule: Revised for Data Preparation, http://www.dmstat1.com/res/8020Rule.html

Management	Identify which datasets provides the appropriate information Identify standards for creating datasets Recognise which datasets are in convenient and modifiable forms
Scrubbing data	Explain how to merge data Identify if my data needs cleaning Deal with unclear/incomplete data (Explain how to) clean data Perform cleaning methods Understand the challenges of messy data Perform record deduplication and/or record merging Identify available tools to clean my data
Analysing data	Interpret data Explain what data means and its value Interpret findings Use analytics tools Perform practical data analysis
Presenting data	Link my story with data visualisation Identify the open data tools for presenting and storytelling Identify available technologies for creating visualisation Use visualisation software

6.2.4 Lesson 4 - Analysing data: do speed cameras improve travel time?

In the fourth lesson of Open Data Fundamentals, analysing data is the main curriculum area. Analysing data to find key insights is the next logical step after preparing the data and normally comes before visualisation. Students are faced with the statistical problem 'do speed cameras improve travel time?' This is another real-world problem which is easy to relate to for European

students. Whilst this might be less applicable in developing countries, the focus of this course is for individuals within the European Union.

Table 11 below shows the curriculum area and learning outcomes covered in week 4 of the course.

Table 11 - Learning outcomes for lesson four mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Recall examples and inspiration for public sector
Management	Discuss ethics in relation to open data
Analysing data	Use analytics tools Identify the proper analysis method to perform based on objective Perform practical data analysis Decide what type of analysis is more appropriate for my data Apply simple ranking of data, proportions and distributions Determine what statistical methods to use in specific situations Interpret data Interpret findings

6.2.5 Lesson 5 - Equal opportunities: Visualising school data

In lesson 5, students focus on presenting data, which is the next logical step after obtaining, scrubbing and analysing the data. In this week, the problem that is explored is 'are all children in Africa getting equal access to education?' Similarly, to health, equal access to education is a global issue that knows no boundaries and is often a subject to mobilise individuals.

Table 12 shows the curriculum areas tackled this week, which is the majority, mapped to the learning outcomes.

Table 12 - Learning outcomes for lesson five mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Recall examples and inspiration for public sector

Management	Identify different data formats Identify the indirect or circumstantial risks regarding privacy whilst using open data Explain what is considered private/sensitive data
Obtaining data	Identify suitable data for blending Knowledge of tools that allow data blending Handle interoperability issues and use existing standards
Scrubbing data	Explain the challenges of messy data Perform record deduplication and/or record merging Identify available tools to clean my data
Analysing data	Interpret data Explain what data means and its value Interpret findings
Presenting data	Link my story with data visualisation Identify the open data tools for presenting and storytelling Identify available technologies for creating visualisation Use visualisation software

6.2.6 Lessons 6 and 7- Rolling your own: building a business with open data

Lessons six and seven both deal with the same problem - 'building a personalised travel planner'. The key difference in the two weeks is the curriculum area that is focused on; in week six it is from a management perspective, whereas in week seven the students examine the problem from the data futures curriculum area. The problem is more complex, as it can be explored from these two perspectives. The aim of this problem is for students to discover how a business can be developed

using open data. Building a personalised travel planner is something that is very personal to the students; no two will be the same, increasing the relevance to their own lives.

Table 13 and Table 14 present the learning outcomes from the sixth and seventh week of Open Data Fundamentals, mapped to the curriculum areas that are included in the problem.

Table 13 - Learning outcomes for lesson six mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Describe the sector wide benefits of open data Recall examples and inspiration for private sector Recall success stories of startups and businesses built on open data Explain how open data creates value
Management	Identify how the specific dataset provides value Identify ways how users want to access the data Uncover consumer preferences, allowing companies to improve new products/services Identify how to reach more customers or provide enhanced services to existing customers Identify how open data is supporting growth by revealing opportunities for business Discuss ethics in relation to open data Recall legalities in relation to open data Explain rules concerning intellectual property Explain licences, decrees, basic law, EU legislature Explain creative commons and open data licences Choose the right licence Verify that the licence used allows for reuse the company wants

Table 14 - Learning outcomes for lesson seven mapped to curriculum area

Curriculum area	Learning outcomes
Culture	Describe the sector wide benefits of open data Recall examples and inspiration for private sector Recall success stories of startups and businesses built on open data Explain how open data creates value
Management	Locate reliable data sources Identify how the specific dataset provides value Identify the proper dataset Identify ways that users want to access the data Choose the right licence Verify that the licence used allows for reuse the company wants
Data futures	Identify available APIs that allow application creation with open data Use APIs in creating applications with open data Create queries that retrieve data from multiple datastores Create data structures Create dynamic displays that will be updated along with the data Identify technologies that allow the creation of live services with open data

6.2.7 Lesson 8 - Final assessment, reflections and futures

The final lesson of Open Data Fundamentals wraps up the course with opportunity for any final assessment and reflections offered on the final problem. As the final problem is the most complex of the course and a combination of two curriculum areas, more time for reflection is essential. Additionally, the final lesson should offer learners a glimpse beyond the course into future directions. As the learning is complete by this point, bringing in an aspect of forward thinking is critical for learners to help not only reflect but also connect back to their working, or upcoming working lives. Tutors should challenge learners to reflect and connect in order to ensure that the

learning gets applied and that the course has fulfilled the learner's goal of ensuring future application in their workplace.

7 Conclusions

This report presented the design and development phases of the VET course open data fundamentals.

Following on from the demand analysis carried out in WP1 of the ODEdu project, it was found that the level of attainment required for professionals in the public and private sectors is the equivalent of EQF level 4. This is a significant result as it demonstrates the demand for basic data literacy skills at EQF level 4.

When considering the opportunities to establish a PBL course, this level of attainment has a profound effect on the decision-making process over what extent certain PBL models can be adopted.

EQF level 4 is described as students who have: a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study.[13]

For example, in the Aalborg model, students are challenged with defining the problem for themselves, however this level of challenge is equivalent of a EQF level 7 course where students are tested in their ability to develop new knowledge and procedures to solve complex and abstract problems. As abstract problems are not introduced until EQF level 5 it would be unsuitable to expect students to define them within the scope of this course. Having students define their own problems would be an unnecessary learning curve and also cause significant challenges in delivering the course in a shortened time period.

Allowing tutors to define specific problems also reduces the need to engage as much with students during the process of problem definition. It also means that students are able to work cooperatively across the entire group of learners. This is particularly important as it allows the course to be delivered online to professionals who might be widely distributed and have limited time to attend a face-to-face course in a specific location.

Even though the course can be delivered online, there is still a need to introduce learners to each topic and problem and connect them to learning material that will help solve the problem. This means that the course will need to be delivered in specific time frames and be tutor led. However, relevant learning materials can be delivered via eLearning or other platforms on which the learning can consume them in their own time as part of the problem-solving process.

Delivery of an online course will require the careful curation of an online community area in which learners can connect to the teacher, other learners and the learning content. This community should draw on paradigms from face to face courses and facilitate discussion among both groups. There

[13] Learning opportunities and qualifications in Europe https://ec.europa.eu/ploteus/en/compare

should also be a consideration given for learner to learner only conversation and well as teacher to learner.

Of the 96 learning outcomes specified in D1.1. 48 have been used in the curriculum of the VET course, demonstrating broad coverage over 7 of the 9 areas outlined in D1.1.

These areas, as summarised in Figure 3, were updated from those in D1.1 in order to clearly separate visualisation from analysis as skills.

Taking the outputs of this report enables a comprehensive and appropriate VET course for professionals in the public and private sector to be developed. Additional work will be required to design the assessment and evaluate appropriate tools for learners (included in D1.3).

Finally, during researching this report, evidence was found that courses such as this developed to be delivered online, regardless of level, require a high quality and experienced trainer in order to guarantee success.

8 Future work

The outputs of this deliverable will be implemented and evaluated during the next stages of the project, which includes the implementation of the course model by the consortium and, trial course delivery as part of work package 4 and the learning platform configuration, as part of work package 3.

The course model has been designed as a framework that any partner in the Consortium can use to design their own open data VET courses. The framework forms part of the design pathway, for creating PBL open data courses outlined in D2.2, and is an essential part of the development and implementation of VET PBL courses in open data, which will take place in WP4.

WP4 is focused on the delivery of trial courses and events to audiences in the public and private sectors, as well as students at universities. This deliverable outlines a vocational course model for professionals which covers many areas of the curriculum and demands an 8-10 week minimum engagement for the full course. During WP4, the consortium will explore this model in practice and with different lengths of engagement to establish which works best in a VET setting.

As part of WP4, the consortium will begin to convene the audiences who will take part in these trials. The Consortium will reach out to community members and stakeholders to take part in the trials. This will enable us to reflect and iterate on the course model as well as the individual courses themselves, and to ensure that they meet the needs of the learners.

There is also potential for alliances to be formed with community members and stakeholders for the delivery of a trial within a specific sector, country or organisation. Running different trials with different audiences will also provide a more in depth evaluation on the strengths and weaknesses of the course model in different professional contexts.

Finally, as the course models have now been developed, the requirements of the online platform are clearer and its development can begin. However, as development of the platform will be ongoing through the project, opportunities to trial the courses and events in other scenarios should also be considered and outputs used to drive the functionality of the platform.

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