EUROPEAN COMMISSION

Erasmus+ Knowledge Alliance

EUFOOD-STA: EUROPEAN FOOD STUDIES &TRAINING ALLIANCE

554312-EPP-1-2014-1-AT-EPPKA2-KA

January 2015-December 2017

Deliverable D5.1

Report on identification of Good Practices in Innovation in teaching and learning

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Delivery date: M10 – October 2015

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including Commission services and projects reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and projects reviewers)	

Summary:

This report describes a range of student-centred approaches to learning. Problem-based learning and project-led education are ideally suited to develop a programme, where the main focus is on developing independent learners. The Problem-based module or project are normally supported by other teaching modules. Team-based learning, on the other hand, might be used as a replacement to modules where a significant proportion of the content is covered through a traditional lecture based approach. Research-based or enquiry-based teaching is introduced that aims at providing students with research skills through working on actual research topics. The report also provides examples of e-learning methods, such as blogs, wikis, videos, podcasting, image creation, mind maps and concept maps, can be applied depending on the type of knowledge that is being learnt and the cognitive process required for learning.

Co-funded by the Erasmus+ Programme of the European Union

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1 Introduction

Teaching of science and engineering in higher education is no longer restricted to the use of traditional methods of content delivery, through lectures, and the demonstration of theories, models and application of techniques with laboratory sessions, tutorials and computer sessions. This "traditional" approach is now in competition with newer innovative teaching practices that are being introduced at the programme[1] and course module[2] levels. Methodologies such as problem-based learning and project-led learning are being used to run the complete programme or may replace the teaching mode for a module. Innovative teaching is a way to strengthen and boost student learning. It can encompass exploring new ideas in teaching, improving practices that are currently effective and broadening the use of technologies.

Teaching no longer needs to be restricted by four walls. More recent changes in teaching practices have seen an increasing use of technology. Teaching can be provided in various forms including via social media, mobile apps and other media applications on smart phones, tablets and laptops. The use of mobile devices in teaching are now being explored by educators and conferences exploring the use of innovative teaching organised by organisations such as EDUCAUSE (http://www.educause.edu/). The rapid rise in the use of technology in teaching in recent years has facilitated the development of more online modules, now being offered by traditional teaching establishments with a technology partner, such as Coursera (https://www.coursera.org/), or in an open courseware format (see for example MIT at http://ocw.mit.edu/index.htm). Massive Open Online Courses (MOOCs) are now being offered by many universities in Europe and beyond.

This report will outline a range of student-centred learning approaches, including problem-based learning, project-led education, team-based learning and research-based teaching. Problem-based learning has also been applied as an online learning method. The report will then provide some examples of online tools and how they can be used for different modes of learning. Some other examples of teaching methods are also given at the end of the report.

2 Problem-based learning

Problem-based learning (PBL) is probably one of the most well known and widely used student-centred learning methodology that has been adopted by a number of universities, in a variety of scientific fields such as medicine (Wood 2005), engineering (Perrenet, Bouhuijs and Smits 2000) and accounting (Johnstone and Biggs 1998). PBL was first introduced to the medical curriculum at McMasters University in the 1960s and a number of different PBL approaches, such as those by the Maastricht and Harvard Medical schools, have been developed (Davis and Harden 1999). PBL consists of using a problem statement or case scenario as the ‘’trigger’’ for independent and self-directed learning, before they share and refined their acquired knowledge in a group (Wood 2005). The nature of the learning process also allows for a range of generic skills to be developed, such as those listed in table 1.

[1] A programme is defined as a complete curriculum of module courses that make up a degree, e.g., An UG degree in Food Science

[2] A module is a subject specific course part of a programme, e.g., a module in Food microbiology.

Table 1. Some examples of skills that can be acquired when using PBL (Wood 2005)

Teamwork	Listening	Critical evaluation of literature
Presentation skills	Recording	Self-directed learning and use of resources
Cooperation	Chairing a group	Respect for colleagues' views

The steps involved in a typical PBL tutorial, based on the Maastricht "seven jump" process, are as follows (Davis and Harden 1999; Wood 2005):

1. **Present PBL scenario.** In the first step, the scenario is presented to each group whereby any unfamiliar terms are identified and clarified. Various different types of "triggers" have been suggested, such as Newspaper clippings, audio or videos, computer simulations, experimental data, scientific research paper.
2. **Define the problem.** The group identifies and defines the problem or problems that need to be discussed further. It is important that the group considers all views at this stage.
3. **Conduct brainstorming.** Possible solutions to solving the identified problems, based on the prior knowledge of group members, should be discussed. Any unresolved issues and incomplete knowledge are identified.
4. **Outline preliminary solution.** The group gathers all the explanations they find into a preliminary solution to the problem/s after reviewing steps 2 and 3.
5. **Formulate learning objectives.** The group defines what are the learning objectives needed to fill any gaps in knowledge required to attain a satisfactory final solution to the problem. The PBL tutor should ensure that the learning objectives identified by the group is "focused, achievable, comprehensive and appropriate" (Wood 2205).
6. **Conduct independent study.** Each group member works independently to gather the information required to achieve the learning objectives
7. **Construct final solution**. Group members discuss their acquired knowledge, by share their results and learning resources with each other. The final solution and explanations on how problems were solved are gathered.

2.1 Designing the PBL scenario

The key to a successful implementation of PBL is partly due to the effectiveness of the PBL scenario in facilitating the learning process, so that learning objectives can be achieved. Wood (2005) provides the following recommendations on how to create an effective PBL scenario[3]:

1. **Learning objectives.** Learning objectives defined by students should be aligned with the module (course) learning outcomes.
2. **Prior knowledge**. The complexity of the problem should be based on the level of students' understanding and at the appropriate stage in the curriculum.
3. **Relevant context**. The problem should be relevant to their future profession and should engage students' interest.
4. **Interesting subject matter.** Scenarios should be interesting enough, such that students would be motivated to seek solutions individually and as a group.
5. **Elaboration.** The scenario should stimulate further discussion and encourage students to find explanations to identified problems.

[3]This has been adapted from Wood (2005) and the original work by Dolmans, Snellen-Balendong and Van Der Veuten 1997)

6. **Integration of knowledge.** Learning of basic science knowledge and concepts should be presented in the context of how they would be applied in practice, so that there is integration with food sector specific knowledge and skills.
7. **Self-directed learning.** Scenarios should help cultivate independent learning.

2.2 Student assessment in PBL

The type of assessment to be used in PBL should depend on the module learning objectives. It should be noted that if the assessment were based solely on recall of facture knowledge, then students would be less inclined to engage in the module (Davis and Harden 1999). It is therefore recommended that a range of different assessment methods should be applied based on whether the aim is to assess knowledge recall, problem solving, skills in analysis and synthesis. A combination of multiple choice questions and essay style written examinations could be used. Portfolios have been suggested by Davis and Harden (1999), as an innovative approach to assessment, allowing the assessor to examine the learning materials collected by each individual student. The final consideration should be on whether the assessment should take into consideration a student's individual performance and contribution, especially if the a group report or some other form of group assessment is used.

2.3 Implementing PBL as part of the curriculum

One of the key question is how should PBL be implemented in the curriculum. Careful consideration should be given to whether PBL should be the centre of the learning process with other modules supporting the main PBL module/s. Another consideration is what percentage of the curriculum should be based on PBL. In an electrical engineering course in Malaysia, Said et al (2005) the percentage of the curriculum using PBL differs from year 1 (20%) to year 4 (90%), with year 2 at 40% and year 3 at 60% of the curriculum. Gradual introduction of PBL makes it possible for students to begin to familiarise themselves with the methodology. Wood (2005) provides an example of how to design and implement PBL in a module. A modified version of this can be found in figure 1. It should be noted that PBL could also be implemented in a face-to-face and online format.

3 Project-based learning

An alternative to the use of problem-based learning is to use a project as the focus of learning, instead of a problem scenario. In project-based learning, the final outcome of the learning process is often the presentation of a product prototype or a final project report. Project-based learning is also known as Project-led education (Powell 2004) or Project-organised learning (Kolmos et al 2006). Project-led education (PLE) or Project-organised learning (POL) is different from Problem-based learning (PBL) in terms of the size of the learning activity. PLE/POL will therefore consist of a series of projects, that would cover different scientific subjects or themes that are part of the module design, each aimed at developing different levels of professional competencies (Powell 2004).

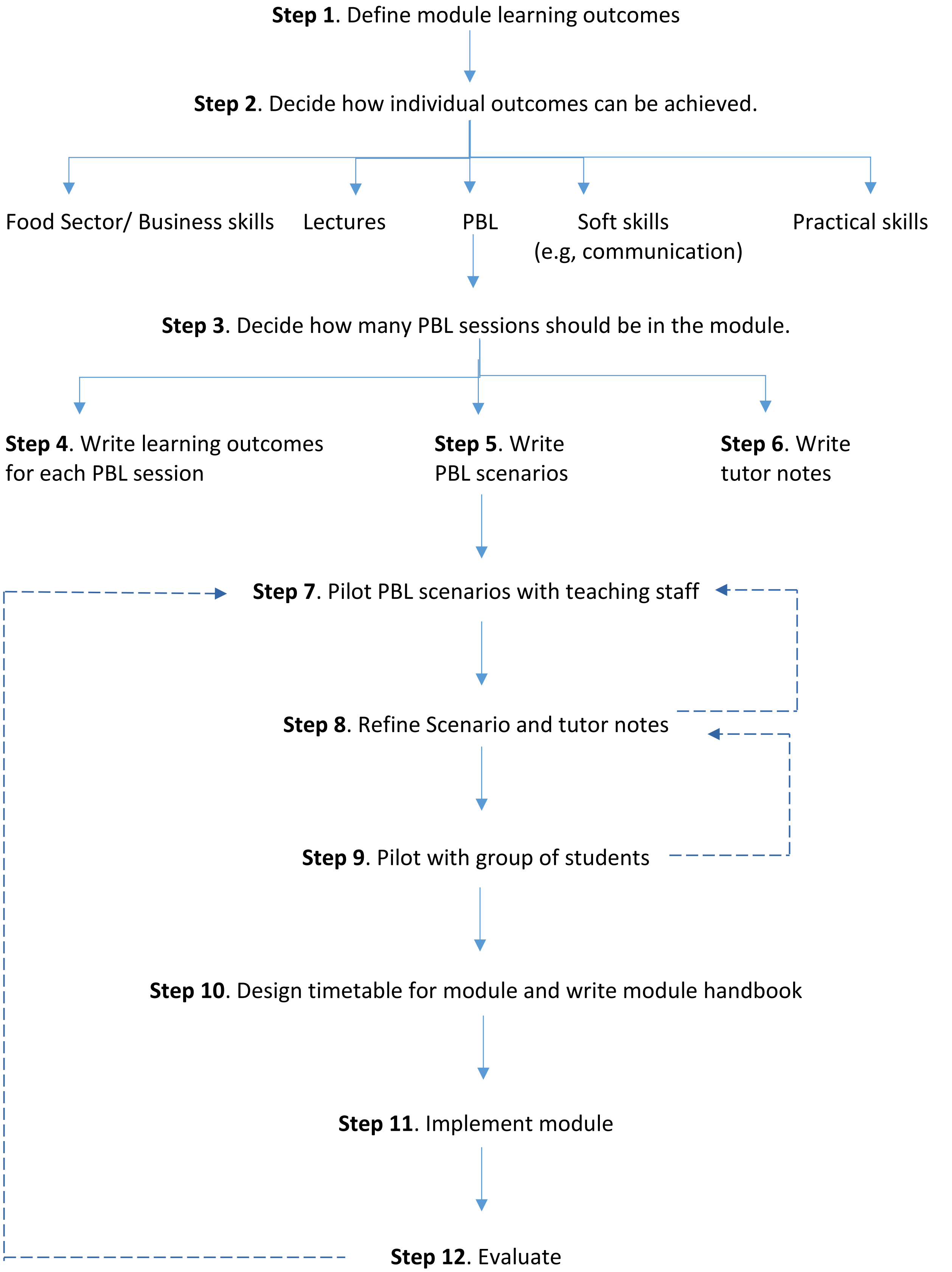

Figure 1. Example of how to design and implement PBL in a module (adapted from Wood 2005)

3.1 Structure of PLE/POL

PLE, like that of PBL, should be supported by a series of lecture-based courses. There is some flexibility as to how lecture-based courses should be linked to projects. Each project could have a single or more than one lecture-based courses linked to it. Powell (2004) suggests 80% of a PLE/POL programme should aimed at covering technical competencies, with the remaining 20% on soft competencies. He suggests that a typical structure in PLE/POL would consists of three types of learning activities:

1. The Project – This will typical run about four half-days per week throughout a semester, with less time spent at the start of the semester and more time spent at the end of the semester on the project.
2. Project related modules – These will run three half-days per week, covering theoretical knowledge and skills necessary to enhance the learning process during the project work.
3. Non-support/ Mandatory modules - These run for three half-days per week and can cover basic sciences (such as mathematics) and soft skills.

Powell (2204) also highlights the importance of the tutor in PLE/POL. Teams should meet their tutor for about three or four half-hours a week. The tutor should guide the students, by suggesting strategies in solving problems when teams are unable to come up with a solution to the problems they face. In the traditional Aalborg PBL model, the project takes up about 50% of student time, with an equal 25% split between project related and mandatory modules (Kolmos et al 2006). In another example, they refer to a Masters programme whereby for each semester the project work accounts for 24 ECTS and remaining credits from fundamental and compulsory courses.

3.2 Student assessment in PLE/POL

In PLE/POL, it is important to ensure that assessment is made both at the group and individual level. Assessment should be aimed at testing the attainment of all module learning outcomes. The assessment of the project prototype or project report is often used as the main source of assessment. If skills outcomes have been defined, then assessment criteria on how to judge them should also be considered. Hence, the use of oral presentation is common and Powell (2004) suggests that both the team and individuals should be assessed on their individual contribution and also their defence of the team's work. He suggests that the assessment panel should comprise of 2 examiners. In a typical six-hour examination of project work, the group is required to firstly give a one-hour presentation that highlights the achievements of the group. It is important that each team member is given equal time to defend the work of the group. A first round of questions is then directed to each individual student (30 minutes per student), based on the material presented in the report or oral presentation. This is followed up with a second round of questions aimed at clarifying any doubts related to the project work or at identifying the individual team member's level of competencies. The examiners are then required to mark the assessment and provide feedback to the team.

4 Team-based learning

Team-based learning (TBL), unlike PBL or PLE/POL, is a learner-centred instructional methodology that combines in class group activities with out of class individual learning activities. TBL was developed by Larry Michaelson at the University of Oklahoma as a way of teaching large class sizes, whereby the principle learning objective is "to ensure that students have the opportunity to practice using course concepts" (Michaelson et al. 2004).

4.1 Structure of TBL

A typical TBL course would be divided into 4 to 7 instructional activity units that cover key topics or themes for a course module. Each instructional unit is made up of (figure 2):

1. **Individual pre-class preparation**. Individuals study pre-class material before the start of each instructional activity unit. This is typical a reading assignment that covers knowledge learning outcomes.
2. **Readiness Assurance Process**. An individual Readiness Assessment test (RAT) is firstly used to assess a student's understanding of basic concepts and course content. Multiple choice questions (MCQs) or true-false questions are typical used in a RAT. Students then retake the same test as a group, during which time the individual tests are marked by the teacher. The group tests allow the students to discuss and choose group answers, which permits pear learning and provides a means for students to uncover any misunderstandings of concepts during their individual study. Immediate feedback on both individual and team RATs are given during the class, so that students can compare how effective they have been in their individual pre-class study. Students are then allowed to challenge any questions they thought should have been correct, through an appeals process, by providing evidence to convince the teacher that they should be given a correct mark. This provides the students with a more focus re-study of learning materials and thereby provides an additional learning opportunity. The final part of the Readiness assurance process consists of the teacher providing oral feedback by outlining any confusions students might have regarding the course concepts.
3. **Application of course concepts**. The final stage of TBL provides the opportunity for students to firstly work individually on simple problems, followed by group work also on simple problems. A series of more complex problems can then be given at both the individual and group level.

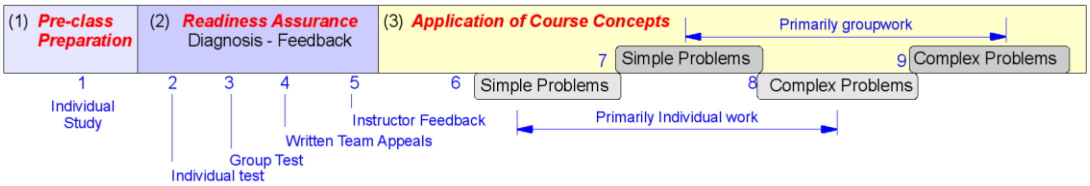

Figure 2. The typical layout of an Instructional Activity Unit (Ho 2008)

The keys to successfully implementing TBL are as follows:

1. **Groups must be properly formed and managed.** An effective team would consist of 5 to 7 team members with diverse and complementary sets of competencies. The teams, which are formed by the teacher, work together during the whole period of instruction. This gives the time for the group learn how to work effectively together to achieve their learning goals.

2. **Make students accountable.** Each team member is responsible for pre-class preparation and thereby able to contribute to team learning during class. The *Readiness Assurance Process* (see section 4.1) is used to ensure individual accountability for pre-class preparation, with peer assessment used to assess individual contributions to team work. Regular and timely group assignments are used to assess team performance and quality of work, with frequent feedback on performance to ensure that teams are aware of where there were gaps in their learning and how they can improve. Finally, the grading system should be fair, such that it highlights both the importance of individual contributions to team success and team performance.
3. **Ensure team assignments promote learning and team development.** Assignments should ensure group interaction if they are to be effective in promoting team learning. Teams should be required to discuss and use course concepts before making cooperative decisions on finding solutions to problems or approaches to completing and solving the assignments.
4. **Immediate and frequent feedback.** Providing immediate in-class feedback at the beginning of each instructional activity unit.

4.2 Peer assessment in TBL

There are two assessment methods that can be used for peer assessment in TBL. In the first approach, marks are awarded for individual performance (all individual RATs and individual assignments), team performance (team RATs and group assignments) and separate peer evaluation score. The peer evaluation score for each individual is calculated from an average score from peer ratings given by each team member. In table 2, each team member is asked to assign a total of fifty points to the other five members. The scores awarded should show a differentiation of ratings between each member (i.e., each evaluator has to give at least one score of 11 or higher, with a maximum of 15, and at least one score of 9 or lower). If two members of the team has the same individual performance and team performance mark, then the mark awarded from the peer evaluation would results in these two team members having a different final mark. Hence, the points towards final mark in table 2 for team work becomes the criteria which sets individuals apart.

Table 2. Method A for calculating peer evaluation scores (adapted from Michaelson et al. 2004)

Team members	Evaluators						Average Score*	Points towards final mark**
	A	B	C	D	E	F		
A		13	13	11	11	11	11.6	174
B	12		11	11	10	11	10.8	162
C	11	11		11	10	10	10.6	159
D	10	10	10		9	10	9.8	147
E	9	9	9	10		9	9.2	138
F	8	7	8	7	10		8	120
Average Mark	10	10	10	10	10	10	10	150

*The average score should be multiplied by the weight for team maintenance and added to the individual team performance scores to calculate a total score for each student.

**The final mark is the average score multiplied by 15, if the weight for team = 15% and the total points = individual performance + team performance + team maintenance = 1000 points.

An alternative method is to use the mark awarded for peer assessment as a percentage multiplier. Team members are asked to rate each individual's contribution to the team by distributing 100 points to the other team members and should also indicate the reasons why they assigned those marks to each member. The sum of ratings for each individual is the calculated, as in table 3. If for example, individual assignments account for 100 points and group assignments are worth 50 points, the total mark for the course is the sum of the individual component and the adjusted mark for group work. The adjustment is made to the group assignment marks, before calculating the final individual mark, by multiplying the initial group mark on assignments by the peer evaluation score from table 3.

Table 3. Method B for calculating peer evaluation scores (adapted from Michaelson et al. 2004)

Team members	Evaluators						Sum of ratings
	A	B	C	D	E	F	
A		20	20	20	20	20	100
B	21		22	21	19	22	105
C	22	23		22	23	20	110
D	17	20	18		19	21	95
E	22	20	23	18		17	100
F	18	17	17	19	19		90
Average Mark	20	20	20	20	20	20	100

4.3 Example of TBL in Food Science

Ho (2008) outlines how TBL has been used to teach Food Unit Operations to students in an undergraduate programme in Food Engineering. A 14-week course in 2007, which ran for 6 hours a week, was initiated with an introduction on the course learning outcomes and format and also an introduction to team-based learning in the first week of instruction. This was then followed by 4 instructional activity units, consisting of a RAT followed by tutorials and practicals, covering:

1. Basic concepts in food preservation and heat transfer (12 hours).
2. Blanching and Pasteurisation (12 hours).
3. Sterilisation (15 hours).
4. Chilling and Freezing (9 hours).

At the start of each instructional unit, students were given a reading assignment 2 week prior to the start of the Readiness Assurance process. Book chapters from Fellows (2000) and lecture notes from a previous year, where traditional lecture-based instruction was given, were used as pre-class preparation material. Each Readiness Assurance process (figure 2) lasted 3 hours, before students examined the application of course concepts through tutorials and practical classes. The final week of instruction was used to provide an overview of all course concepts and content before a final individual examination, consisting of all questions from all four RATs.

5 Research-led or Research-based teaching

The term “Research-led teaching” has been understood by academics as either a teaching method (i) where the content of teaching is influenced and based their own research or others in their field; or (ii) students undertaking research is seen as part of the pedagogy or content of the course (Zamorski, 2002). These two definitions are essentially what Griffiths (2004) has defined as Research-led and Research-based respectively, with a third method called Research-oriented teaching that focuses on students learning the research process. Healy (2005) introduced a fourth aspect, where the curriculum is focused on students writing and discussing papers, which is termed Research-tutored. A slightly different definition has been given by Holbrook and Devonshire (2005), whereby Research-led teaching consists of three aspects: (i) Research-informed teaching, which is what Griffiths calls Research-led teaching; (ii) Research-skills training, which is focused on develop skills needed to conduct research; and (iii) Research-inquiry teaching which looks at teaching research methods that examines the effectiveness of teaching activities and student learning. A number of authors (Justice et al. 2007; Kahn and O’Rourke 2004; Weaver, 1989) consider that in Research-Based or Enquiry-based teaching:

1. learning is stimulated by inquiry, i.e. driven by questions or problems;
2. learning is based on a process of constructing knowledge and new understanding;
3. it is an ‘active’ approach to learning, involving learning by doing;
4. is a student-centred approach to teaching in which the role of the teacher is to act as a facilitator; and
5. there is a move to self-directed learning with students taking increasing responsibility for their learning.

Louise Goldring and Jamie Wood (2015) from the University of Manchester’s Centre for Excellence in Enquiry-Based Learning provides a useful guide on how to conduct Enquiry-based learning.

6 E-learning and Web 2.0

Most universities are using virtual learning environments (VLE), such as Blackboard and Moodle, as a repository for learning materials, such as lecture notes, and for providing online tests. VLEs also have the facilities for online activities. Blogs and Wikis are used as a means of assessing student learning, and discussion forums can also be used to allow online collaboration on assignments. Online collaboration is often asynchronous, as these activities occur outside of class hours. Microblogging (e.g, Twitter), which can be used to share documents, and web conferencing (e.g, goto meeting, google handouts, skype), are examples of synchronous activities. When learning is conducted solely through online methods, we called this E-learning. However, e-learning is more commonly used together with face-to-face teaching methods. The combination of these two teaching approaches is called Blended learning. Recent advances in online teaching methods and the rise of the use of social media has resulted in the movement from Web 1.0 to Web 2.0. Although, many of the online learning methods are the same for both Web 1.0 and Web 2.0, perhaps the mostly distinctive difference between them is based on how these tools are used. Web 1.0 focuses on presentation of information, whereas Web 2.0 refers to both presentation of information on the web and participation of users (Rosen and Nelson 2015). Web 2.0 makes use of the open web instead of the closed systems of VLEs. Web 2.0 also focuses on the use of social media tools for collaboration between learnings. Massive Open Online Courses (MOOCs) are also offered by universities as free courses that provide an introduction basic concepts. Brown (2008) made a comparison between the characteristics of VLEs used in universities against that of Web 2.0. methods.

Table 4. Comparison between Web 2.0 and Web 1.0 (VLE) (adapted from Brown 2008)

Web 2.0	Web 1.0
Mostly freely available	Costly
Web-based	Enterprise-wide infrastructure required
Easy to use	Training often needed
Bottom-up individually led solutions	Top-down management led solution
Open access allowing for modification of material	Controlled access
Social and collaborative	Used mainly to support traditional teaching methods

A clear difference in the two approaches to teaching can be seen (table 4). The VLE approach requires large investment by the institution and time for teaching staff to be trained to use the systems, whereas web 2.0 tools are web-based, open and easy to use. A recent study by Newland and Byles (2014) suggested that students expect e-learning to be part of their learning experience at university. Table 5 shows examples of the type of e-learning tools (Resources) that can be used by different teaching pedagogies. In their study, they concluded that students' learning experiences were enhanced through collaborative learning and the use of "quality e-resources". However, the study also highlighted some of the problems that may be encountered for successful implementation at a wider scale. In particular, they identified the need for "high level of support required from a team of pedagogical and technical specialists" and the need to provide continual professional development in training in use of technology for teachers. Teachers should have a range of competencies in order to be an effective online teacher (Gail and Stacy 2004). These are outlines in Appendix 9.1.

Table 5. Examples of e-learning methods used with different teaching pedagogies (adapted from Newland and Byles 2014)

Pedagogy	Methods	Examples
Problem-based	Blogs, wikis and e-journals	Developing solutions in groups
Critical thinking	e-journals and e-news	Critiquing and finding information
Collaborative learning/ Social knowledge construction	Blogs, Blackboard scholar, Wikis.	Finding and critiquing articles using a blog; sharing information by social bookmarking; Creating group based resources

Different online teaching tools should be appropriately selected based on (Brower, Hedberd and Kuswara 2010):

1. The learning goals and outcomes
2. The type of knowledge (factual, procedural, conceptual or metacognitive)
3. The cognitive process required for learning (Remember, Apply, Analyse, Evaluate, Create)

4. The preferred modalities of representation (text, image, audio, and/or video)
5. If the mode of instruction should be synchronous or asynchronous

6.1 Blogs and Wikis

Blogs and Wikis are two very similar tools that can be used together to examine all four type of knowledge dimensions. These activities are run asynchronously. Blogs are normally used as an individual activity where the learner might be asked to explain a concept or issue (Conceptual), describe the stages during a product development process (Procedural) or to reflect on their own learning process (Metacognitive) (table 6). Completed Blogs can also be used to examine a learner's ability to evaluate the quality of factual or conceptual information provided by peers by providing feedback, evaluate a production process develop by peers or to self reflect on the degree to which one's own learning process has improved.

Table 6. Learning using Blogs (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember				
Understand		Explain the concept or issues as they arise		
Apply			Create a portfolio explaining stages of a product development	Explain how own approach to learning changes the subject progresses and as a result of reflecting on learning own processes
Analyse				Analyse own learning process throughout the unit of study
Evaluate	Evaluate the factual quality of information on peer blogs and post constructive feedback	Evaluate the conceptual quality of peers based on their blog postings and provide them with constructive feedback	Evaluate the production process that peers have described and post constructive feedback	Evaluate the degree to which own learning process improves as a result of self-reflection
Create				

Table 7. Learning using Wikis (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember		Identify main concepts relevant to topic		
Understand		Explain a set of concepts		
Apply				
Analyse	Analyse the definitions provided by peers and provide them with constructive comments on how to improve	Construct/Adjust a knowledge network so that it appropriately interrelates concepts		
Evaluate		Evaluate the quality of peer conceptual explanations and make appropriate alterations or suggestions		
Create				

Wikis, on the other hand, is more likely to be used in a situation where more than one learner would be required to collaborate. Wikis can be used to both examine if learners can identify or explain concepts relevant to a topic (table 7). They can be used to analyse definitions provide by peers and to construct a knowledge network to examine how concepts interrelate to each other. Wikis have also been used as a means to evaluate the quality of peer explanations and to make suggestions or alterations to content.

6.2 Videos and Podcasting

Videos and podcasting are another form of asynchronous learning tools. Video recordings of lectures are being used by universities, so that students can used them as a study aid for updating their lecture notes for revising before an examination paper. Videos could be used by learners to show the application of a concept or to demonstrate how they perform a process (table 8). They might also provide feedback on a video posted by their peers. Flipped classrooms can employ podcast (recorded video) of a lecture, as a means to replace existing face-to-face lectures. The face-to-face sessions can then be used for tutorial work or other learning activities in groups. Learners can be used the podcast to recall main concepts, provide definitions on an audio discussion board, or create their own podcast describing a process they have observed during a face-to-face session (table 9).

Table 8. Learning using Videos (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember			Watch a video of a process and recall the key stages	
Understand				
Apply		Create a video that applies the concept you have learnt to a concrete situation	Create a video that demonstrates how to perform a process	
Analyse			Analyse all the ways in which peers/self performs a process by posting comments on video page	
Evaluate			Evaluate a performance of a kinaesthetic process and provide constructive feedback	
Create				

Table 9. Learning using Podcasting (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember		Listen to a podcast lecture and attempt to recall the main concepts	Create a podcast describing a process that has been observed	
Understand	Provide definition of terms on an audio discussion board		Describe to peers the best way to perform a process and then provide constructive feedback to one another	
Apply				
Analyse		Collaboratively analyse an image or artefacts using a voice-thread		
Evaluate				
Create				

6.3 Image creation and mind maps

Creating an image to represent a concept, describes an item of knowledge or a flowchart explaining a process is an effective way to examine learning (table 10). Image creation is an asynchronous activity, although images might also be created using a collaborative white board tool. On the other hand, mind maps are used as synchronously where the focus is on collaboration between learnings. They are ideally suited to examine metacognitive knowledge (table 11).

Table 10. Learning using image creation (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember		Draw an image representing concept or set of concepts		
Understand				
Apply	Construct an image that represents or describes an item of knowledge			
Analyse				
Evaluate				
Create	Use a collaborative whiteboard tool to create new definitions for an area of innovation being considered		Draw a flowchart to explain a new process	

6.4 Concept maps

A concept map is a “graphic technique” that attempts to mirror a student’s cognitive framework in a given domain in order to gain insight into his/her understanding (Edwards and Fraser 1983). Although, concepts maps can help represent and structure knowledge, like a mind map, it provides additional information about the nature of the relationship between concepts. Hence, they are ideally suited as a learning tool which helps a teacher better understand the thinking process used by a learner during the construction of the map. The structure of a concept map is as follows:

1. Each concept is written in a box
2. Concepts are arranged in a hierarchy; whereby main concept appear above more specific concepts below them
3. Each concept can only appear in one place on the map
4. Each concept is linked by an arrowhead which also indicates the direction in which concepts should be read

5. A label should be included between links, describing the meaning od the relationship between concepts
6. There is no limit to the number of links coming from and going to a concept box
7. The number of concepts in a single concept map should be limited so that the overall structure of the map does not become unclear.

Table 11. Learning using mind maps (Adapted from Brower, Hedberd and Kuswara 2010)

	Examples of learning activities for type of knowledge			
Cognitive Process	**Factual**	**Conceptual**	**Procedural**	**Metacognitive**
Remember				Describe own cognition
Understand		Draw a mindmap representing a concept or domain		Explain own thinking based on theories of thinking
Apply				
Analyse				
Evaluate				
Create		Demonstrate a new conceptual understanding or innovation		Suggest a more efficient way of thinking

7 Conclusion

This report examines a number of student-centred learning methods, outlining how they can be used in the design and implementation of a curriculum. These methods focus using projects or problem scenarios as a “trigger” for learning, whereas Ecotrophelia is strictly a project competition. The authors are not aware of any university that have implemented the competition rules into a learning framework. The “garage” concept, where students learn how to start a business, also requires students to work on a project. However, both of them do not strictly fit into the definition of problem-based learning, project-led education. The report also outlines different types of e-learning tools that can be used as an alternative to more traditional face-to-face teaching, which as been the mode of choice for teaching at universities. Universities are beginning to see the need to embrace the use of web 2.0 tools. One key conclusion from this report is that the design of online courses should carefully consider the use of the appropriate tools with the methods of pedagogies that might be used. Two additional points to consider in the use of online courses are the need to determine how to conduct assessments and the use of appropriate tools to provide adequate formative or summative feedback.

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9 Appendix

9.1 Competencies of an effective online teacher

Gail and Stacy (2004) noted that the range of competences for a confident online teacher, as outlined by (Goodyear, Salmon, Spector, Steeples and Tickner 2001), has been used by Cowan University as the basis for a Graduate certificate in Online Teaching which was aimed at development of teachers' abilities to teach effectively using information and communication technologies. These competences are:

1. The role of content facilitator, concerned directly with facilitating the learners' growing understanding of course content;
2. The role of technologist, concerned with making or helping make technological choices that improve the environment available to learners;
3. The role of designer, concerned with designing worthwhile online learning tasks;
4. The role of manager/administrator, concerned with issues of learner registration, security, record keeping, etc;
5. The role of process facilitator, concerned with facilitating the range of online activities that are supportive of student learning;
6. The role of adviser/counsellor, concerned with offering advice or counselling to learners on an individual or private basis to help them get the most out of their engagement with the course;
7. The role of assessor, concerned with providing grades, feedback, and validation of learners' work; and
8. The role of researcher, concerned with engagement in production of new knowledge of relevance to the content areas being taught.