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RESEARCH-BASED LEARNING

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Research-based learning (Basic Guide)

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1. INTRODUCTION

Thanks to the work of universities and professors, no longer is it a novel idea to say that teaching should be student-centered. Even those teachers who have been the most resistant to change have had to act to try to not only center their students more in the autonomous and collaborative learning process but also to move beyond the belief that lectures are the only teaching method available.

For many decades, but especially since the implementation of the European Higher Education Area, active methodologies that promote diverse ways of learning have been used. These methods look to adjust to the heterogeneity and complexity of the student body, to the constant advancement of technological resources, and to the need to develop generic competencies that are being demanded of education by today's society.

The short guides that the Educational Innovation Service at the Technical University of Madrid (UPM) has developed intend to provide information regarding the most up-to-date trends in educational innovation with the goal of contributing to the improvement of the innovative practice of teachers.

In this guide, we present "research-based learning (RBL)" with the main goal of bringing research closer to the teaching and learning process. This method consists of learning from doing, that is, from the generation of knowledge itself thanks to teachers being involved in the constant research processes and being able to accompany, advise, and tutor the research processes and projects with their students.

"World Class Universities" are those which are characterized by their creation of knowledge using their projects with society. These universities are all based on four fundamental pillars:

1) research;
2) connection with society, materialized through projects;
3) high standard teaching;
4) and administration at the service of research and educational innovation, which serves as a means and support for the management of these projects (Altbach & Salmi, 2011; Altbach, 2016; Cazorla & Stratta, 2017).

In these universities, it has been shown that being able to connect teaching and research increases the quality and attractiveness of educational programs (Zamorski, 2002; Healey, 2000; Jenkins et al., 2003; Marsh & Hattie, 2002; Healey, 2005; Scott, 2002). RBL is therefore a fundamental methodological approach for universities, especially at the graduate level.

In the following pages, we intend to offer an overview of the fundamental questions regarding RBL: what it is, what it implies, how to apply it, and how to evaluate at the level of university teaching.

2. What is RBL?

Research-based learning (RBL) consists of offering students the possibility to carry out or participate in research processes. In these processes, students apply methodologies to check the veracity, or lack thereof, of hypotheses with the goal of providing a response to a problem or question. They are accompanied and supervised during the whole process.

Vilá et al. (2014) state that "one of the functions of Higher Education is to enable students to produce knowledge, apply skills, and continue learning throughout their professional careers". In order to develop all the competencies needed for academic, professional, and personal life, it is essential that students understand, learn, and know how to apply research and inquiry methods.

Ernest Boyer (1928-1995) is considered to be one of the precursors of RBL for his defense of linking teaching with reality and due to his questioning of traditional teaching. In his speeches, he would maintain that education must prepare students to be independent and self-sufficient, as well as help them to go beyond their private interests, obtaining an integrative vision of knowledge by relating their learning to life. In the document "Reinventing undergraduate education: a blueprint for America's research universities (1998)" in the Boyer Commission on Educating Undergraduates in the Research University, there is an exhaustive development of this teaching model in which, among other aspects, it is stated that the purpose of RBL is to promote the interaction between teaching and learning in the following scenarios:

- functioning as a distinctive feature of a curricular program,
- functioning as part of the didactic strategy in a course, or
- functioning as a complement to a specific activity within a teaching plan.

Similarly, the EUA (European University Association) (2017) includes the development of students' research skills through:

- participation in courses on research methods and techniques
- problem/project-based learning methodologies that include real cases of analysis and solution.

The RBL model is coherent with current didactics and is based on the idea that students take ownership and develop their own knowledge based on practical experience, autonomous work, collaborative learning, and discovery. These are fundamental aspects for achieving learning and developing knowledge and attitudes for scientific, technological, humanistic, and social innovation (Peñaherrera et al. 2014).

Bringing research closer to the classroom and making students the researchers positions the teacher as the main researcher as, through their example, orientation and supervision will the RBL process be developed.

3.   Characteristics of RBL

Depending on the nature and area of the research project, as well as its scale and methodology, it would be necessary to adjust RBL to the specific needs of each educational situation. In this regard, Plomp (2007) recognizes five possible research **functions and objectives**:

- To describe
- To compare
- To evaluate
- To explain or to predict
- To design and develop

Regarding the possible ways of proceeding, Plomp lists tools that are applicable to any discipline:

- **Survey**: to describe, to compare, to evaluate.
- **Case studies**: to describe, to compare, to explain.
- **Experiments**: to explain, to compare.
- **Research**: to design/develop a solution to a practical problem.
- **Ethnography:** direct study of people or groups to describe or explain.
- **Correlational research**: to describe, compare, or relate variables.
- **Evaluation research:** to determine the effectiveness of a program.

Depending on what the purpose of the research is, this may be developed through various different strategies.

The starting point for training organized around research is the formulation of questions and hypotheses that outline the process, which can be differentiated according to:

- Experiences of structured and guided inquiry, in which the teacher notes the problem, the questions, and the terms regarding which the students may explore with a varying degree of autonomy.
- The open RBL models, in which the students themselves formulate the questions and complete the entire research cycle with institutional support and supervision from the teacher).

In this regard, Griffiths (2004) and Healey and Jenkins (2009) highlight four work trajectories that bring research closer to the students:

- **Research-lead teaching:**
   the focus is on <u>learning about the outcomes of a particular research project</u> on a subject or discipline that has already been completed.

- **Research-oriented teaching:**
   the focus is on <u>understanding and developing research skills and techniques</u> in order to generate an interest in research.

- **Research-based teaching:**
    the students are the <u>researchers</u> and carry out research and inquiries themselves.

- **Research-tutored teaching:**
    learning happens through students' participation in <u>discussions with researchers</u> on the results of their own and others' research work.

The authors note that these paths are not rigid nor independent but rather they are interrelated and their application is essential for the design of successful experiences.

Figure 1, developed by Peñaherrera et al. (2014) reflects the more or less active role of the students depending on the strategy followed and whether the emphasis is on the content or on the research process.
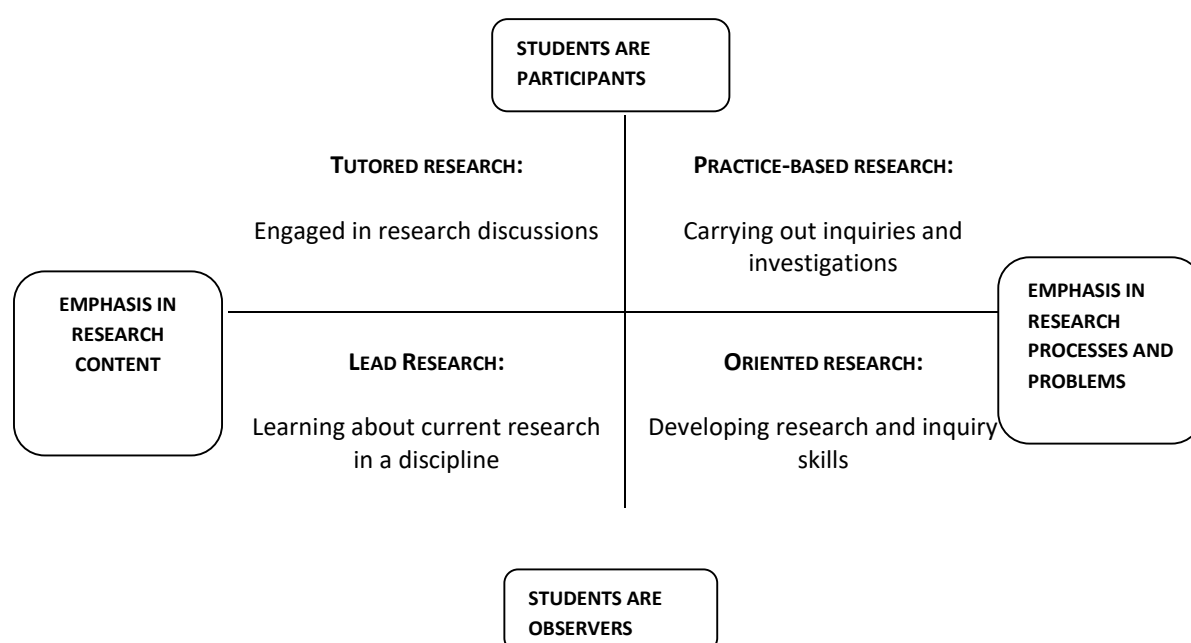
Figure I. Types of RBL. Peñaherrera et al. (2014) and Healey and Jenkins (2009)

<u>Tutored research</u>, as proposed by Healey and Jenkins, could correspond to <u>inquiry-based learning</u>, which is based on asking questions about a given context or situation.

Peñaherrera et al. (2014) and Montero (2009) emphasize that in order to implement RBL it is necessary:

- That teachers incorporate research into their teaching as a didactic strategy.
- That both students and teachers improve their research skills and that these skills become part of their academic work culture.

Lastly, it is worth noting the term *formative research* (Vilá et al., 2014) as a reference to RBL as a tool for research itself, the improvement of teachers, and as an instrument for the training in and for research (Sabariego, 2012).

Whatever its nomenclature[1], it seems that RBL is a necessary and significant methodology for the involvement of students in current problems or situations that are related to particular topics, and favors processes of reflection, inquiry, and the generation of knowledge.

When carrying out research, the hope is that students will be able to apply the scientific method, which includes:

- Identifying problems or problematic situations that need researching.
- Structuring the problem.
- Theorizing about possible solutions.
- Choosing a methodology to investigate alternative solutions.
- Generating evidence based on the research.
- Analyzing information or data.
- Using inductive and hypothetico-deductive thinking.
- Making inferences and conclusions through a research process with scientific rigor.

The development of these competencies is important as with them students are able to address the research process with basic tools and are capable of managing any possible difficulties that may arise.

ADVANTAGES OF RBL

There are many benefits regarding the use of RBL in the teaching and learning process. The following are contributions from the relevant authors in this field.

Loukkola and Dakovic (2017) identify the following advantages of RBL:

- It centers students in the **creation of knowledge,** allowing for the acquisition and development of necessary skills and competencies, like autonomous learning.

- By involving students in the research process, they learn to establish **important connections** between their knowledge of a subject, their skills, and their future professional life (whether they become researchers or not) in a more effective way.

- It increases the students' **sense of belonging** with the university.

- It offers teachers the opportunity to successfully practice and improve their leadership skills with research teams.

- It allows for collaboration beyond the classroom, for example, between subjects and/or entities.

- The usefulness of carrying out joint research projects can be extrapolated and may be useful for other areas of development, such as curriculum innovation, for example.

- It supposes a rebalance between teaching and research.

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[1] Other ways to refer to RBL may be: *research-tutored teaching, research-led learning, research-based-teaching, research-oriented teaching, inquiry-based learning, research informed teaching, research enhance learning and teaching, undergraduate research and inquiry.*

- It contributes to the improvement of teaching (interdisciplinary and in a team) and promotes collaborations between subjects, courses, centers, and universities.

    In 2010, ITESM noted that RBL contributes to:

- Promoting innovative knowledge through interdisciplinarity. Students being able to develop their abilities to innovate, that is, to not simply be a reproducer/receiver but rather a producer of knowledge.

- Developing critical thinking; a fundamental aspect for a scientific mindset that favors objectivity and tolerance.

- Developing the ability to research and learn in a self-directed way.

- Increasing the sensitivity and perceptive capacity of scientific, humanistic, and socio-cultural phenomena.

- Strengthening attitudes toward ethics, commitment to knowledge, and academic honesty in the research work carried out.

Using a global analysis of RBL, it can be noted that it: gives visibility to research, improves the employability of students by developing their professional skills, favors the involvement of students in university life, strengthens students' social commitment, promotes student curiosity, and favors the integrated development of competencies that are valued in the professional world and which are necessary for life. Moreover, in accordance with the aforementioned points, it may be considered that RBL promotes other skills such as:

- Information management (access, search, analysis, etc.)
- Cooperation, collaboration, and teamwork
- Written/oral expression
- Problem solving
- Project management
- Creativity
- Critical thinking
- Scientific rigor

4. RBL in the classroom

RBL can be applied to any course, any discipline, and any moment thanks to its versatility and different levels of depth. The main limitations that can be found with its use are the duration of the academic year and/or the lack of means, equipment, or space.

In the following table, **four main strategies** are noted for linking teaching and research in courses and programs (Jenkins et al. 2003; Healey & Jenkins, 2005):

1. Understanding of the importance of research in a discipline.	2. Development of research skills.	3. In-depth understanding of research developments.	4. Managing and directing the research experience of students.
Integrating information and references to past and current research in the curriculum. Being conscious about the connection between research and the knowledge of a subject. Learning from past research projects. Demonstrating how to organize and finance research.	Learning about research processes. Familiarization with research evaluation methods. Specific training in the research field. Participation in the research process. Development of skills that enable the communication of results to specific audiences.	Bringing the role of researcher close to freshman year students. Development, as the course progresses, of necessary abilities and competencies for research. Participation, during the final courses, in entire research processes that help to integrate all the knowledge of a discipline.	Limiting consequences for those students who do not participate in the research processes. Evaluating and offering feedback about the research experience. Certifying the students' research experience with the purpose of improving employability.

Table I. Teaching-research connection. Own source provided using the contributions of Jenkins et al. (2003); Healey & Jenkins (2005)

Espinel et al. (2016) note that many different strategies can be used:

- To tell students about current research projects that are related to topics that are being studied in a subject at a particular moment.
- To incorporate the latest research projects into a specific topic in the classroom.
- To contextualize discussions about current research results; referring to those that have been discredited in the past and mentioning current debates.
- To analyze methodologies and arguments that have been submitted to a journal article that outline recent research findings.

ITESM (2010) offers and develops different strategies for the application of RBL in the classroom:

- **Designing learning activities around contemporary research projects**
  This involves students exploring research problems or suggesting solutions to current global problems by applying their knowledge of a subject. The students analyze a current research project: the methodology, its arguments, results, etc., and revise the current literature on a particular research topic...

- **Teaching research methods, techniques, and skills that have been specified in the curriculum**
  Students learn about research methodologies and their application to real situations, and are given the opportunity to develop abilities that are associated with research.

- **Constructing research activities on a small scale as part of the course activities** (individually or in a team)
  Analysis of data from existing projects; documented resolution of a question answered by the existing literature; advanced training in research skills and techniques...

- **Involving students in research projects being carried out in the department**
  Beyond understanding the current research topics being developed by the department, students may participate and support wider projects with assigned tasks with which the students have to behave as researchers and are managed and supported by the teacher.

- **Imparting researcher values**
  Showing students the research process, the reviews, the existing problems before publishing a paper; demonstrating the importance of values such as: objectivity, respect for evidence, respect for others' point of view, tolerance toward ambiguity, and analytical rigor; and offering the opportunity to analyze works that present contrasting arguments of a topic and carry out a deep analysis of them.

Dekker and Walsarie (2016) provide evidence for the application of RBL with very specific activities:

- Carrying out interviews with prominent figures in the fields of study and reporting the results to the students' course mates.

- Studying and debating scientific research articles.

- Writing analyses about scientific research articles and presenting them to peers to facilitate debates and discussions.

- Developing and presenting an article on a current topic.

- Proposing hypotheses using leading articles.

- Formulating research questions.

- Developing complete research proposals.

- Collecting and analyzing data with the purpose of answering a research question.

- Writing articles about one's own research project.

- Presenting research work orally or using a poster at a department and/or university student research conference.

- Publishing, if possible, an article in a research journal.

- Disseminating research in topic-related blogs/networks.

- Writing reflective self-evaluation regarding the learning process.

Other activities may also be: visiting research institutes or centers; participating in workshops and seminars, in laboratories on scientific methods and researcher's ethics, etc.

However, any RBL experience can be complemented and supported by methodologies like: problem-based learning (PBL), project-oriented learning (POL), challenge-based learning (CBL), collaborative/cooperative learning, case method[2], etc.

The POL and PBL methods are closely related to RBL since the former consists of developing a research project (entirely or in part) and the second involves solving a real problem for which a research project is needed (information search, analysis, solution planning, etc.).

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[2]Quick guides for these methodologies are available for download
Https://innovacioneducativa.upm.es/guias_pdi

As a notable case, the GESPLAN research group at the UPM, after over 25 years of perfecting their teaching from learning strategy in the Master's Degree in Project Planning for Rural Development and Sustainable Management, has developed a "Work With People (WWP)" model (Cazorla-Montero et al., 2017, 2019) which integrates the following elements to achieve the successful research-based learning method:

- To jointly promote educational innovation and research, seeking synergies from research groups and educational innovation groups (GIE).

- The existence of teacher-researchers, who are directors of the groups and who have a "**strategic vision**" with regard to linking actions from the research universities' three pillars: teaching, research, and connection with society.

- To have a solid body of knowledge and educational **lines of research** and **innovation** that are of interest to the needs of society.

- To promote **teamwork** between **educational research and innovation groups**, as basic units of stable collaboration for the promotion and development of research activity. To define the groups **responsible for lines** of research by their recognized competencies in the subjects.

- **To have competent teachers available for the creation and direction of projects** using their own educational strategy with which both students and teachers improve competencies (technical-practical, behavioral and contextual) from a culture of "working through projects".

- To develop **international** collaborations and **interdisciplinary teams**, creating alliances (with universities, businesses, civil society) and promoting **University-Business Chairs** to bring the university closer to the business environment.

- To integrate **research-based learning** with real scenarios in order to facilitate the development of the research competencies needed to work through projects. These projects provide an added value to the model as "learning laboratories" for research, educational innovation, and the resolution of real problems.

- **To improve continuous teaching** using research and educational innovation, especially at the postgraduate level (master's degree). The knowledge that is generated through research is incorporated into the educational strategy, which is in a constant process of renovation and is attractive to society.

- **To generate and disseminate new** knowledge, acquired as a consequence of the outcomes from particular projects, enriching the lines of research of the groups. To this end, it is necessary to understand the processes of **intellectual property protection** to provide legal certainty to the people involved in the research processes and to know how the Research Results Transfer Offices (OTRIs) of the Universities work.

The following figure integrates the three dimensions of the model. There are synergies between the three pillars of the research universities: teaching, research, and connections with society.
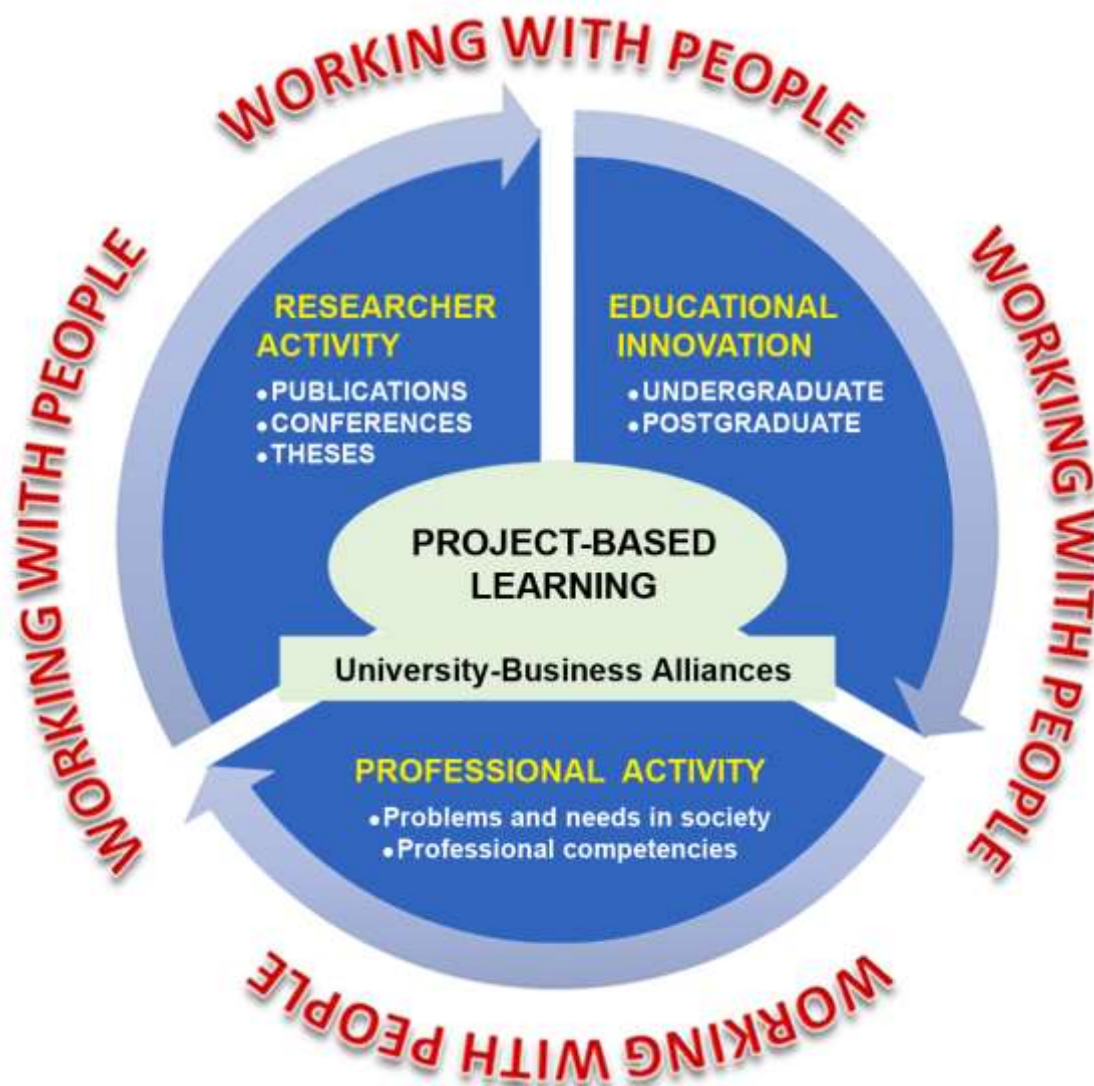

Figure II. Dimensions of the WWP model (De los Ríos et al., 2016).

WHEN IS THE USE OF RBL RECOMMENDED?

Kelly (2007) notes that the use of RBL increases its benefits when:

- The learning object is being questioned/researched at the same moment.

- The way of teaching particular content is not clear nor well defined.

- The materials for teaching are limited.

- The teacher, for whatever reason, does not feel entirely able to teach particular content.

- There are interests (political, social, etc.) that can affect the learning of content in a certain way.

5. EVALUATION IN RBL

We can distinguish two necessary evaluations:

- The experience of RBL
- The achievements of the students (generic and specific competencies)

In both aspects, evaluation has to be constant and must address both the research process (formative evaluation) and the product (summative evaluation).

EVALUATION OF THE EXPERIENCE

Regarding experience, Nieveen (2007) highlights that the purpose of a formative evaluation is improvement and it should be centered in discovering the faults in the development process in order to improve it. The purpose of the summative evaluation is to evaluate the educational intervention: the results and its efficacy in deciding whether to continue or not.

For this evaluation, the following can be used as evidence:

- The students' results.

- The students' satisfaction/involvement/learning (through a questionnaire, for example).

EVALUATION OF THE STUDENTS' ACHIEVEMENTS

Generic competencies:

RBL allows for the development of several generic and transversal competencies. Information on the UPM generic competencies and their assessment can be found in the following link[3]. This portal may be useful for organizing evaluations.

Evaluation will be simpler or more complex depending on the experience and its breadth[4].

The following is a rubric developed by ITESM (2000) that can help both in planning the experience and evaluating the students.

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[3]Using this link, you will be able to access the complete list of competencies, learning outcomes, teaching strategies/methods, levels of proficiency, indicators of achievement and evaluation.

[4] If methodologies such as PBL, POL, etc. have been used, we recommend reviewing the quick guides about them at https://innovacioneducativa.upm.es/guias_pdi as they have their own evaluation section.

Design canvas
Research-based learning

Subject	Name of teacher
Semester	Name of the task

Sub-competencies

Note the sub-competencies that the students will develop throughout the activity, including:

• Conscious entrepreneurship
• Collaboration
• Ethical argumentation
• Citizen commitment for social transformation
• Systemic thinking
• Scientific thinking
• Critical thinking
• Oral language
• Written language
• Understanding of other codes
• Dialogic communication
• Digital culture

1

The task

Write a paragraph contextualizing the activity.

Specify the stages in which the activity will develop:

1.
2.
3.
4.

Define the time needed for the activity to be carried out.

2

Contents

What do the students need to know to be able to achieve the sub-competencies and successfully complete the activity?
Content list for Research-Based Learning:
Conceptual:
   1) Textual prototypes
   2) Text types
Procedural:
   1) Oral communication skills
   2) Written communication skills
Attitudinal:
   1) Teamwork
Note: Add the contents related to your course/module/topic/unit, which the students will need to perform the activity.

3

Final resut

Describe the product the students develop through the activity
   • Define the product(s) at each stage
   • Define the final product

4

Evidence of competency

- Argumentation document
- Visual supports for the argumentation
- Audio-visual record of participation

5

Recommendations for the teacher

- Provide the students with a list of topics for the documentary research and define the characteristics of the types of resources to be consulted.
- In research-based learning, diagnostic evaluation is particularly important in order to validate sources and orientate the students in their search for information.
- Plan a debate session and consider whether external support is necessary (colleagues, advisors, officials, etc.)

8

Supporting resources

Students must be aware of and have access to the following resources:
   • Repositories
   • Tutorials
   • Academic advisor support.

7

Evaluation

How will students' performance be evaluated?
• Define: when the students will be evaluated and will be given feedback (diagnostic, formative, and summative).
• Design evaluation instruments (rubric, checklist, observation guide, interview).

6

In terms of evaluation, the following are offered as an example:

- **Diagnostic stage:** Submission of an essay about the subject (opinion)

- **Formative stage:** Submission of research progress.

- **Summative stage:** Oral presentation of research and participation in debates

In these three cases, it is recommended to have a rubric in order to clarify what is going to be evaluated and to be able to evaluate all students using the same criteria.

Specific competencies

How will the knowledge acquired during the RBL process be evaluated?

The research process itself is a particularly complex learning process that can be evaluated through the following:

- Tests regarding the contents and concepts to be acquired.

- Presentations of the research (with the theoretical basis and argumentation, discussions, evidence, findings…).

- Through a portfolio in which the students collect all the evidence and processes that they followed throughout the RBL process.

The dedication of the teacher to the students is very important to be able to successfully develop the RBL experience. Frequent tutoring sessions, the possibility the students have to contact the teacher about any doubts, suggestions, supervision, guidance... are all indispensable aspects that, on the one hand, help to understand the students' progress very closely and, on the other, suppose a considerable effort that, undoubtedly, may be very beneficial and motivating both for the students and for the teacher.

6. RELATED RESOURCES

The UPM's Educational Innovation Portal, which has access, through calls for application, to the Educational Innovation projects that relate to RBL. Available at: https://innovacioneducativa.upm.es/proyectosIE/buscador

Carnegie Foundation's Boyer Commission (1998). Outline summary of Boyer Report Recommendations. Reinventing Undergraduate Education: A Blueprint for America's Research Universities. Available at:
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University of Manchester. The Centre for Excellence in Enquiry-Based Learning (CEEBL). Available at: http://www.ceebl.manchester.ac.uk/

Sheffield Hallam University, the Centre for Promoting Learner Autonomy. Available at: http://extra.shu.ac.uk/cetl/cpla/cplahome.html

University of Oxford. Centre for Teaching and Learning. Available at: https://www.ctl.ox.ac.uk/

Universities of Warwick and Oxford Brookes, The Reinvention Centre. Available at: https://warwick.ac.uk/fac/cross_fac/iatl/cetl/

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