



# Erasmus+



## COLIBRI MODULE O17: Documentation of project results Final report

This material is developed as a part of the Erasmus+ Strategic Partnership Colibri: Collaboration and Innovation for Better, Personalized and IT-Supported Teaching.

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COLIBRI: FINAL REPORT



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## **Preface**

During 2014 and 2017 the project COLIBRI (Collaboration and Innovation for Better, Personalised and IT-Supported Teaching) was carried out between seven European Universities, two companies, and a national documentation center. The aim was to develop and try out new and innovative teaching methods. You can read more about the project at [www.erasmus-colibri.eu](http://www.erasmus-colibri.eu).

The purpose of this document is to share the experiences we had during the three years, in a way that is useful for others, and in particular for university teachers, university staff involved in the didactical communities, and institutions/decision makers. The different parts can be read independently as to increase the usability for different target groups. To keep the document at a reasonable length, we would refer to some of our publications for more elaborate discussions of some of the more specific aspects of the project.

All results and materials we have developed can be accessed from the project website (visit [www.erasmus-colibri.eu](http://www.erasmus-colibri.eu)). You are welcome to reuse or adapt any of the materials we have made. Here we want to provide a shorter document that summarizes the teacher guidelines.

The report is organised as follows:

- Executive Summary
- Reading material: teachers/practitioners, the didactical community, decision makers
- COLIBRI motivation and objectives
- COLIBRI methods (Description of what we have done)
- Year 1 experiences
- Year 2 experiences
- Year 3 experiences
- Summary of overall experiences and results
- Moodle and course experiences
- Learning Management Systems and Alternative Platforms
- On the use of Open Education Resources
- Recommendations for decision makers and institutions
- Conclusions

## **Executive Summary**

During the COLIBRI project, we have been trying out new and innovative teaching methods, especially focusing on blended learning and problem based learning. The project has been carried out in collaboration between seven European universities and three enterprises, where the universities have developed teaching materials and provided project supervision, and the enterprises have delivered input to the production of teaching materials (form and content), co-supervision of projects, and of particular importance real cases for the students to work on.

Each of the three years, a living lab has been established with the materials being tested out in a course with around four students from each of the seven universities. The students have been following course modules and working together in international and interdisciplinary groups, mixing virtual and physical collaboration. Each year the teaching methods and teaching materials have been adjusted to take the experience of the previous years into account, including feedback from students, teachers and companies.

The evaluations collected each year demonstrates that all stakeholders find that the teaching methods used in COLIBRI increases the quality of the learning offer, the relevance of the learning offer, and the labor market relevance of learning provisions and qualifications. Even from the first year the results were very positive, and they improved further during the following years. The same was the case when students evaluated their personal outcomes of participation in the project.

Apart from that, two trends are worth noticing from the evaluations:

- Throughout all the years, students, teachers and companies have been especially positive about the the aspect of collaboration in international and interdisciplinary groups on real-world problems.
- The satisfaction with the virtual project collaboration has increased significantly from the first year to the last year. We believe this reflects that we have improved many aspects of the support for this part of the learning process.

While in general students, teachers, and companies have evaluated all the teaching methods used in a positive way, the conclusion that stands out is that the international and cross-disciplinary collaboration on real-world problems is very valuable, and that this kind of learning activities can happen in a blended setting combining virtual and physical mobilities, if properly supported and facilitated.

The results and experiences were communicated to various target groups using different communication channels: In particular, all staff who participated in the project at some point have been serving as “Colibri Ambassadors”, helping to spread the work to colleagues - through presentations, workshops, support and help for colleagues wanting to try out new things - and so on. In this way, we have reached more than 1.500 teachers face-2-face - within and beyond the institutions participating in the partnership. Moreover, the results were published and presented in more than eight conference papers targeting the didactical community, and all materials have been made publicly available for others to use or modify.

### **Reading material beyond this report**

To achieve a systemic impact, the COLIBRI project searches to reach a number of target groups including university teachers/practitioners, members of the didactical community of higher education, as well as decision makers at all levels at universities.

While this report searches to balance an elaborate presentation of our approach, results and experiences, we would like to refer interested readers to supplementary material provided either on our homepage [www.erasmus-colibri.eu](http://www.erasmus-colibri.eu) or from papers published based on the project. Naturally, the division between the different target groups is not set in stone, and should not be seen as a restriction for potential readers.

For practitioners (university teachers), all the teaching material produced throughout the three years is available for download from the website. It is all published using the Creative Commons License, so you are free to reuse it fully or in parts, and to revise it as you see fit. We are just happy someone will make use of the materials. You can also find the full curricula describing the content and learning objectives of the course as a whole as well as the specific modules. You might also be interested in the evaluation of each individual module, which is also accessible from here. Moreover, a number of articles may be of interest:

- Colibri : An International Blended Learning Experience based on Real-World Problems. / Pedersen, Jens Myrup; Kuran, Sükrü; Frick, Jan; Mank, Lea. Proceedings of the PAEE/ALE'2016, 8th International Symposium on Project Approaches in Engineering. red. / Rui M. Lima; Erik de Graaff; Anabela Alves; Andromeda Menezes; Diana Mesquita; José Dinis-Carvalho; Lamjed Bettaieb; Natascha van Hattum-Janssen; Nelson Costa; Rui M. Sousa; Sandra Fernandes; Valquiria Villas-Boas. University of Minho, 2016. s. 259-268 (International Symposium on Project Approaches in Engineering Education (PAEE)). This article provides quite a hands-on description and discussion of the teaching methods used, and the results achieved during the first year of the project.
- Moodle: Practical Advices for University Teachers / Jens M. Pedersen, M. Sukru Kuran. In: Choraś M., Choraś R. (eds) Image Processing and Communications Challenges 9. IP&C 2017. Advances in Intelligent Systems and Computing, vol 681. Springer, Cham. This article contains a very hands-on introduction on how to use features in Moodle in order to deliver a better and more interactive learning experience.
- International student projects in a blended setting: How to facilitate problem based project work /Jens Myrup Pedersen, M. Şükrü Kuran, Lukasz Zabłudowski, Raphael Elsner and Lauris Prikulis. Submitted for PAEE/ALE'2018 (abstract accepted, paper pending acceptance). This article focuses specifically on how to support project work in a blended setting, mainly describing how we improved the virtual part which turned out to be the most challenging.
- Dynamic Content in Future Internet Opportunities Grad Course / Jan Frick and Jens M. Pedersen. In book: Evaluating Media Richness in Organizational Learning, A. Gyamfi and I. Williams (edt.), IGI Global, August 2017.

For the didactical community within higher education, a number of articles are expected to be of high interest:

- The Colibri Project : Overcoming diversity in blended e-learning activity preparation. / Lopez, Jose Manuel Gutierrez Lopez; Frick, Jan; Kirikova, Marite; Solé-Pareta, Josep; Pedersen, Jens Myrup; Tran, Nga. Proceedings of the 43rd SEFI Annual Conference 2014 : Diversity in engineering education: an opportunity to face the new trends of engineering. red. / Kamel Hawwash; Christophe Léger. 43rd. udg. SEFI, Brussels, Belgium : SEFI: European Association for Engineering Education, 2015. 54863. This article describes in more detail the methods and thoughts behind the project.
- Variability handling in an educational context. / Sausina, Anete; Kirikova, Marite; Pedersen, Jens Myrup; Rudzajs, Peteris. Information Systems Development: Complexity in Information Systems Development (ISD2016 Proceedings). Association for Information Systems, 2016. s. 284-293. This articles describes how to handle the complexity in determining and setting up personalized learning paths.
- Blended Learning and Problem Based Learning in a multinational and multidisciplinary setting. / Pedersen, Jens Myrup; Lazaro, José; Mank, Lea; Eichhorn, Vanessa. 6th International Research Symposium on PBL: PBL, Social Progress and Sustainability. Aalborg Universitetsforlag, 2017. s. 535-546 (International Research Symposium on PBL). This article focuses on the application of blended learning and the project work.

For decision makers, the presentation of results for years 1, 2 and 3 can be found on the website <https://www.tuhh.de/colibri/downloads.html>. They give a quick overview of methods, results and experiences throughout the three years. Also, the following article can be useful when it comes to choosing a learning management system:

- Learning Management Systems on Blended Learning Courses: An Experience-Based Observation / M. Sukru Kuran, Jens M. Pedersen, Raphael Elsner. In: Choraś M., Choraś R. (eds) Image Processing and Communications Challenges 9. IP&C 2017. Advances in Intelligent Systems and Computing, vol 681. Springer, Cham. This article contains a comparison of different learning management systems, especially focusing on their application in a blended learning setting.

## **Colibri motivation and objectives**

In this project entitled Colibri - "Collaboration and Innovation for Better, Personalized and IT-Supported Teaching" - we intended to tackle some of the major challenges we are experiencing with university teaching today internally and externally. There are four main aspects that motivated us to carry out this project:

First, our universities are faced with an increase in the number of students who would previously not have chosen a university education. This tendency is especially outspoken in some of the more technical areas of engineering, where it has become hard to recruit students, often leading to a broad intake of students in order to satisfy the needs of the labour market. The challenge is not just to accommodate them in the universities, but also to make sure that they become as qualified for the labour market as those who would traditionally choose a university career.

At the same time, there is a pressure to ensure that the students not only become skilled academics, but that they are also ready to take on the challenges experienced in the labour market after graduation, which requires not only good technical skills, but also collaboration skills, project management skills, presentation skills etc. In other words, we need to educate students to solve problems rather than (just) equations (Walther et al., 2011), (Crawley et al., 2007), (Walther et al., 2007).

As a third point, traditional universities are being challenged by technology, and need to find their position in a world where Massive Open Online Courses (MOOCs) are becoming increasingly popular (Martin, 2012), and where even students in our own universities sometimes prefer to follow online courses rather than courses offered locally (Wulf et al., 2014), (Christensen et al., 2013). With the interactive, highly relevant, and professionally produced content of some of the courses, it is not surprising that a single lecturer giving a similar course cannot keep up to speed here – and often the use of new technology, including the many features of modern Learning Management Systems (LMS), is left to the individual teacher to explore and use. To address this challenge, universities need to define their own roles and value propositions, and decide how and for what virtual learning platforms and other technologies should be used.

Lastly, companies are dependent on good university education, as students are future employees. Therefore, it is of interest to companies that students face real-world challenges already at university and that they get prepared for the labour market during their education.

In short, Colibri's main objectives can be described as follows: Improving the quality of the academic teaching offer with respect to future challenges like increasing internationalization and digitization and preparing students better for the national and international labour market.

The figure below outlines the challenges and our approach to targeting them:

We experience: Increase on the number of students



The challenge: Student diversity

Cultural  
Background  
Learning styles



We need: Personalised teaching + new and innovative teaching methods



We want:

Students ready for the labor market + collaborate across nationalities, cultures, and technical disciplines.



By: Institutions working and experimenting on joint learning activities

And the overall objectives:

Enhancing the **quality and relevance** of the learning offer in education

by

developing new and innovative approaches, and by supporting the dissemination of best practices

Promote the **take-up of innovative practices** in education

by

supporting **personalised learning approaches, collaborative learning,**  
by making **use of ICT and Open Educational Resources,** and by  
**exploring the use of blended and virtual mobility**

Increase **labour market relevance** of learning provision and qualifications

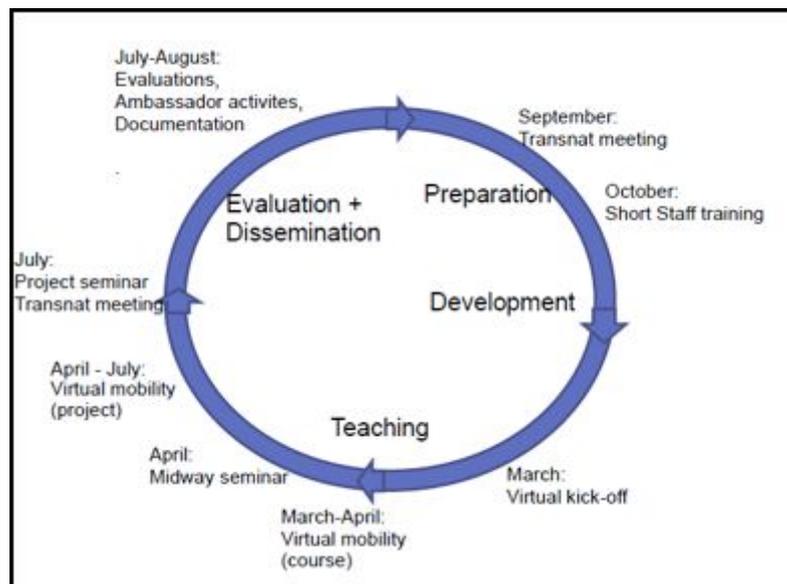
## **The COLIBRI methods**

The methods used in Colibri are based on the two main innovative methods: blended learning and problem based learning.

Blended learning is a combination of face-to-face teaching and e-learning and can also include the use of various media and teaching methods. In COLIBRI, blended learning was carried out by providing online lectures in 10 different modules with three varying levels of difficulty combined with two physical meetings where students and teachers came together. Between these two physical meetings students worked together in groups of three to five students from different universities. Innovative teaching methods were included in the modules such as videos, interactive quizzes, short case studies and peer learning.

Problem based learning is an innovative instructional method, using a practice-oriented approach to solve so-called real world problems. On the basis of case studies students have to develop strategies for problem solving by interacting in a learning group and discuss with fellow students and teachers. They are then to apply their knowledge and expertise in a specific thematic area. In COLIBRI, the participating companies provided the case studies based on the topics treated in the 10 course modules. The students worked on the cases in mixed groups from different universities, with different cultural and subject backgrounds.

The methods and materials were revised every year, but would in general follow a yearly cycle as depicted below:



The scheduling of learning activities was adjusted every year. In general it consisted of the following steps, which took place during the Spring semester (February-July):

- A virtual kick-off meeting in February, where students (and teachers) met for the first time, with an introduction to the course.
- A virtual study phase, with focus on the online modules. This started at the kick-off meeting, and lasted until the Midway seminar in April.
- The Midway seminar, where the course modules were finished, and the project work introduced and initiated.

- A virtual collaboration phase, where students were working together in groups of 3-5 students per group, all from different universities and backgrounds, on the projects introduced during the Midway seminar.
- A project seminar, where the students got to finish the project work, and the exams were conducted.

The modules were adjusted from year to year, but in general the following components were used at different levels of each module:

It was defined that the modules at different levels would contain some of the following elements (a module need not contain all of them):

Introduction level:

- Overview lecture (max. 2 videos of max. 10 min.)
- Individual task or assignment
- Individual task or assignment + peer review
- Peer learning in project groups
- Optional literature/material

Basic level:

- 10 min. self-assessment (+ preliminary material)
- 60-120 min. literature study
- Video lectures with shorter tasks (max. 10 min. lecture/5-10 min. self-correcting questions / working with tools) (120-180 min.) max 50% of video lectures.
- Self-correcting quizzes and assignments
- Practical exercises to work with the relevant tools
- Q&A forum

Advanced level:

- Literature reading
- Video lectures (max. 10 min. lecture)
- Group assignments (in groups of 3-4 students)
- Peer assessment workshops: Assignment + peer assessment (students assessing students)
- Article assignment: Reading, discussion, presentation of work in relation to an article
- Additional material in the form of videos, books, scientific papers, PPTs...
- Quizzes

## **Year 1 methods and experiences**

This section is divided into four parts: Modules, Projects, Tools/Platforms and Results. The Results part is again organised into Modules, Projects, and Tools/Platforms.

### **Year 1 - Module Structure and Content**

Each module consisted of three levels: Introduction (1 h. workload), basic (5 h. workload), and advanced (5 h. workload). Each student was required to follow all the modules at introductory level (10 modules) and at least 3 modules up to advanced level. The total number of hours of the selected modules had to be 60. This meant that students had the flexibility to choose the following configuration of modules in addition to the 10 introductory modules that were mandatory for everyone:

- 5 modules at basic level, and of these 5 modules at advanced level
- 6 modules at basic level, and of these 4 modules at advanced level
- 7 modules at basic level, and of these 3 modules at advanced level

The teaching methods implemented in each module would depend on whether the module was offered at introductory, basic or advanced level. This would reflect among other things that we wanted to present the introductory parts in a standardised way (as the time students should spend on each is rather short), and also that the students would get more chances to apply the knowledge and obtain a deeper understanding.

The modules were finished during the midway seminar. In the programme, each module had one hour allocated, which was for most modules spent on closing notes by the teachers, small 5-10 minutes presentations from the students following the module at advanced level, and a Q&A session in the end.

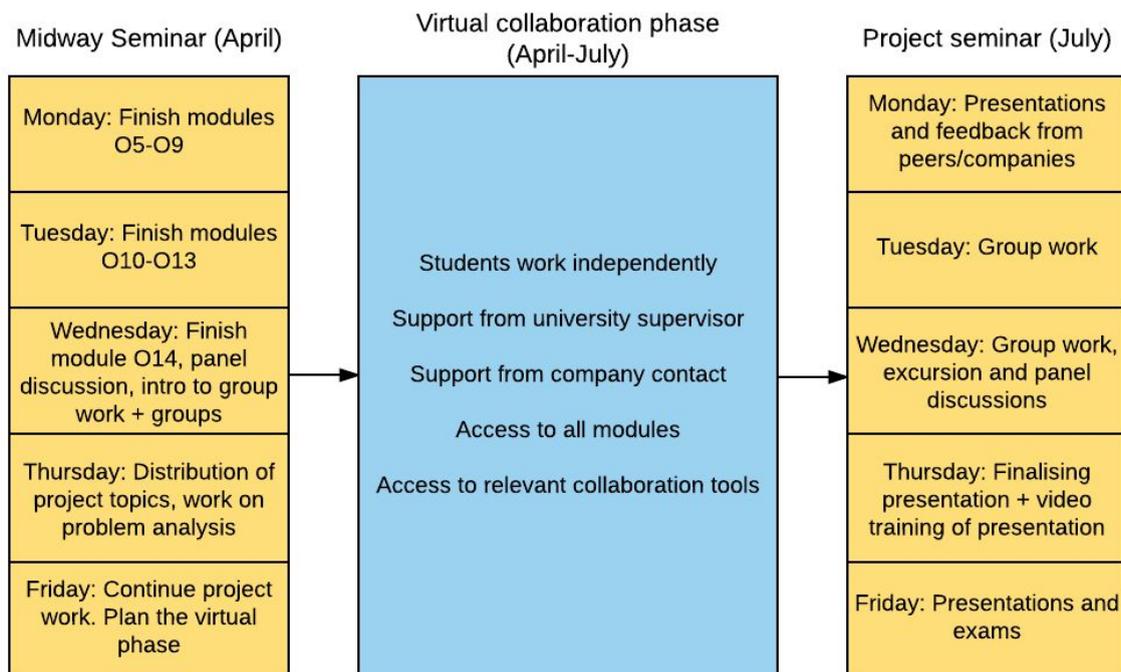
### **Year 1 - Project and project support:**

In short, the following points explain how the project was supported and carried out.

- In order to ensure a good fit between project proposals and modules, the potential project proposals were presented and discussed at the teacher training seminar in November.
- The main concern regarding choice of modules was that all modules would have a minimum number of participants to ensure we could evaluate the content of all modules. With this in mind, the students chose their basic and advanced modules independently, but we reserved the right of negotiation in case some modules were not chosen by at least a few students (this turned out not to be a problem).
- The groups were formed by us in an attempt to achieve as much diversity as possible: In terms of gender, nationality, cultural background and educational background. In order to be able to get all the students to get to know each other before splitting into groups, we did not announce the groups until day 3 of the midway seminar. We did consider that the students could form teams on their own, but found it hard to facilitate this process as the students did not know each other beforehand.
- The projects were distributed during day 4 of the midway seminar. They were randomly distributed - this way we avoided a situation where not all projects were chosen, and we avoided potential conflicts due to disagreement on project topics.

- The midway seminar was designed to put more weight on projects than modules: The first two days were dedicated to completing the modules and to activities that facilitated the students getting to know each other. The last 3 days of the seminar were dedicated to the project work. On day 3 the students were introduced to group work, with case studies and exercises in the newly announced groups, and on days 4+5 the students worked on their projects, supported by the supervisor.
- As an end goal for the midway seminar, the students were asked to create an initial problem analysis, as well as a plan for their work until the project seminar.
- The students also were introduced to online collaboration tools.
- As a goal for the virtual collaboration period, the students were required to create a preliminary presentation for the project seminar, which should be uploaded a week before the start (so it could be reviewed by other students, supervisors and company representatives before the seminar).
- During the project seminar, the first day was dedicated to feedback: Each group presented their preliminary report in front of an audience consisting of other groups, supervisors and company representatives. The remaining days focused mainly on students finalising the projects and presentations, but included also excursions and joint sessions.
- During both seminars, some focus was put on presentation training - both for individual and group presentations. This included video recordings of presentations, followed by feedback.

The flow of the project work, including a high-level overview of the seminar programs is shown in the figure below.



The flow of the COLIBRI project work - year 1.

The exam was held at the end of the seminar. It was an oral group examination based on their project presentation, with around one hour allocated per group: Approximately 25 minutes for presentation and 25 minutes for discussion/examination. Each student received an individual assessment (pass/fail). As a base for the exam, each group would submit their presentation together with a 2-page learning reflection report before the exam. All other students participated in the session as well, so they could hear the presentation and discussions, and also participate in the discussion once the official examination was over.

#### Year 1 - Tools and Platforms used:

- Moodle was used as a learning platform. All students were registered with access to Moodle.aau.dk, and Colibri was established as a single course.
- Videos for video lectures were uploaded and accessed either directly in Moodle, or (in most cases) accessible through Youtube.
- For project work, the students in each group were free to choose the platform(s) according to their preferences. We did make some tools available such as Adobe Connect and Mahara, but it turned out that most students used tools they were already familiar with, e.g. Google Docs and Google Hangouts, Dropbox, Facebook and Skype.
- A closed Facebook group was used for the general communication about the course.
- For the kick-off meeting in the first year, pre-recorded videos of project presentation and student presentations were used, then a “real-time” meeting took place using Adobe Connect, and finally Kahoot was used as a platform for online quiz-based games - both to spread knowledge about the course in a gamified way, and for the students to get to know each other better.

#### Results and experiences from year 1 - Modules

As the modules were implementing the different components to different extents and in different ways, the quantitative and qualitative evaluations also varied from module to module (these statistics are all available as part of the modules on the COLIBRI website).

With this in mind, we would still present the activities that most students found to be either “efficient or very efficient” in the table below. It is important to notice that those with a low score often had many answering “Not applicable / did not use”, and as such indicates that this was not used by the students of this module. Nevertheless, it provides an insight into what worked really well.

Module number	1	2	3	4	5	6	7	8	9	10
Module satisfaction	79	94	86	86	89	85	82	100	82	93
Module overall	72	71	63	57	75	64	48	93	57	85
Introductory level	59	79	57	72	79	71	55	96	65	90
Video lectures	55	78	56	50	71	60	50	100	67	81

Questions/quiz material	54	43	66	34	63	43	35	90	50	71
Q&A forum	21	18	19	18	18	15	11	29	25	15
Self-study activities	68	22	42	46	57	36	38	75	36	48
Peer learning activities (basic+adv. stud only)	24	0	27	36	38	57	18	50	20	33

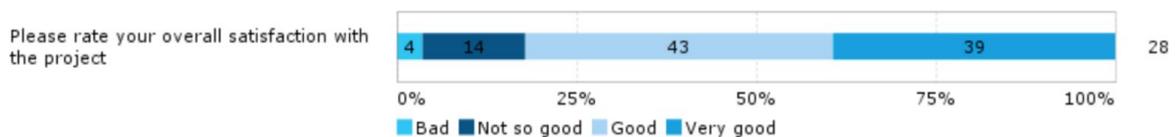
Year 1: Percentage of students rating the learning efficiency of the different elements to be either "efficient or "very efficient". Green marks a score of at least 50%.

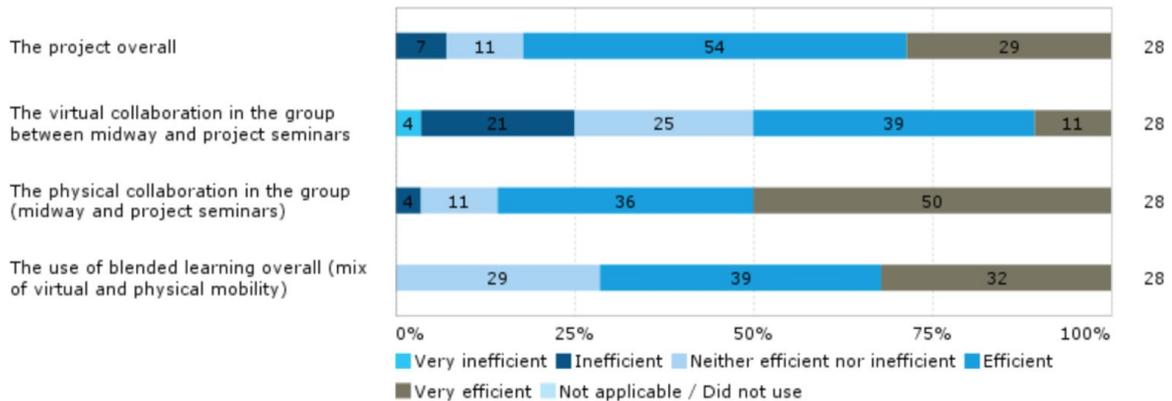
The overall evaluation of the modules taking into account qualitative and quantitative evaluations can be summarised as follows:

- The modules were generally well received by the students.
- The video lectures, quizzes and to some extent self-study activities received the best rating from students.
- Short videos of 5-10 minutes seem to be the ideal size, especially if combined with quizzes whereby there is a short quiz after each video.
- We need to be more precise about what is expected from group exercises and peer learning, e.g. any kind of facilities that are required for collaboration between students - especially when that collaboration requires the students to synchronize their work through e.g. joint meetings. Just saying that "students should form groups" is not enough - it should be clear exactly who is doing what - otherwise it might never happen.
- Peer learning is a good idea, but needs clear instructions and guidelines.
- With no physical interaction between students and teachers at the beginning of the modules, it must be very clear and explicit what the students are expected to do (with hindsight, having a way for students and teachers to follow their progression through the modules would have been very beneficial).

## Results and experiences from year 1 - Projects

In general, the project work with both interdisciplinary and international aspects was the most well received part of the COLIBRI course. The figures below illustrate the students' satisfaction with the project as a whole as well as the different elements of the course.





Students satisfaction with the project and evaluation of learning efficiency of different elements - year 1.

We see that the students are generally happy about the project work, as 82% of the students rate their satisfaction as either good or very good. However, the numbers are a bit more mixed when it comes to evaluating the efficiency of the different elements. The physical collaboration between the seminars received a very good rating with 86% finding it either efficient or very efficient, whereas only 50% of the students found the virtual collaboration to be efficient or very efficient – something that probably contributed to the mixed scores of the overall evaluation of the blended mobility.

The qualitative evaluations were generally positive as well. That said, critical comments included indications that some of the students found the projects to be unclear (or very open), that it was in some cases hard to relate modules and projects, and that it would have been an advantage to form the teams earlier.

In general, we found that it would be an advantage to let the seminars focus more on project support and less on modules, which is also reflected in the program of the midway seminar during the second year.

### Results and experiences from year 1 - Platforms

- Moodle seems to be acceptable and suitable for courses, and allows for some interactive content. However, several shortcomings were also identified: The user interface does not provide a good user experience. The support for personal learning tracks is not good, since all content is shown to all students, so it is hard to keep an overview of what each individual should do. Activity tracking and completion could be a good help. While Moodle does allow for guest access, guests can only access limited content - not including the interactive quizzes. Finally, Moodle does not support project work in groups, so another platform is required for e.g. group communication, document sharing and time/task planning.
- For general communication Facebook has advantages as well as disadvantages. The advantages include the fact that almost everyone is using it, and that it works well on all platforms including computers, phones and tablets. As most students have it on their phone, this makes it a fast and reliable way of spreading information. However, using it as a platform in our case also had disadvantages: If there were many posts

during a short time span, messages would disappear and/or be forgotten. Also, the way files are stored and displayed is quite messy.

- As a more general note, we found that having too many platforms would be too confusing, especially for a project in which the students are only engaged “part time”, and it would be too easy to forget the activities going on in each. Therefore it is essential to keep the number of platforms used to a minimum. A particular challenge with Moodle was that notifications are only sent to “\*.aau” email addresses, which the non-AAU students did not read regularly. As such, email and Facebook were the media that could be used for communication with the students.
- Tools such as Adobe Connect and Skype worked well e.g. for supervisor meetings with smaller groups of people (usually with just one person per location). For larger meetings such as the kick-off (with around 40 people in 10 different locations) quality problems were noticeable. Kahoot worked well, but some tolerance to chaos had to be applied.
- For video platforms, we found both Moodle and Youtube to work well. However, Youtube comes with the advantage that it works well across numerous platforms including mobile phones, tablets, and across the different operating systems used by students - something that was appreciated by the students, as it makes the videos available from anywhere. On the other hand, Moodle allows the students to download the videos and watch them offline - but the students did not make use of this feature. While Youtube videos integrate nicely into Moodle and other learning management systems, it does not support interactive videos and interactive content without adding this as an additional layer.

## **Year 2 experiences**

This section is as for the previous year divided into four parts: Modules, Projects, Tools/Platforms and Results. The Results part is again organised into Modules, Projects, and Tools/Platforms.

### **Year 2 - Module Structure and Content**

Each module consisted of three levels: Introduction (1 h. workload), basic (5 h. workload), and advanced (10 h. workload). Each student was required to follow all the modules at introductory level (10 modules), four modules at basic level, and of these four two at advanced level. This adds up to 60 hours - in addition to these comes 2 hours allocated for preparing a presentation for the Midway seminar.

Compared to the previous year, this implies a higher level of specialisation: The workload of one advanced module is increased, so a student following an advance module has essentially studied this topic for  $1+5+10=16$  hours. On the other hand, the number of advanced modules per student has decreased, which also makes it easier to carry out the synchronised collaborative tasks among students.

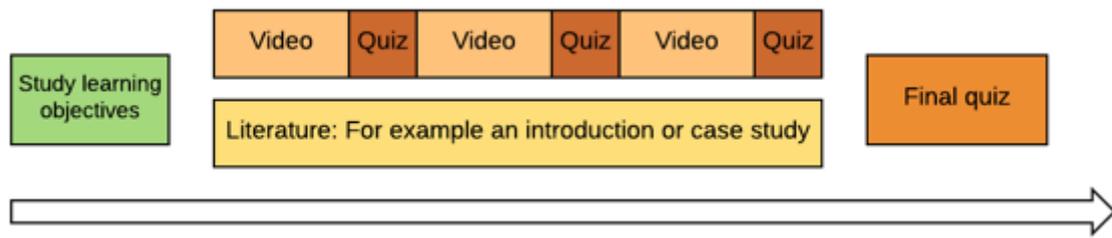
The form of the module was kept within the description from the previous year, as focus was on improving the implementation based on the experiences from year 1. However, all activities that required synchronisation/collaboration between students (such as peer learning activities) would now take place only in the advanced module. In this way we could reduce the complexity and planning associated with these activities.

Another difference was that the students would coordinate the module choices in the groups (partly to have earlier interaction in the groups, and partly to ensure that all modules were covered as in this setting each student would follow fewer modules).

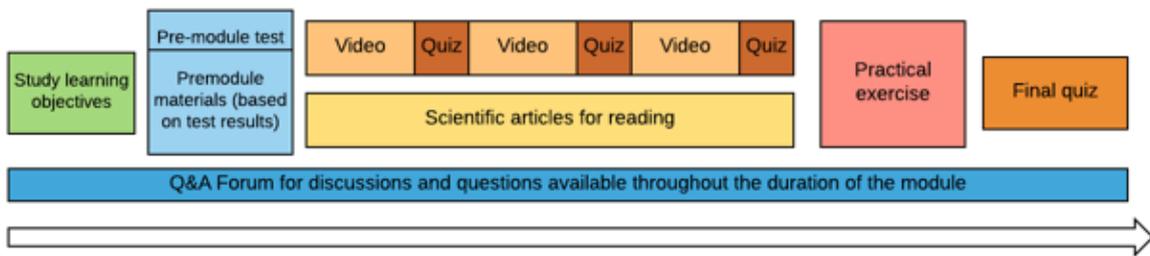
A main difference was that the whole course organisation/presentation in Moodle was adjusted: Each level of each module were now set up as separate courses (except that all introductory modules were one course), it was very clear when a module was considered finished (usually through a final quiz), and completion tracking was enabled. Moreover, when creating the modules we were very much aware of making all tasks clear and explicit - so all in all, the students would know exactly what to do.

Also, more individualisation was introduced as all basic modules now contains both a self-assessment test and preliminary study material, so it was possible to “enter” the course with different prerequisites. The use of Q&A forums was also standardised. In general, the students would this year meet a more smooth and coherent experience, with more standardisation between the modules based on what worked well in the first year - especially regarding the mix of short videos and quizzes.

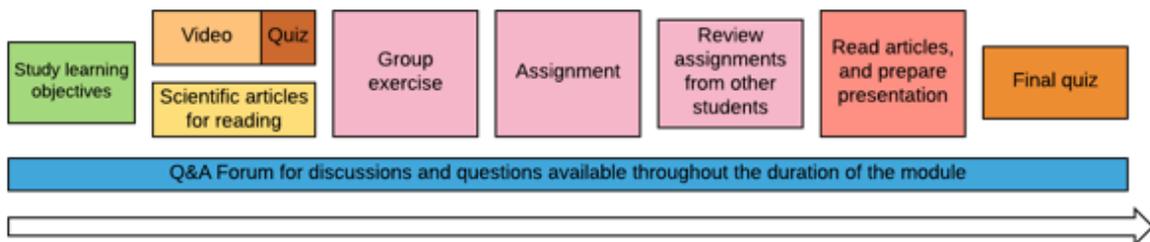
The following figures exemplify the standardised structure of modules during year 2, but still with room for some differences between the modules:



An example of an introductory module (1 hour workload) - year 2.



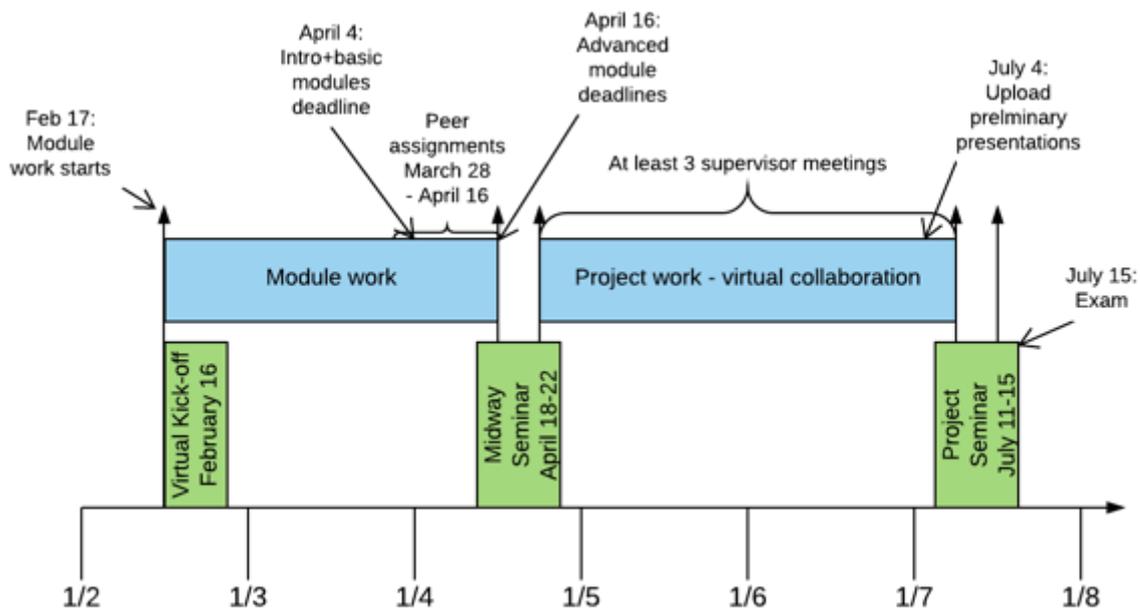
An example of a basic module (5 hour workload) - year 2.



An example of an advanced module (10 hour workload) - year 2.

Modules were finished in a more conference-style setting with two parallel tracks. Each student had prepared a short presentation from one of his/her advanced modules. This replaced the more “lecture style” approach of the first year.

During year 1, we had deadlines for finishing introductory, basic and advanced modules, but not for internal activities within the modules. Especially given the large number of modules taken by each student - and the lack of ability to send out reminder to students specifically following one activity - this again turned out to be rather confusing. So for year 2, we created a graphical timeline which also included e.g. the timeframe for peer assignments of all advanced modules. The figure of this is included below:



The flow of the COLIBRI course - year 2.

### Year 2 - Project and project support:

Based on our experiences from year 1, we wanted to give the project work higher priority during the Midway seminar. This was done partly by reducing the day for module work to one day, partly by having in mind that all activities were designed to support the project work. Moreover, the company representatives (who were not present in year 1) participated in a co-located management meeting, which made it possible for them to discuss the projects with students and clarify any necessary details regarding these.

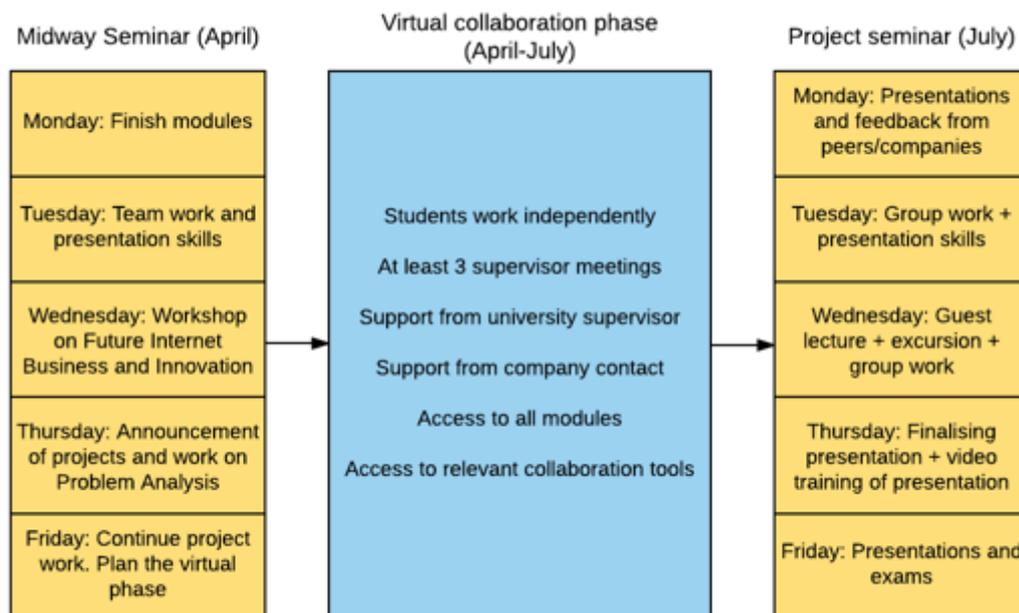
As in year 1, the project proposals were discussed during the teacher training seminar in November. The discussion this year was more concrete, and the project proposals more mature already at this stage: In this way it was possible to identify at least 3-4 modules that would fit well with each project proposal. A list of such matches was also useful when forming the groups as described below.

Some of the changes compared to the previous year are highlighted in the following:

- The groups were announced already during the virtual kick-off meeting. This made it possible to use the Kahoot-based competition as an exercise in the groups that would work together throughout the course.
- Another aspect where the groups were working together was with respect to the choice of basic and advanced modules: The groups this year would have a virtual meeting with the coordinator to discuss their module selection and ensure a broad coverage within the groups. Also just the fact that the students would meet and discuss their profiles would contribute to them getting to know each other before the midway seminar.

- The distribution of projects between the groups was done by the coordinator, matching as good as possible the module choices of the groups with the modules identified for each project proposal.
- As already mentioned, the project seminar focused this year more on supporting the project work. Another change to support the group work better was to do the team building activities in the project groups - even if it meant less activities across the whole class of students.
- To help the students get a good start on the virtual phase, each group was asked to present their preliminary problem analysis for the rest of the students, together with a plan for the virtual phase. Also we provided templates for project group meetings and time plans, and we set out guidelines for supervision which were discussed among the supervisors during the midway seminar.
- We also provided the students with a more elaborate introduction to various online collaboration tools.
- As for year 1, each group had to submit a preliminary presentation one week before meeting for the project seminar.

The examination was held as in the previous year. However, to have more time for breaks/transitions and discussions it was held in two tracks, and students would follow the examinations of half of the groups.



The flow of the COLIBRI project work - year 2.

### Year 2 - Tools and Platforms used:

Moodle was again used as the main platform for modules and projects. As also mentioned in the previous section, we did a number of modifications in the way the course was organised. The fact that students only saw the activities they actually had to complete, together with the use of completion tracking, made the appearance look quite different.

Facebook also saw improvements in terms of fixing some of the weaknesses from the first year. In particular the possibilities for organising documents had improved, making it less messy.

### Results and experiences from year 2 - Modules

As the modules were implementing the different components to different extents and in different ways, the quantitative and qualitative evaluations also varied from module to module (these statistics are all available as part of the modules on the COLIBRI website).

With this in mind, we would still present the activities that most students found to be either “efficient or very efficient” in the table below. It is important to notice that those with a low score often had many answering “Not applicable / did not use”, and as such indicates that this was not used by the students of this module. Nevertheless, it provides an insight into what worked really well.

Module number	1	2	3	4	5	6	7	8	9	10
Module satisfaction	93	97	90	97	100	93	90	100	76	94
Introductory level	89	97	72	80	86	89	73	96	73	89
Basic level	88	80	88	87	91	70	76	100	75	93
Advanced level	40	67	86	72	85	50	100	100	88	78
Video lectures	62	82	72	65	72	79	73	96	55	79
Questions/quiz material	72	76	69	63	79	80	79	86	59	79
Q&A forum	31	34	20	21	31	31	28	35	31	28
Self-study activities	55	55	52	45	58	51	58	76	45	75
Peer learning activities (basic+adv. stud only)	13	84	14	43	57	25	25	0	38	78

Year 2: Percentage of students rating the learning efficiency of the different elements to be either “efficient” or “very efficient”. Green marks a score of at least 50%.

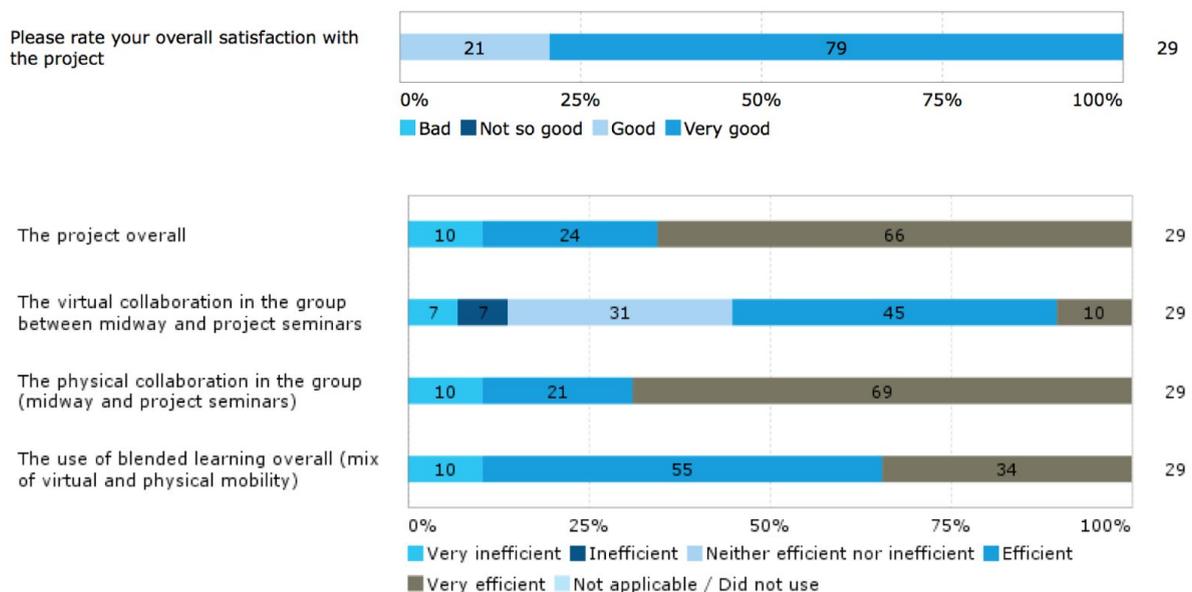
In the following we highlight our overall evaluations of the modules taking into account both quantitative and qualitative evaluations:

- The modules generally worked well, and was improved significantly in the 2nd year. In particular, the expectations and activities were much more clearly formulated, and the amount of activities requiring the students to collaborate was reduced to two advanced (but larger) modules.
- Progression tracking, more individualized setups (students could only see the modules they chose), clear formulations of tasks, and clear conditions for finalizing each module helped improve the students experience.

- The structure with short videos and quizzes was again well received this year, and generally received even more positive feedback than in the first year.
- On the other hand, peer learning received quite mixed evaluations. The students felt it is a good idea, but it needs very clear instructions and guidelines (e.g. it is hard to self-organize). The numbers also reflect many “not applicable” as it was only used in some basic/advanced modules.
- Self study activities generally received better evaluations than in the first year, but also here it is important with clear descriptions, instructions and goals. It is not sufficient to ask students to e.g. read an article if there is no follow-up activity such as quiz or assignment.
- As for the first year, it was very hard to create an activity in the discussion forums of Moodle.
- Even if we managed to create good relationships between modules and projects, this relationship could have been more visible for the students.

## Results and experiences from year 2 - Projects

We obtained statistics on the same parameters as in year 1, which can be seen below. According to these, it is clear that the students were even more satisfied with the projects in general than for the previous year, something that we also recognized in the qualitative evaluations.



Student satisfaction with the project and evaluation of learning efficiency of different elements - year 2.

The fact that 79% of the students found the project to be very good, and that the remaining 21% found it to be good, tells us that the changes we made compared to the previous year had worked well. We can also see in the qualitative evaluations that the different adjustments all contributed to this. Digging into the more detailed statistics, we see that the project overall and the physical collaboration during the seminars received very good evaluations, the evaluation of the blended learning overall was also quite good, and that the

virtual collaboration between the midway and project seminars was the weakest point. However, the virtual collaboration between the seminars worked better in the second year than in the first year – early formation of groups and more focus on team work processes in the midway seminar helped in this.

Looking into the qualitative evaluations, only very few critical comments were given to the projects. One student mentioned that more contact with the supervisor during the virtual phase would have improved it, while another student felt that the topics of the modules could fit better with the project proposals. The evaluations were discussed between teachers and students, and we developed an understanding that while the students thought they were well on track after the midway seminar, it was quite hard to get started on the virtual phase. Reasons for this also included that different students have different schedules, so exams and other time consuming activities make it hard for all students in the group to contribute at the same time.

Regarding the seminars, the value of the presentation technique training was mentioned again and again by the students, both in written and oral evaluations.

### **Results and experiences from year 2 - Platforms**

- We found that the different organisation of modules in Moodle, together with the introduction of completion tracking, was a major improvement in the experience of both students and teachers.
- On the other hand, we again experienced that the user experience was let down by the user interface in Moodle which could be hard to grasp. Also, the other weaknesses pointed out during the first year still remained.
- For the general communication, the experience with Facebook was comparable to that of last year - but some improvement was noticed regarding the file sharing capabilities.
- The students this year tried out different platforms to support the project work (Adobe Connect, Skype, Google Hangouts and BigBlueButton). However, there was again some frustration that none of the tools available provided all the tools needed for the project such as document management, remote meetings, messaging etc. Among the tools provided there was no clear winner - all had pros and cons. The feedback was that it would be ideal for one platform to support both project work and modules.
- For the virtual kick-off meeting we asked the students to see a pre-recorded introduction to COLIBRI (it was made available on Youtube), but we experimented with real-time communication during the presentation round. Our conclusion is that even with a professional tool such as Adobe Connect, having many (2-10 per location) in many different locations (9) is challenging and will not work out smoothly.

### **Year 3 experiences**

Being the last year, we generally wanted to focus on improving the aspects that left room for improvements during the previous years. In particular, it was decided to have four focus points:

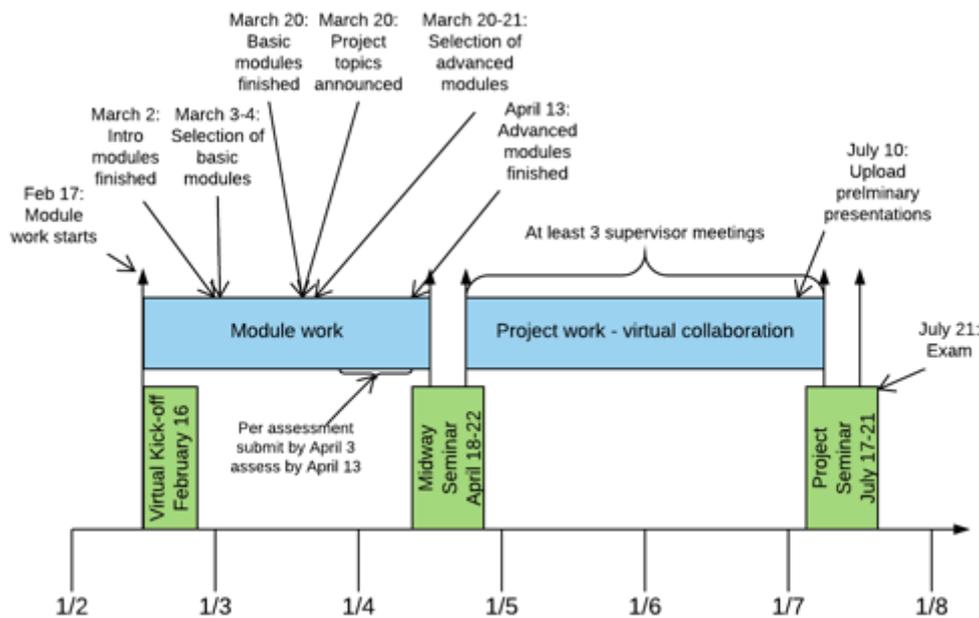
- To improve the modules in terms of the peer learning activities as well as the interaction between students and teachers (forums).

- To improve the relationship between modules and projects, or at least make this relationship more visible.
- To improve the students' experience with the virtual part of the project work.
- To improve on the offering of individualised learning paths.

### **Year 3 - Module Structure and Content**

We generally kept the same structure as for year 2, but with the following changes:

- A more coherent presentation of introductory modules. In fact these were now presented as a single course in Moodle, and all introductory modules had the same kinds of elements, and a quiz would mark when each introductory module was complete.
- The choice of basic and advanced modules was again done in the groups. However, advanced modules were not chosen before the basic modules were finished.
- The project topics were announced and distributed already when the basic modules finished, and before the students chose their advanced modules. In this way, the assignments and peer learning tasks could be related to the project domains.
- Peer learning was discussed during the teacher training seminar ("How to make peer learning work?"), and a template/guideline for the peer review was developed. In this way the different peer learning tasks would follow the same structure. The template was designed so it was very clear what was expected from the students. To further harmonize the tasks, all peer learning activities would have the same dates for submission and assessment, as can be seen in the course flow below.
- To overcome the previous challenges of not using the forums in Moodle, and to further integrate modules and project work, it was decided to move these discussions to the new Humhub platform, which would also be used for the project work. The platform is described later in this report.
- Also, a more standardized set of requirements for the pre-module test and provision of pre-study materials was provided in order to support the individualised learning paths.



The flow of the COLIBRI course - year 2.

### Year 3 - Project and project support:

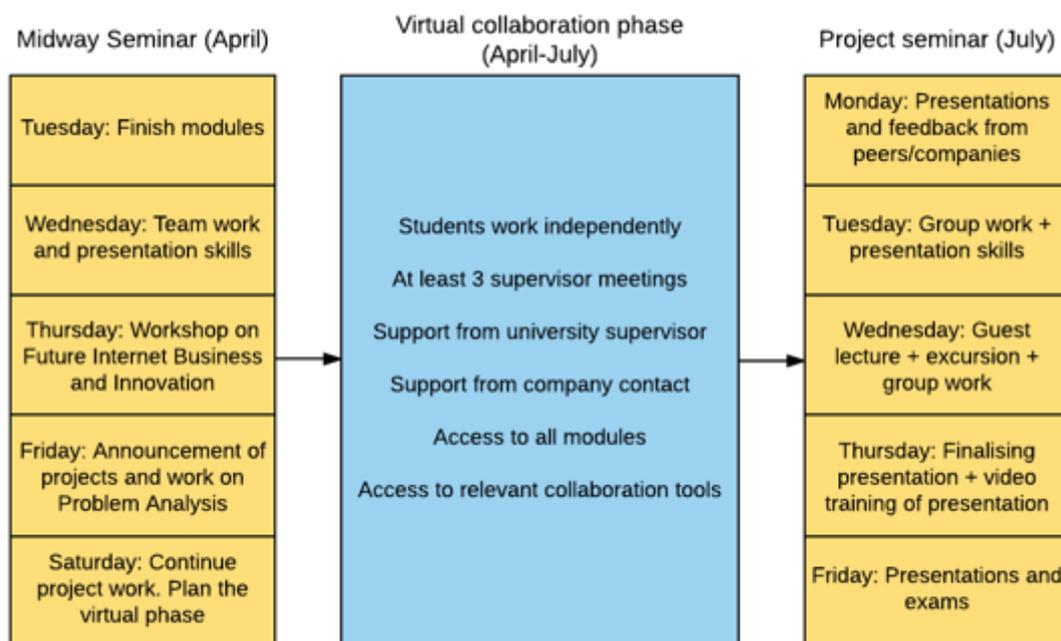
The main changes related to the project work aimed at (1) creating a better connection between modules and projects and (2) to improve the students' perception of the virtual collaboration phase. This was done through the following changes/adjustments:

- As mentioned in the description of modules, the groups were announced by the virtual kick-off meeting, and project topics were announced before the choice of advanced modules.
- The general structure of the midway seminar was kept, with every activity during the last four days designed to support the students in getting a good start on the project work, and a good preparation for the virtual phase.
- More time was allocated for group discussion and problem solving during the workshops on teamwork, collaboration etc., and these activities were also done earlier in the seminar. Also, many of these activities resulted in tangible outcomes (e.g. time plans and collaboration agreements) that would help them during the virtual phase.
- To ensure the students would get a good problem understanding, more supervisor meetings were scheduled (not only by request from the students), and additional activities where students could discuss their problem with different teachers/supervisors/company representative were held, such as panel discussions where students had to prepare questions related to their projects. Also, there was time included in the schedule for all teachers and company representatives to pass round in the groups and discuss various aspects of the projects/problems.
- During both the teacher training and midway seminars, the exchange of good supervision practices was a theme - a short set of guidelines were developed, but

most importantly supervisors learned from the discussions with each other. The particular focus of the discussions during the midway seminar was how to give the groups a good start for the virtual phase.

- At the end of the midway seminar, the students were asked to prepare specific plans – including meetings and milestones for the virtual phase. Supervisors also made a stronger effort to ensure that the plans were sufficiently substantial and specific.
- The students were also provided with templates to be used for task descriptions, meeting minutes and time plans.
- During the virtual phase, it was required that each group should submit a short status report to their supervisors every second week, and that there should be at least three supervisor meetings during the virtual phase. These requirements were introduced along with the other project requirements, and announced during the midway seminar.

As can be seen in the figure below, the structure was quite similar to that of year two.



The flow of the COLIBRI project work - year 3.

### Year 3 - Tools and Platforms used:

For the modules, Moodle was again used with a similar structure as for year 2. However, the content was created and presented using various new tools:

- A new theme was setup, including the COLIBRI logo. While this only impacts the layout and design, it provided a much smoother and intuitive user interface.
- Bootstrap elements were used to further improve the user experience (for example, dropdown elements allowed for hiding large amounts of text).
- The H5P plugin was installed on the Moodle platform and used in several modules. This plugin makes it possible to add many different kinds of interactive content, such as interactive videos where the H5P plugin adds a layer on top of videos playing from

e.g. Youtube. In our setting it was mainly used for interactive quizzes: The advantage over the quiz functionality in Moodle is that the video and quiz appears in the same window: The student is watching a video, at a predefined time a quiz is shown and the video pauses, and once the student has correctly answered the question(s) the video simply resumes.

- Finally, a standardized setup was used between the modules for assignments and peer reviews - by having this set up in the same way for all modules, we would reduce complexity for the students.

For general communication, seminars, project work and discussions of modules, a new platform (Humhub - see [www.humhub.org](http://www.humhub.org)) was installed and used. Humhub describes itself as a flexible open source social networking kit, and in many ways the user interface is similar to that of Facebook which makes it intuitively easy to use. Compared to Facebook it appears more professional, and offers good collaboration possibilities through the use of spaces (which can be closed or open, and allows for file sharing, a calendar, wiki pages, link lists, meetings, tasks and polls) . We were also able to host it ourselves, which gave a better control of the data provided. We created a general space and a social space for everyone to use, as well as specific spaces for each project group and for each module to be used instead of the forums in Moodle.

### Results and experiences from year 3 - Modules

The modules generally worked well, and was improved further in the 3rd year: In general it was more clear what was expected, and the more homogeneous presentation was well received (even if it became clear that the students still perceived the modules as quite different).

As the modules were implementing the different components to different extents and in different ways, the quantitative and qualitative evaluations also varied from module to module (these statistics are all available as part of the modules on the COLIBRI website).

With this in mind, we would still present the activities that most students found to be either “efficient or very efficient” in the table below. It is important to notice that those with a low score often had many answering “Not applicable / did not use”, and as such indicates that this was not used by the students of this module. We also found that there are some variations from year to year, so even very similar material could get quite different ratings - especially in the basic and advanced parts where there are few participants, so each participant has a big impact.

Nevertheless, it provides an insight into what worked really well.

Module number	1	2	3	4	5	6	7	8	9	10
Module satisfaction	86	97	100	79	96	93	93	100	69	86
Introductory level	79	89	79	72	83	90	66	100	66	72

Basic level	67	72	75	69	100	89	77	88	100	100
Advanced level	75	100	100	76	60	50	33	100	50	100
Video lectures	62	96	86	59	86	79	58	93	69	75
Questions/quiz material	76	72	79	58	87	76	62	96	69	76
The space in Humhub	24	24	13	13	24	24	17	31	13	24
Self-study activities	66	69	58	55	65	58	48	72	38	66
Peer learning activities (basic+adv. stud only)	25	33	57	25	100	60	100	66	50	38

Year 3: Percentage of students rating the learning efficiency of the different elements to be either “efficient” or “very efficient”. Green marks a score of at least 50%.

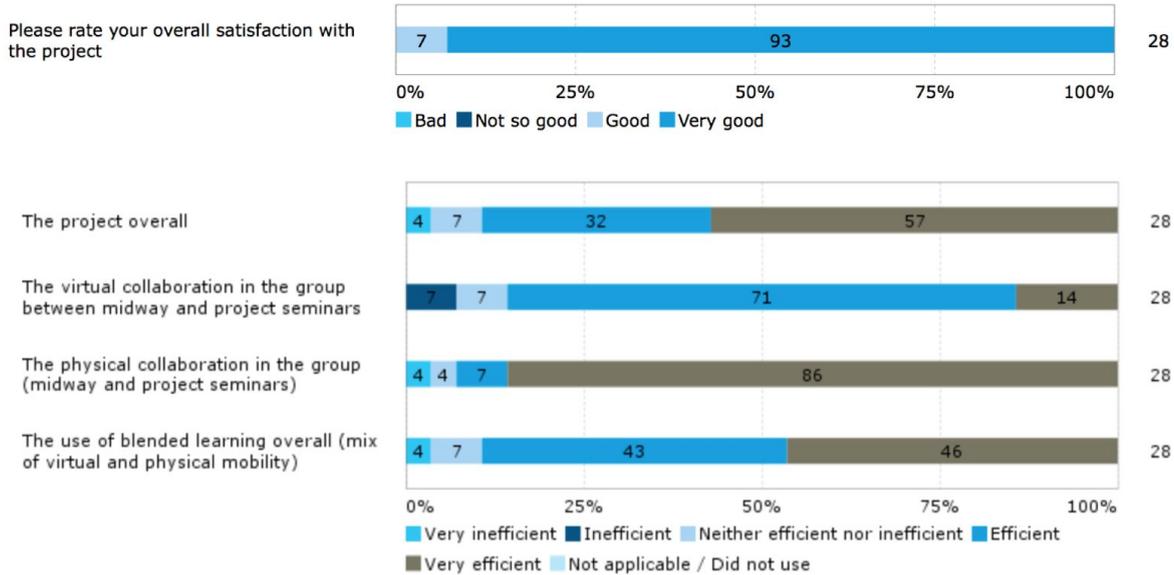
The peer learning activities received more positive comments in the previous years, but still with some challenges, both technically and content wise. Technically, we experienced some challenges in setting it up correctly in Moodle, which in some cases delayed submission, reviews or final assessment. However, once we became aware of such a problem it was easy to fix. With respect to the content, the feedback from the students underline the importance of not having peer assessments just for the sake of peer assessments: These should always be followed by an explicitly formulated learning goal.

Based on the feedback and comments from students, it is also our impression that the modules were more helpful for the students than in the first years, and that the efforts in creating a better link between modules and projects worked well - even if some projects still had a better fit to the modules than others.

Finally, using Humhub for discussions of the modules resulted in slightly more activity than with Moodle in the previous year; In some modules a few discussions took place, but in most cases just questions to and answers from the teachers. In other modules there was no discussion activity. For all modules, the students were asked to upload the midway seminar presentations of advanced modules to Humhub, but this only sparked discussions in a few cases.

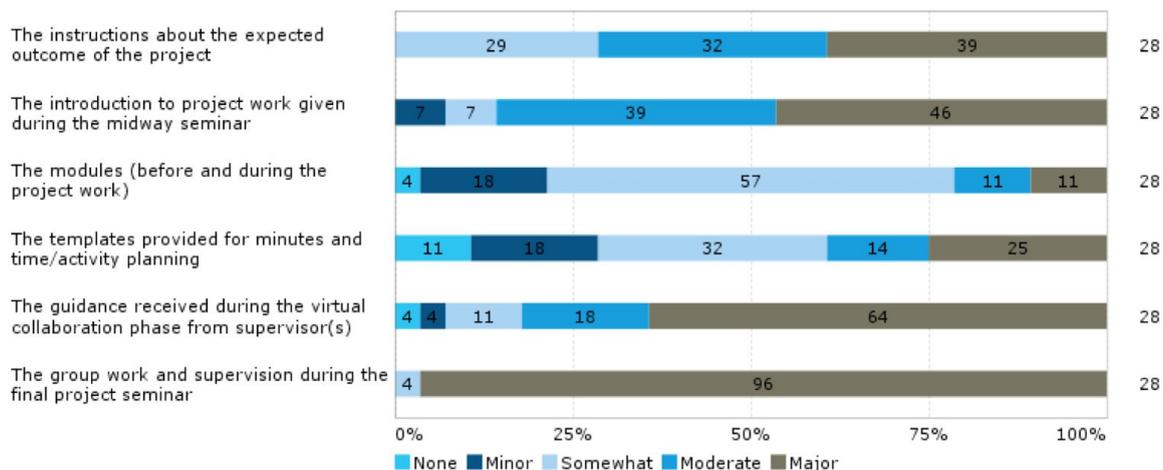
### **Results and experiences from year 3 - Projects**

We obtained statistics on the same parameters as in years 1 and 2, which can be seen below. We see again an increase in students' satisfaction, and we were quite happy to see that even the evaluation of the virtual collaboration phase and blended learning overall has reached a high level - especially as this was a main focus point of this last year.



Students' satisfaction with the project and evaluation of learning efficiency of different elements - year 3.

In order to understand which kinds of support had been most important for the project work, we asked the students to indicate the effectiveness of the different elements. the results can be seen in the figure below.



Students' evaluation of learning effectiveness of different elements of the project - year 3.

It is clear that the project work and supervision during the final project seminar received a very high score, and that the modules seemed to play a lesser role. The evaluation of the other elements is more mixed. The templates provided were not used by all groups, but it was our experience that those who used them found them rather useful. Otherwise, we believe the survey demonstrates that supporting the project work in a blended setting such as the COLIBRI course really requires a good amount of support from beginning to end.

As in the other years, a very common comment from the students in the written and oral evaluations was that the experience of working in international and interdisciplinary teams on solving a real-world problem had been very positive.

One comment that we saw from more participants (teachers, company representatives, and students) was that the projects were “too small”: More substantial projects would allow for more technical depth, and also create more value for the companies.

### **Results and experiences from year 3 - Platforms**

The changes in Moodle were positively received by the students. More specifically:

- Students with previous experience of Moodle found the updated user interface to be more user friendly (change of themes and use of bootstrap elements).
- Students were happy with the use of the H5P plugin, but also made us aware that it only works when logged in (it does not allow for guest access). When directly questioned if H5P was preferred over the usual Moodle quizzes, the replies indicated that it depends on the topic and what makes sense from a learning point of view.
- Some of the positive trends in the modules’ evaluation also reflects the improved user experience.

The students were generally happy with Humhub, and it provided a good base for the project work even if we were missing functionalities regarding online meetings. The mix of social media platform and professional collaboration tool seemed efficient, and the students also found it to be more supportive in the project work than Facebook. We noticed that the students were much more active in Humhub than they had been in the Moodle forums during the previous years, but less active than on Facebook (and with usually longer response times). The fact that Humhub would send out email notifications also contributed to relatively quick interaction when something happened.

However, we also noticed some flip sides compared to Facebook:

- There was no app, which could push notifications on mobile devices (and the user experience was mainly geared to devices larger than phones). Also, students would usually check up on Facebook activity more often than they would check the Humhub platform.
- Even if instant messaging was supported, messages and discussion threads would not update automatically. So to participate in a chat-alike discussion it was necessary to manually update the website all the time.
- One of the big advantages of using a Facebook group was that the students would create links and “Facebook friends” across the group, which would last even after the project - and the groups would remain, sometimes with active members. This has not been the case with the groups in Humhub, as the students did not use it after the project ended.

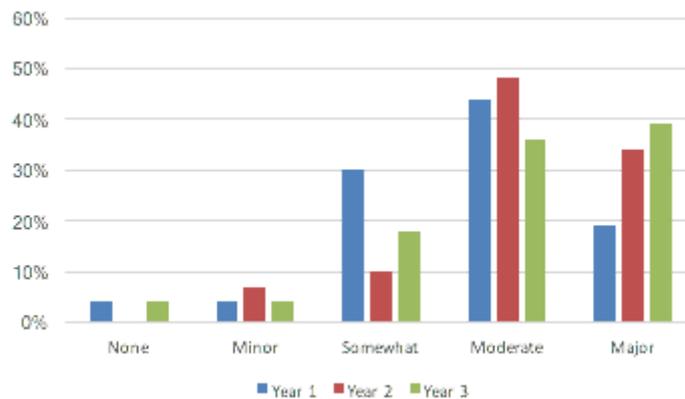
## **Summary of overall experiences and results**

This section is divided into two parts. First we present the overall evaluations, and second we provide the take-away messages from modules and project work.

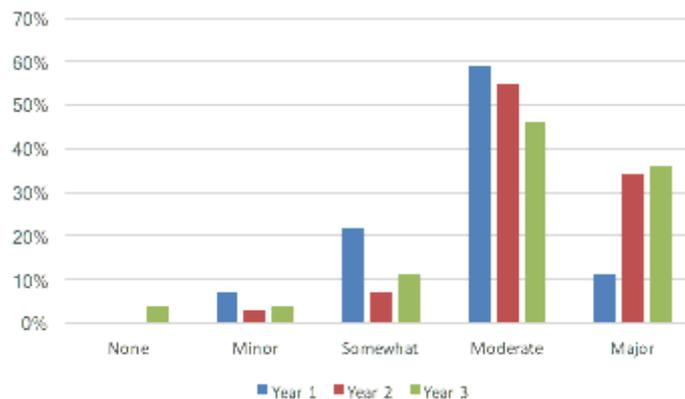
### **Overall evaluations**

Each year, a survey was made among all participants. They evaluated not only the specific COLIBRI experience, but also to what extent the teaching methods used in COLIBRI would improve the quality and relevance of the educational system, and what impact participating in the COLIBRI project had on them.

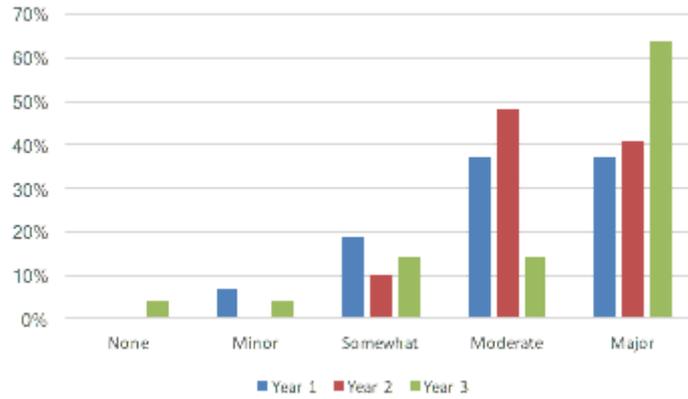
The statistical evaluations from the students are presented in the following three graphs:



Students: To what extent do the teaching methods used in COLIBRI increase the quality of the learning offer?



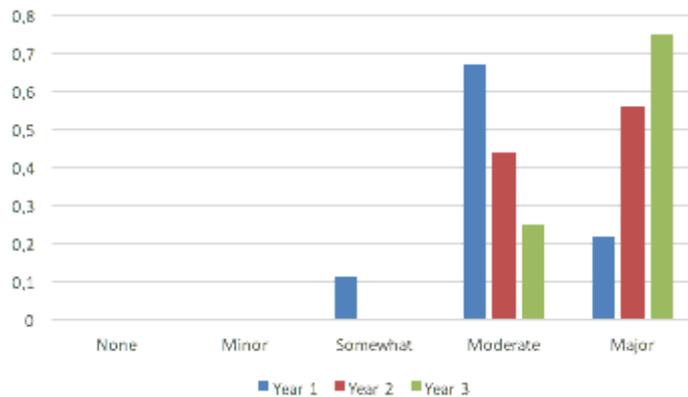
Students: To what extent do the teaching methods used in COLIBRI increase the relevance of the learning offer?



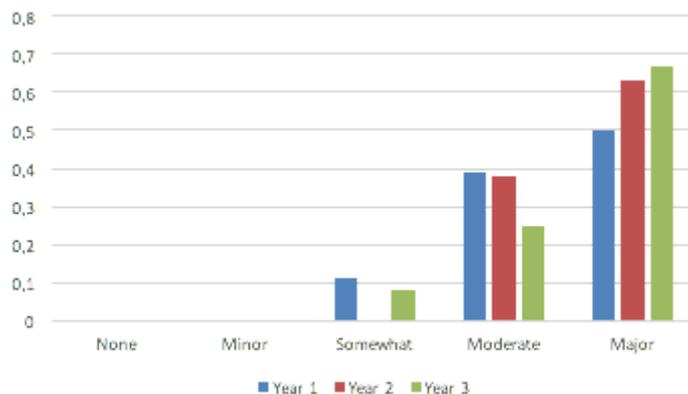
Students: To what extent do the teaching methods used in COLIBRI increase the labor market relevance of learning provisions and qualifications?

For all three points, the trend has been positive throughout the three years: Last year 75%-82% of the students answered these questions with “moderate” or “major”.

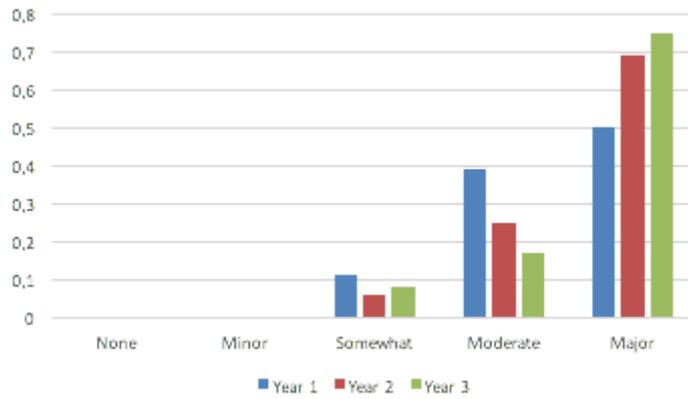
The teachers and company representatives are similarly positive as can be seen in the following figures:



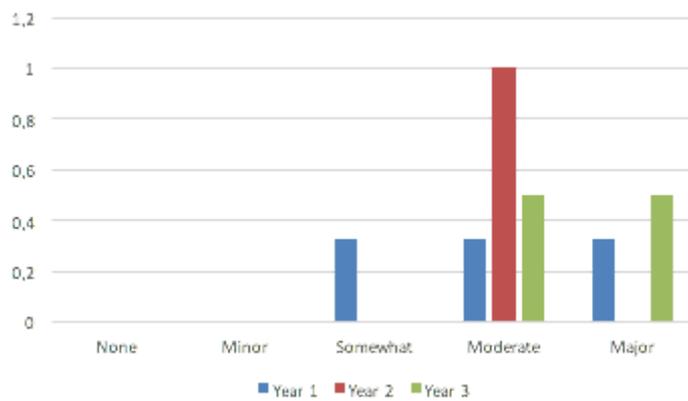
Teachers: To what extent do the teaching methods used in Colibri increase the quality of the learning offer?



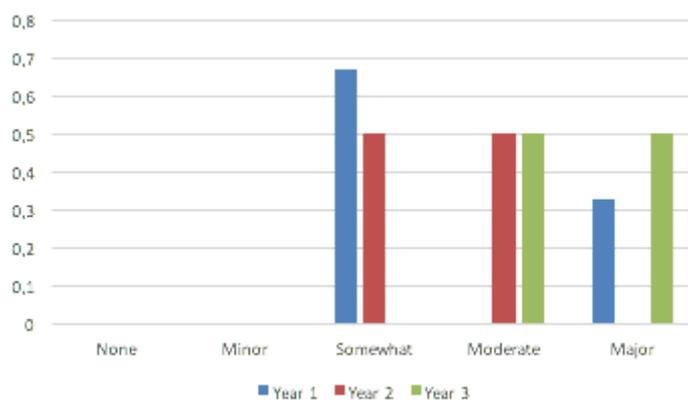
Teachers: To what extent do the teaching methods used in Colibri increase the relevance of the learning offer?



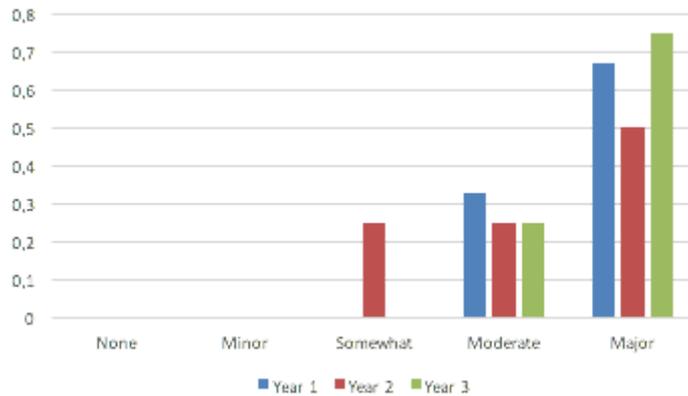
Teachers: To what extent do the teaching methods used in Colibri increase the labor market relevance of learning provisions and qualifications?



Companies: To what extent do the teaching methods used in Colibri increase the quality of the learning offer?

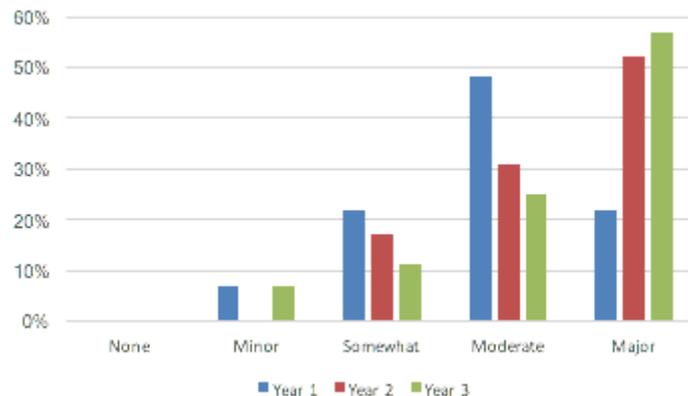


Companies: To what extent do the teaching methods used in Colibri increase the relevance of the learning offer?

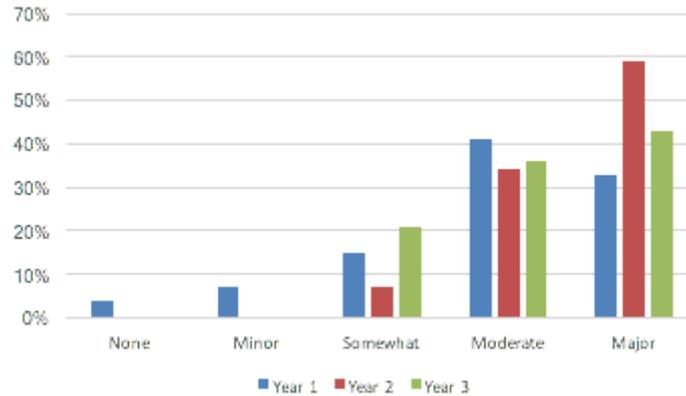


Companies: To what extent do the teaching methods used in Colibri increase the labor market relevance of learning provisions and qualifications?

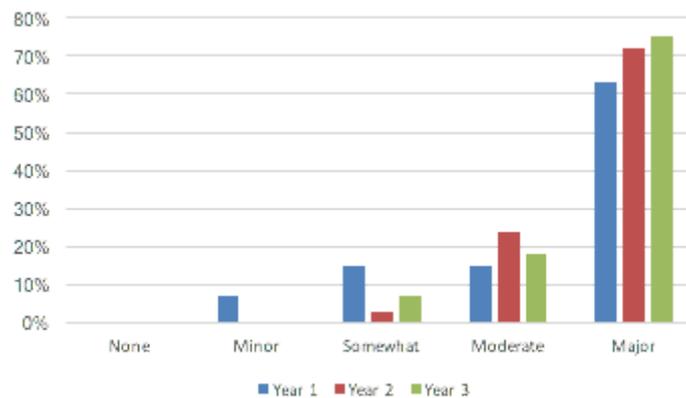
For the students, we also evaluated their personal opinion of their participation, and the responses were quite positive - especially when it comes to how well prepared they felt for the international labour market. In the last year 93% of the students found that the course had made them better prepared for the international labour market to a “moderate” or “major” extent. The results demonstrate not only that we improved a bit from year to year, but also that the students were generally very satisfied with the approach taken through both course modules and the project work. When digging into the comments the students gave for the modules, they were happy about the flexibility it provided and the possibility of “going back”. For the projects they were especially happy about the international and interdisciplinary aspects, and about working together on real-world problems.



Students: Personal outcome: To what extent do you think the teaching methods used in Colibri will help you in your further studies?



Students: Personal outcome: To what extent do you think the teaching methods used in Colibri will make you better prepared for the national labor market?



Students: Personal outcome: To what extent do you think the teaching methods used in Colibri will make you better prepared for the international labor market?

By the end of the COLIBRI project, the Facebook groups from the previous years still existed. So we were curious whether the students had found the COLIBRI course as helpful for their first labour market experience as anticipated in the surveys. So we asked them, and while not everyone replied, those who did had positive stories to tell. The answers we received are listed in the following:

*I was already working in a wireless home networking company when I joined COLIBRI. I knew some of the concepts but I did not have the vision COLIBRI helped me to have. Before COLIBRI, I was working as a software developer for a specific project in the UK. COLIBRI taught me how to work as a team with people from different countries and very different cultures which helped me a lot in my job and got me promoted. After COLIBRI, I joined an international team and become responsible for all Scandinavian customers as field application engineer. - Asli Erdal, participant in the 2nd year of COLIBRI (Bogazici University).*

*I was also already working while participating in COLIBRI. But it helped me grow professionally in multicultural environments (both with different domains and different nationalities). Now I am in London (visitors are welcome) working for a company where over*

*60 different languages are spoken. COLIBRI gave me confidence to apply for this position. My experience still helps me to survive in London. I would say I am quite appreciative about cultural aspects of the course. Also working in independent teams to create a solid project in a feedback loop gave me valuable experience about the product development process. - Helin Ece Akgul, participant in the 2nd year of COLIBRI (Bogazici University).*

*I was working my first job at the time of studying and participating at COLIBRI. For me, COLIBRI course was great as it gave me an insight into the IT world which I find useful and helped me to grow professionally. Thanks for the experience! - Alberts Jekabsons, participant in the 2nd year of COLIBRI (Riga Technical University).*

*Participation in COLIBRI helped me in several ways to start working. It is not precisely my first job because I worked for a short duration in the automotive sector after my bachelors beforehand but I wanted to switch towards the IT-based technology trends (big data, IoT, machine learning etc.) but my educational background was mechanical and offshore engineering. COLIBRI helped me understand the basics of these trends, therefore, I was able to get a research fellow position at UiS where the key focus of my research is implementation of these trends in different organizational settings.*

*I believe that COLIBRI helped me in getting some insights about these trends and I was able to convince the recruitment committee that I have requisite knowledge of the modern technology trends plus the implementation capacity that I acquired in bachelors and masters degree.*

*COLIBRI also helped me improving my communication skills and trained me to work in a truly diverse environment. These are additional reasons that indirectly contributed to getting the position. - M. Ahmad Tauqeer, participant in the 2nd year of COLIBRI (Stavanger University).*

*I got a job working with data collection and cyber security for some video games right out of the university. While I've also acquired knowledge regarding these fields elsewhere, participation in the COLIBRI course has helped me develop relevant skills. The interdisciplinary aspect of COLIBRI, and the course material therein, has been very valuable in assessing my strengths and weaknesses, which made me more decisive when shaping my education going forward. Considering the modest amount of ECTS points distributed to the course, the positive influence it has had on my education is staggering. - Daniel Svejstrup Christensen, participant in the 2nd year of COLIBRI (Aalborg University).*

*I started to work for Siemens as Intern Engineer in the medical equipment field. Erasmus + COLIBRI course helped me to improve my efficiency in various fields of my individual and social development that are having a big influence on my current carrier. In my interview with Siemens they asked me about this project and I had many stories to talk about: team work, fun, modern technology and creativity. In COLIBRI I was lucky to get the project for my group called "Nanotechnology in Medicine" which was the best opportunity for me to show that our team was able to hit the peak of creativity supported by a broad knowledge of brand new technologies that cover medical business needs and, what I found out later, future employer requirements.*

*Well, your project taught me much more than that and tools that we were learned to work remotely helped to accelerate foundation development for poor kids in case of teaching robotics technology and provide emotional support which I created with two of my friends in Poland. - Lukasz Weder, participant in the 2nd year of COLIBRI (UTP University of Science and Technology)*

*The COLIBRI program helped me to understand how to approach a project and take note of every minute detail in order to make it complete so that the audience can receive the whole message in its entirety as much as possible. This certainly have helped me in my Masters Project and now in my Thesis progression. This is indeed a good addition to the CV and may help me in future as I found some people at a job fair that were certainly excited to see the particular project topic when I gave them my resume. I hope it helps me in future, but it certainly added a dynamism to my education space. A reference from my project mentor may help my cause even more so, but it is strictly personal. - Ankit Ghosh, participant in the 2nd year of COLIBRI (Technical University of Hamburg)*

*The COLIBRI project clearly contributed to improving our group working, remote working and communication skills while we are learning the regular course materials. But in answer to your question, it didn't help me find my first job, since my working field is different from the course's direction. - Fatih Caltapepe, participant in the 1st year of COLIBRI (Bogazici University)*

*The course didn't help me get the job, but during my job I have used some of the things I learned. Especially the remote group work, and how to organize this, have been useful. - Jais Christensen, participant in the 1st year of COLIBRI (Aalborg University).*

*Well I would say that it kind of helped me to get my previous job (got that job in the middle of the project) because in the interview they were interested in project. That was not my first job but if that helps then we can discuss this in private. - Andris Grapens, participant in the 1st year of COLIBRI (Riga Technical University).*

### **Take-away messages**

- Based on both comments and qualitative evaluations, it is clear that the international, cross-disciplinary and problem-based approach is highly valued. This is seen by many of the participants as the most valuable aspect of COLIBRI. Thus, it is especially the improved horizontal competences that are seen as benefiting from the project.
- This is also confirmed in the rating of personal outcomes, where the students are particularly happy about the improvement of their preparedness for the international labor market.
- The course was generally well received by the students – especially when they got to work in international groups on real-world problems.
- The modules generally worked well, and were improved each year. In particular, the expectations and activities were much more clearly formulated, and the amount of communication between students reduced to two advanced (but larger) modules.
- The last year in particular generally gave a better fit between modules and projects.

- Progression tracking, more individualized setups (students could only see the modules they chose), clear formulations of tasks, and clear conditions for finalizing each module helped improve the students experience.
- Peer learning is a good idea, but needs clear instructions and guidelines (e.g. it is hard to self-organize). Also there has to be clear and explicitly formulated learning goals with the activities instead of just “being there”.
- The combination of short videos and quizzes worked well – both in a setting with quizzes at the end, and in the last year where the quizzes were integrated in the videos. Again it depends on the content what makes sense to have in different places. And multiple choice questions are not suitable for all courses! It is important that the form does not dictate the content.
- The virtual collaboration between the seminars worked better for each year– early formation of groups and more focus on team work processes in the first seminar helped for this, and the more structured approach to group work, supervision, templates for minutes, tasks and time plans introduced in the last year improved it even further.
- Video/presentation training during the midway seminar was well received through all the years. The students improved a lot on their presentation skills, and became much more confident with making presentations in front of other people.
- In future projects, working with larger and more substantial student projects could be considered, which would allow for more technical depth and also be more valuable for the companies. The latter is important in order to create a sustainable model, where the companies are motivated to participate because the benefit is greater than the time and effort invested.

### **Moodle and course experiments**

During the COLIBRI project we had the opportunity to explore many of the features in Moodle, which is the most widely used learning management system in Europe with a market share of 65%. Despite its many capabilities, it is our experience that few university teachers are aware of these, and most use the platform just as a repository for course materials. While the tools offered by Moodle should not dictate how courses are presented and conducted, at least teachers and instructors should be aware of them and consider them as additional tools they can use where it fits.

With respect to course organisation, we found the following elements to be very useful in order to create a smoother user experience:

- Bootstrap elements, which makes the layout nicer and less messy.
- Completion tracking, which makes it possible for each student (and teacher) to follow the students’ progress. However, it is important to be aware of how to use it, in particular when an activity is marked as completed.
- Access management, which can be used to set up the conditions for accessing learning activities: For example, students might need to complete all tasks in a module before being able to take the final quiz. This can be a nice feature as it enforces progression, but should also be used with caution - for example if some students would like to get an overview of all materials before starting on a module.

Also, we experienced that the manual grading of some tasks was needed before the students could proceed.

- Data and statistics: Which allows the teacher to better understand the students' study behaviour and challenges - which can be a help in determining what challenges to address during the course, as well as to how future versions of a course could be improved.

With respect to interactive content, we found the following elements to be very useful:

- Videos and quizzes: The mix of short 5-10 minute videos and quizzes worked well, especially when properly designed (alignment between learning objectives, videos and quizzes). It is important to note that Moodle offers a much greater variety of quizzes than just multiple choice, and that it is important to choose quiz forms that fit the topics and learning objectives.
- H5P interactive quizzes: H5P is a plugin that can be used with Moodle, which allows for a large number of interactive activities, including interactive videos: The experience when using Moodle, H5P and Youtube is more smooth because the students watch a video, which is interrupted by a quiz in the same picture, and the video is resumed after correctly answering the quiz. If the H5P plugin is installed, these interactive activities are just added like any other activity in Moodle.

Moreover, Moodle also offers a number of activities that facilitate collaboration and interaction between students and teachers.

- Forums, but in our experience it is hard to motivate the students to participate, unless they are asked to provide something very specifically (e.g. using it for uploading assignments, abstracts, etc.).
- Assignments, where Moodle provides a platform for submitting and assessing/grading these. One advantage of keeping this in Moodle is that it works with completion tracking and access management, but also because it provides a single platform/interface to the students.
- Workshops, which allow for e.g. peer assessment and peer grading. The stages are that (1) students submit an assignment, (2) students peer review each other assignments, and (3) the teacher can go through both assignments and reviews - and a total grading can be done taking both parts into account. Moodle offers that reviews are distributed automatically between students, but we found that it added quite a bit of manual work when some students did not submit by the deadline and a manual distributed between those students was needed.

For an elaborate discussion of this topic, as well as concrete instructions on how everything can be setup in Moodle, we would refer to our paper:

- Moodle: Practical Advices for University Teachers / Jens M. Pedersen, M. Sukru Kuran. In: Choraś M., Choraś R. (eds) Image Processing and Communications Challenges 9. IP&C 2017. Advances in Intelligent Systems and Computing, vol 681. Springer, Cham. This article contains a very hands-on introduction on how to use features in Moodle in order to deliver a better and more interactive learning experience.



### **Learning Management Systems and alternative platforms**

Based on our experiences with Moodle during the first (and second) year, we considered using other learning management systems in order to test out a wider variety of platforms. In particular, we looked into Moodle, Blackboard Learn, Canvas and Stud.IP. We found that despite every one of them having advantages and disadvantages, the features they offer are quite similar. So, instead of switching between different systems we stayed onto Moodle, improved the usability of Moodle significantly from year to year by adding and using additional plugins/features, and tested out additional platforms that could support the project work - something none of the Learning Management Systems were capable of. In that sense we did not manage to find a single platform that could accommodate the whole COLIBRI course, something we would have very much preferred.

For our comparison, we distinguished between different kinds of features:

Accessibility features:

- Internal messaging
- Mobile App (Android and IOS)
- Automatic Instant Messaging Forwarding
- Content Exportable
- Public access

While all the systems would support all these features, the detailed answers would reveal some differences, also depending on how it is installed and operated.

Content-related features:

- Activity access restrictions
- Allow course modules
- Progress tracking
- Outcome management

There are a few more differences here. Moodle and Blackboard are strongest when it comes to Activity access restrictions, all systems except for Stud.IP support course modules and progress tracking, and only Canvas supports outcome management. It should also be noted that at this time, only Moodle supports interactive content such as H5P.

For an elaborate discussion of this topic, we would refer to our paper:

- Learning Management Systems on Blended Learning Courses: An Experience-Based Observation / M. Sukru Kuran, Jens M. Pedersen, Raphael Elsner. In: Choraś M., Choraś R. (eds) Image Processing and Communications Challenges 9. IP&C 2017. Advances in Intelligent Systems and Computing, vol 681. Springer, Cham. This article contains a comparison of different learning management systems, especially focusing on their application in a blended learning setting.

## **On the use of Open Educational Resources.**

This section serves as a guideline to Open Educational Resources, and how they were used in the COLIBRI project. In the end we also discuss our experiences and recommendations for further use.

### **Introduction**

The COLIBRI project has produced an innovative set of educational resources for Masters students on various ICT domains concerning the future internet but also on more business-related topics such as enterprise architecture and entrepreneurship. They are free and open to use according to the provisions of the Creative Commons Attribution Share Alike 4.0 International License. Public and private educational institutions, teachers and other educators can download and use them for online and offline activities. They can also modify and redistribute them under the same licence.

These guidelines outline how the project's module creators can ensure that their educational resources meet the requirements necessary to be made 'Open'. They are effectively the same steps that users of these resources must abide by in order to ensure that they, and their derivative works, remain open.

### **Definition:**

Open Educational Resources (OERs) are defined as the technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes. They are typically made freely available over the Web or the Internet. They are mainly used by teachers and educational institutions to facilitate course development but they can also be used directly by the students themselves. OERs include learning objects such as lecture material, references and readings, simulations, experiments and demonstrations, as well as syllabuses, curricula, and teachers' guides.

As a critical feature of OERs is that they are open to use, revise and redistribute.

### **Licencing**

The project's educational resources have been developed with 'openness' in mind. They will be made openly available under the Creative Commons Attribution Share Alike licence (CC BY-SA 4.0). It includes the following legal clauses which users of such materials must observe and respect:

1. The author and other parties designated to receive attribution must be named in the manner requested by the licensor
2. If supplied by the licensor, copyright notices, a reference to the CC licence (preferably as a link to the CC website), a notice that refers to the disclaimer of warranty and liability and a link to the original source must be retained.
3. If the work is shared in an adapted version, it must be indicated that it is a modified version. Former indications to modifications must be retained (section 3.a.1.B of the legal notice).
4. If the licensor requests to remove any of the information referred to in paragraph 2 above, the user has to do so as long as it is reasonable.

5. The licensee must not create the impression that their use is in any way endorsed by the licensor or any party designated to receive attribution (section 2.a.6 of the legal notice)
6. The adapter's licence must either be the original licence or any later version of that licence. Earlier versions cannot be used.
7. A hyperlink or other reasonable reference to the adapter's licence must be included.
8. The use of the modified version must not be restricted by additional terms and conditions.

The full text of the legal notice can be viewed at:

<https://creativecommons.org/licenses/by-sa/4.0/legalcode>

### **Content types**

The following formats are recommended for the document type indicated:

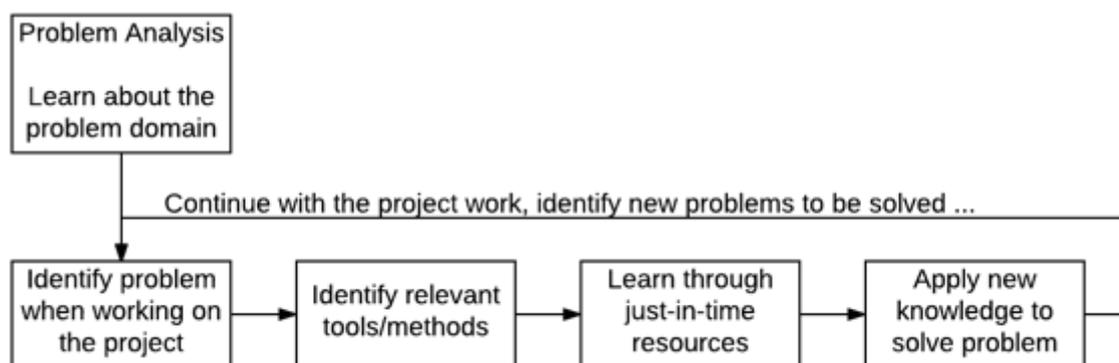
- For documents the recommended file formats are DOCX, PDF, ODT, RTF, HTML, XML
- For cartographic materials such as maps, charts, etc. the recommended file formats are ArcInfo, BIL, BSQ, CAD, DEM, E00, MID/NIF as well as file formats included in two-dimensional graphics such as JPEG, JPEG2000, TIFF and PNG
- Sound Recordings. These can be captured in mechanical, electromagnetic or digital mode in a medium that permits reproduction using audio equipment or software. It can include the recording of text (interviews, speeches, theatre), music recordings, etc. Recommended formats are MP3, WAV, RealAudio, DAISY, DVD Audio, RealAudio and SACD
- Video. This includes films, video material, recorded images in motion that may be accompanied by sound, etc. Recommended file formats are MPEG, Blu Ray, DVD video, HD video, QuickTime, RealVideo, SVCD, VCD, Windows Media and PPT.
- 3D objects and works of art. These objects consist of 3 dimensions (LxWxH) such as sculptures, coins and other 3-D works of art or their imitations, machines, clothing, toys, handicrafts, etc. They also include natural objects such as microscope specimens or other samples that are mounted for viewing e.g. in museums or exhibitions. Recommended file formats are 2-D graphical types such as JPEG, JPEG2000, TIFF, PNG
- Musical Scores. This refers to music written and produced for mass consumption. It can be written for different instrumental or vocal parts or for a single one. It includes sheet music for dance, choreography. Recommended file formats are JPEG, JPEG2000, TIFF, PNG and text formats PDF, ODT, RTF, HTML and XML.
- Data sets. This material consists of data and/or electronic computer programs that is intended for use and/or processing by a computer or a peripheral device connected to a computer e.g. an electronic game, an online system or service, software, etc. It includes primary research data for each of the other types of content e.g. cartographic data, laboratory notes, conceptual models, etc. Recommended file formats are Access, CSV, JSON, CSV. For items that do not fall into this content category, use one of the other categories that is most relevant e.g. a map is cartographic, an article is text, and so on.

## Our experiences and recommendations

There is no doubt that Open Education Resources has a big potential in the system of higher education: It can provide access to education for students who would not otherwise have it, and it can be used by educators to free up time to participate in interactive learning activities by the students when e.g. used in a flipped classroom setting. Especially in a situation where Massive Open Online Courses are gaining ground, Open Educational Resources can help universities in offering the best from the online and offline worlds.

During the COLIBRI project we developed the model of Just-in-time learning resources for Problem Based Learning, where Open Educational Resources can play a major role. Today, these kinds of projects are often supported by courses in a way where the students first study the courses that enables them to do the project work, and then carry out the projects. However, it is hard to determine the right content of these courses, and it is a challenge that the students cannot see exactly how and why they need the knowledge taught.

With just-in-time resources for PBL, we can provide the learning resources to students just when they need it. So while the students still need some background knowledge of the problem domain, when they need knowledge about e.g. a specific theory, method, or tool, they can access this from just-in-time resources such as an Open Education Resource. See also the figure below.



Concept of Just-in-time resources for Problem Based Learning, e.g. available as Open Educational Resources

As such, we see a big potential in the use of Open Educational Resources, especially when it comes to supporting students working with a focus on problem solving.

However, we also see challenges in developing and using Open Educational Resources, which should be considered also at decision maker levels. Three main challenges are:

- When producing Open Educational Resources, which will become publicly available, it is important that no copyrighted material is used in e.g. powerpoint slides. This can create a significant additional workload compared to teaching material that is only shared in closed groups, e.g. within the classes of a university. It often also implies

that different or additional explanations are needed since figures need to be substantially different than those available from the textbooks that students are using - something that can be a challenge both in terms of pedagogy and time usage.

- As we also experienced in the COLIBRI project, creating interactive learning materials is very time and resource consuming, and thus a large investment for universities. Whether this material should be made publicly available as Open Educational Resources should be a strategic decision taken at university level. We would encourage universities to do so, as it also helps universities to increase their impact and visibility.
- Finally, we note that making perfect teaching materials takes time, and it is hard to make a sound recording, video, or podcast where nothing could be improved. Making teaching materials available in the public space such as with Open Educational Resources exposes these materials to a far larger public than students of a single class or education, and teachers might be reluctant to share materials they find to be less than perfect. Again we would encourage universities to consider their position on Open Educational Resources and, when doing so, to also take such teacher concerns into account.

## **Recommendations for decision makers and institutions**

Throughout the COLIBRI project, we have gained valuable insight into how new and innovative teaching methods can be implemented in an international and cross disciplinary setting.

Among the many results and findings throughout the project, one aspect stands out: How much the students value the possibility to work on real world problems in collaboration with companies, in an international and interdisciplinary setting. This conclusion is reflected in the evaluation of the COLIBRI course, in the students assessment of the teaching methods, and in the students assessment of the impact the project had on them personally. These are also the aspects mentioned when we asked previous COLIBRI students how it affected their entry to the labour market.

We also found that carrying out these projects in a blended setting (mixing virtual and physical collaboration) was not trivial: While the activities and work during the seminars received consistently good ratings from students, their evaluation of the virtual/blended aspects were mixed the first year: However, as demonstrated in the results, we managed to increase student satisfaction with these aspects significantly, and the last year 85% of the students found that the virtual collaboration phase had been either effective (71%) or very effective (14%). 89% found the use of blended learning overall to be either effective (43%) or very effective (46%).

Thus our main recommendation will be to create these kinds of learning opportunities for students, preferably as integrated and recognized parts of the study programme. However, in this respect we note the following:

- The efforts and learning outcomes in terms of transversal competences should be explicitly formulated as learning objectives and evaluated as part of the examination.
- Facilitating the collaboration is important - while still retaining the overall control of the project and ownership with the students. It is important that the learning process is thought through from beginning to end, and that the students get help to plan virtual collaboration phases.
- When students with different educational backgrounds and cultures come together in a project, it is important to explicitly discuss and define the expected learning objectives and outcomes with the students - different students will often have different understandings of what a project is and what is expected from them.
- Even with improved results of the virtual phases, our experience is that the physical seminars are crucial for the students to get a good start on the project.
- Finally, we can not emphasize enough that the supervisor plays a key role when it comes to facilitating the project work. It is important that the supervisors also receive support from their organisations (time, competence development) in order to be able to sufficiently support the students.

## **Conclusions**

The COLIBRI project has served as a living lab for developing and testing new and innovative teaching methods in collaboration between 7 European universities, two companies, and a national documentation center.

Each year we carried out a joint course on “Future Internet Opportunities”, experimenting with blended learning and project work on real-world problems in an international and multidisciplinary setting with students from engineering, business and entrepreneurship. The course and the teaching methods were adjusted each year, based on the experience from previous years.

While the course was generally well received by students, teachers and company representatives, each year revealed some aspects with room for improvement: The modules were significantly improved in many aspects: The presentation, the implementation in the learning management system, and in general more consistency and clarity in the definition of tasks were identified as very important when a course is conducted mainly online. The projects received good evaluations already from the first year, but with some challenges in the blended and virtual parts. Throughout the three years, we managed to find a way of supporting the projects in a blended setting, so that the students of the last year were also very satisfied with the virtual collaboration period, and found it to be useful for their learning.

Initially the main reason for having students from so many countries following the course was that we wanted to test out the teaching methods with very diverse groups of students in order to see how different students reacted to different elements. However, we soon learned during the course that exactly this international dimension was what was most appreciated by the students. So, in fact, our conclusion is two-fold:

We have achieved our project goal of developing, testing and evaluating new teaching methods, and we have documented and disseminated our findings. In total we have reached more than 1.500 teachers face-to-face, we have published 9 conference papers and a book chapter, and we have promoted the take-up of new teaching methods at all levels in our organisations. All teachers who participated in the COLIBRI project will remain COLIBRI ambassadors, and continue to spread the word and experiences we achieved.

But we have also found that training students to work together across countries, cultures and educational disciplines on solving real-world problems has an incredible impact on the participants. And we have demonstrated how this can be done in a blended setting with a mix of virtual and physical collaboration.

Even as the COLIBRI project is finishing, we can already see that the results continue to have an impact: colleagues being inspired by our methods (or some of them), asking for advice on how to start out or take a step further; universities developing joint courses, based on the COLIBRI methods; and universities being inspired from our results when developing strategies for the modernisation and digitisation of education. We are happy and thankful to Erasmus+ that we were given the opportunity to work together on this, and to see that

ultimately we have managed to achieve a systemic impact that goes beyond our initial expectations.