The development and implementation of a coaching model for project-based learning

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INTRODUCTION

Since the Bologna Declaration (1999), higher education in Europe has been undergoing a significant reform process. As a result of this process the emphasis in higher education is clearly shifting to more student-centred and competence-oriented learning environments, which lay emphasis on equipping students with the skills and competencies necessary for our modern labour market [1].

As a consequence, higher education in science and engineering (S&E) has changed fundamentally during the last decade. Besides their solid base of scientific and technological knowledge, present-day engineers also need a broad set of technical and social competencies to compete in our ever-evolving society. To meet these educational needs, the KU Leuven has been investing heavily in the development and implementation of student-centred and competence-oriented educational programmes and teaching methods [2].

Because the conventional teaching methods (emphasis on transfer of knowledge) were not suited to realise this educational change, they opted for the implementation of a student-centred teaching method that supports the students' self-development:

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project-based learning (PBL). Over the last few years PBL has been successfully implemented in our S&E Faculties and nowadays it plays a pivotal role in our educational programme.

To consolidate this teaching method and its learning outcome, the Faculty of Bioscience Engineering has started an educational research project (OWP/2010/22) to define and optimise the role of the coach in PBL. The correct interpretation of the coaching role is crucial for the success of a project and the (self-)development of the participating students. But in spite of all the (inter)national studies that have been done on this teaching method, insufficient light has been shed on the role of the coach [3]. What is needed is a coaching model that helps the coaches with defining the best coaching method for each specific project and that provides them with the accompanying education tools to successfully fulfil their coaching role in practice.

This paper describes and comments on the development and implementation of this coaching model at the S&E Faculties of the KU Leuven. It focuses on and illustrates the different steps in the development process, the outcome of every step and its implementation and use in educational practice.

1 PROJECT-BASED LEARNING AND THE ROLE OF THE COACH

1.1 Project-based learning

Project-based learning is becoming increasingly more popular in S&E education [4]. In this teaching method a group of students works on a problem for a longer period of time, in consultation with a coach who guides and facilitates the learning and the self-development of the students. Taking a closer look at this definition of PBL, five key characteristics can be distinguished [5]:

1. *Working in groups:* Students work together in small groups (ideally 4-6) towards a common objective. Through this collaborative learning specific competencies can be developed, the attained knowledge is more durable and students can be motivated more easily [6].
2. *Working on a problem:* Students work on a problem based on real life, of which the course and result are not predetermined. This reduces the gap between theory and practice and activates the students to apply their attained knowledge in practice.
3. *Longer period of time:* Students work on this problem for a longer duration, ranging from a semester to a year. This allows them to study the subject thoroughly and to go through every step in the research and development process.
4. *Consultation with a coach:* During the course of the project the students are provided with the necessary guidance from the coach concerning the progress of the project and their personal development.
5. *Self-development:* Students are encouraged to reflect upon their personal and intellectual development, so they can make adjustments if necessary.

1.2 The role of the coach in project-based learning

The correct interpretation of the coaching role is crucial for the success of PBL and its learning objectives. Because this teaching method and its educational approach are so different from the conventional teaching methods (focus on the transfer of knowledge), this can sometimes be a troublesome task. In PBL the focus lays on the self-regulation and -development of the students and their group [7]. So as a coach it's important to find a good balance between the autonomy of the students and

providing them with the necessary guidance. Therefore it's recommended to provide them with indirect guidance and to avoid ready-made answers or solutions [8].

Because of the importance of this coaching role for the success of PBL and the significant differences with conventional teaching methods, it's crucial to professionally train the coaches and to provide them with the necessary support during a project. But in practice this level of professionalism is difficult to achieve, as a consequence of the underexposure of the coaching role in research, the lack of ready-to-use manuals or training programmes and the educational situation at the average institute of higher education. Usually the coaching is done by research assistants, resulting in a large turnover and no time or means to professionally train them. With this research project the KU Leuven intends to meet this educational need and to provide its coaches with the necessary support and guidance to successfully fulfil their coaching role, resulting in a more qualitative and professional education for its students.

2 RESEARCH OBJECTIVES AND METHODOLOGY

What we want is an easy to use instrument that helps the coaches with defining the best coaching method for each specific project, based on the characteristics of this project and the participating students *(See Fig. 1)*. The goal of this research project was to develop, implement and validate this much needed instrument in the S&E education of the KU Leuven. This instrument, also called 'coaching model', intends to fine-tune the role of the coach and to provide him with the necessary guidelines.

Fig. 1. Schematic overview coaching model

Research started with a thorough analysis of the existing scientific literature and projects on this subject. Based on this analysis, a theoretical framework was created that collects all the different aspects of coaching into nine specific coaching roles. This overview collects and uniformly defines all these coaching roles and served as the theoretical foundation of our further research. Based on this framework a survey was conducted (800 students, 50 coaches) to study the role of the coach in PBL. An in-depth statistical analysis of these surveys was done and used to map out the relationship between three key factors: the coaching roles, the learning objectives and the learning outcome. Based on this relationship the proposed coaching model was developed. To facilitate the dissemination and the use in practice of this theoretical model, an accompanying manual and a web application were developed.

3 LITERATURE STUDY

The first step in this research process was a thorough analysis of the existing specialist literature on the subject of PBL and the coaching of PBL. This analysis provided us with a solid basis for our future research and an overview of the current state of the (inter)national research on this topic: what has been realised, how does our research relate with it and what are the gaps that need to be filled?

Based on this analysis three main themes could be distinguished that dominate the existing research: the theoretical background of PBL, PBL in higher education and how to develop a project for PBL *(See Table 1)*. Professional literature clearly

focuses on the theoretical and pedagogical aspects of PBL. As a consequence of this approach the more practical side of this teaching method, or how to use it in practice, is underexposed and not much research has been done on the role of the coach. Therefore, the priority was to gain a clear insight into this coaching role and its functions: what is the role of this coach and how does it manifest itself in practice?

Table 1. Main themes and research topics in existing research

Themes	Research topics
1. *Theoretical background*	▪ What is project-based learning? ▪ What are the main characteristics of PBL? ▪ Where does PBL originate from?
2. *PBL in higher education*	▪ Why, where and how is PBL used in higher education? ▪ What are the educational benefits of PBL? ▪ What's the educational context of its popularity?
3. *Developing a project*	▪ What is a project in PBL? ▪ How do you develop a project for higher education? ▪ How do you implement a project in higher education?

4 FRAMEWORK OF COACHING ROLES

Through this analysis it became clear that little in-depth research had been done on what the role of the coach is in PBL and how it can or has to be taken on. For the successful continuation of the development process an organised and univocal framework was needed, based on our literature study and complemented with internal knowledge and experience, with the following characteristics:

- Schematic overview of the different roles a coach can take on during the course of a project.
- Clear and univocal definition of each of these coaching roles.
- Overview of the different skills and attitudes that are necessary to successfully take on each of these coaching roles.

Firstly, a list was drawn up that collects all the different 'coaching roles' a coach can take on during a project. All these coaching roles represent a main didactical aspect of coaching a project in PBL. For example: providing the students with feedback → coaching role: feedback provider or motivating the students and group → coaching role: motivator. Together these roles represent the whole spectrum of coaching tasks. Based on the work of Beart *et al.* (2002), multiple hearings with the educational staff and the professional advice of the Educational Support Office (ESO) of the KU Leuven a framework was developed that consists of nine coaching roles *(See Table 2)* [9]. Each of this coaching roles was then defined and linked with the skills and attitudes that are necessary to successfully take it on. All this information was collected in a schematic overview and this 'framework of coaching roles' served as the theoretical foundation of our further research.

Table 2. Overview of the nine coaching roles

Coaching role	Description
1. Advisor	Provides the students with indirect answers and advice.
2. Authority	Provides the students with ready-to-use answers and instructions.
3. Problem solver	Can be reached when problems emerge and helps to solve them.
4. Inspector	Verifies if the students are working and making progress.

5. Model	Acts as an example for the students and lets the students gain insight into his reasoning and thinking.
6. Motivator	Motivates the students during the course of the project.
7. Feedback provider	Provides feedback on a regular basis to the individual students and the group.
8. Educator	Steers the learning process by urging the students to reflect on their personal development and their learning methods.
9. Group specialist	Makes sure the group and all its members are functioning properly.

5 SURVEY

The next step in the research process was collecting the necessary data for the development of the coaching model. Given that no data was available that links the role of the coach with the learning objectives and the learning outcome, the necessary measurements needed to be carried out. These measurements focused on the relationship between the three key factors of our future coaching model: the coaching roles, the learning objectives[2] and the learning outcome. We opted for a written survey and journal, developed in co-operation with the coordinators of the involved projects, the ESO and LESEC. The students and coaches of the involved projects had to fill in the journal during the course of their project and complete the survey at the end of their project. The goal of these measurements was:

- To get an overall picture of the coaching in its current state and form.
- To map out the relationship between the coaching roles, the learning objectives and the learning outcome.
- To collect data for the optimalisation of this relationship.

During the selection of the projects that would be questioned, the following factors were taken into account: the targeted learning objectives, the characteristics of the participating students, the characteristics of the coaching and the educational setting. Eventually four projects with a total of ± 800 students and ± 50 assistants were selected to fill in the survey and keep a journal *(See Table 3)*.

Table 3. Characteristics of the selected projects

Project	Institute	Faculty	Year	Students	Coaches
Guided & Integrated Group work	KU Leuven	Bio- Engineering	3rd bachelor	154	27
Problem solving & Eng. design 2	KU Leuven	Engineering	1st bachelor	410	3
Engineering Experience 2	Group T	Engineering	1st bachelor	114	10
Engineering Experience 4	Group T	Engineering	2nd bachelor	111	10

6 DEVELOPMENT OF THE COACHING MODEL

The data of all these surveys and journals was collected and put through a thorough statistical analysis, in co-operation with the statistical department of the ESO of the KU Leuven. A confirmatory factor analysis was done to verify if this survey was representative for and compatible with the original framework and its classification into coaching roles. This resulted in a good model fit and the confirmation of the validity and representativeness of this survey. In the following two sections we will take a more elaborate look at the coaching in its current form and at how the coaching model was developed.

[2] To guarantee uniformity and a broad applicability, a fixed set of seven learning objectives was used. These were based on the international ACQA-profiling system that is used to specify & accredit the learning outcomes of S&E programmes [10].

6.1 The coaching in its current form

An exploratory data analysis (EDA) was performed on the data set to provide an overall picture of the coaching in its current state and form. Based on this EDA, the following primary conclusions could be drawn:

- Students clearly see the added value of PBL for their S&E studies. 88% feels that participating in PBL has positively influenced their intellectual skills and competencies *(See Fig. 2).*
- Students clearly see the added value of the coach and his guidance. 72% of the students feels that the coach and his guidance provided a substantial contribution to their project and development *(See Fig. 3)*.
- The coaching in its current form mainly focuses on observing the students and helping them with problems concerning content and course progress, while it does not pay enough attention to the more fundamental learning and group processes that focus on the development of the students and their competencies and play a pivotal role in this teaching method *(See Fig. 4)*.

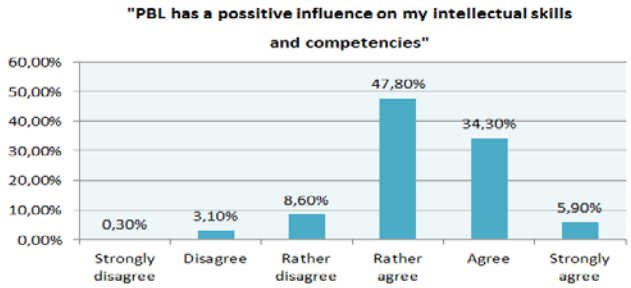

Fig. 2. Added value of PBL

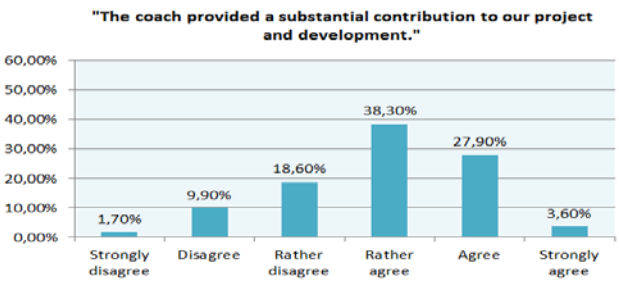

Fig. 3. Added value of the coaching

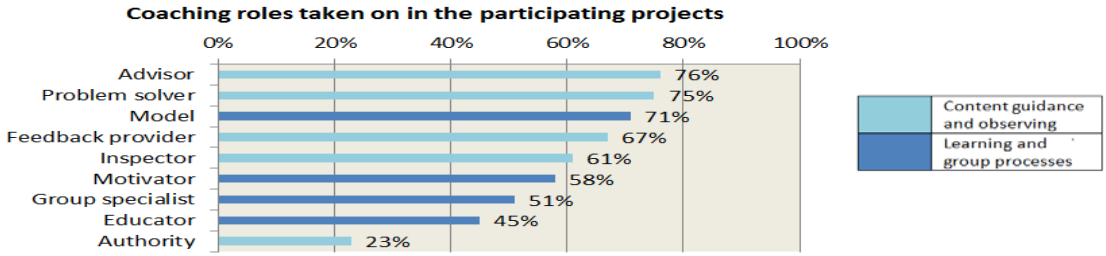

Fig. 4. Focus of coaching on content guidance and observing

6.2 Development of the coaching model

Although the guidance of the coach clearly provides a substantial contribution to the development of the students, there's still room for progression. The coaching in its current form is to superficial and does not provide the necessary, more in-depth, guidance to support the fundamental learning and group processes of the students. Given that these processes (and the competencies they aim to develop) play a pivotal role in the success of PBL, it's crucial to take them into account and to adapt the coaching to the specific details of every project.

Therefore a more in-depth statistical analysis was performed to map out the relationship between the coaching roles, the learning objectives and the learning outcome. The main part of this analysis consisted of a regression analysis (RA). The result of this RA was a clear insight into the causal relationship between these three factors and consequently the ability to formulate the optimal coaching for every specific project. All these results were combined to construct a 'coaching model' *(See Fig. 5)* with the following applications:

- Formulate which role(s) need(s) to be taken on by the coach to develop a specific learning objective.
- Formulate which role(s) need(s) to be taken on by the coach to achieve the highest learning outcome.
- Formulate a unique 'coaching profile' for every specific project that tells the coach which roles he has to take on during the course of this project to achieve the highest learning outcome.

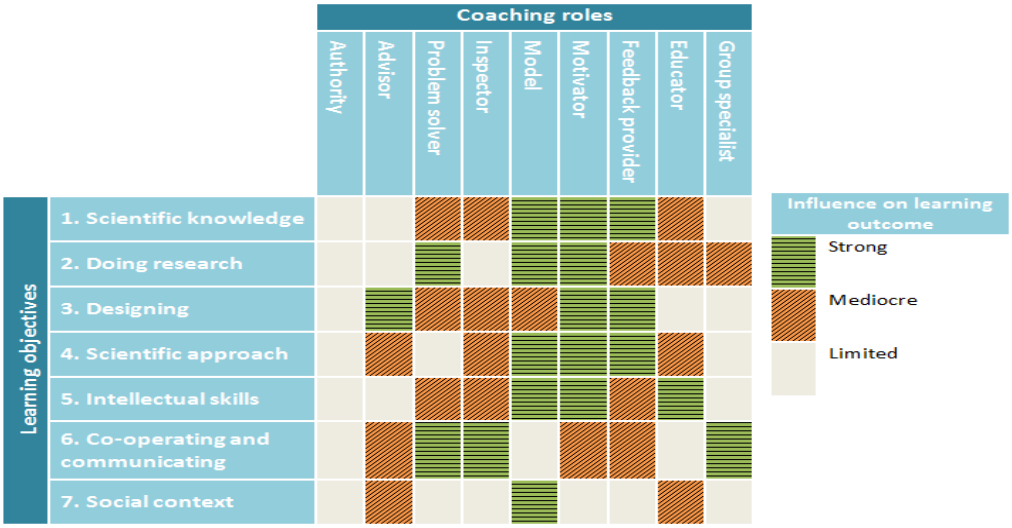

Fig. 5. Graphic representation of the coaching model

7 WEB APPLICATION & MANUAL

The next step in this research project was the development of an accompanying web application and manual to facilitate the use and dissemination of the coaching model in the educational practice. They will provide the coaches with the necessary guidelines and background to successfully take on their coaching role and to achieve the predetermined learning goals.

7.1 Web application

The goal of this web application was to transform the theoretical coaching model into an easy-to-use instrument by which the coach can determine the optimal coaching for his project. Therefore an online application was developed using the (statistical) data of the theoretical coaching model. This application was developed in ASP.net, is open for all users and gets updated on a regular basis.

https://www.biw.kuleuven.be/projectbegeleiding

This web application has the following applications in the educational practice:

- *Determining coaching profile:* Based on the learning objectives and educational setting of a project (manual input or database) the optimal coaching profile (which roles have to be taken on during the course of this project to achieve the highest learning outcome) can be determined.
- *Guidelines:* Tailored guidelines and background information to successfully take on the proposed coaching role(s) in practice.
- *Reference work:* An interactive version of the manual that contains all the information on the learning objectives, coaching roles and educational settings.

7.2 Manual

In addition a manual was developed that serves as an easy-to-use reference work and provides the coaches with the necessary background information and guidelines to successfully take on their coaching role and to achieve the predetermined learning objectives. This manual was provided to all the PBL coordinators and coaches in our university and will be made publicly available online.

This manual has the following applications in the educational practice:

- Extensive background information on PBL and the coaching of PBL.
- An overview of our research project and its results.
- Guidelines and background information on all the different coaching roles, learning objectives and educational settings.

8 SUMMARY

During the last decade the S&E Faculties of the KU Leuven have been investing heavily in the implementation and optimalisation of student-centred teaching with project-based learning. Because the correct interpretation of the coaching role is crucial for the success of PBL and the (self-)development of the students, a research project was started to develop, implement and validate a coaching model that helps the coaches with defining the best coaching method for each specific project.

Firstly, a framework was created that collects and defines all the coaching roles. Based on this framework a survey was conducted to study the role of the coach in PBL. A statistical analysis of these surveys was done to map out the relationship between the coaching roles, the learning objectives and the learning outcome. These results were then used to develop a coaching model, which presents the coaches with the optimal coaching for a specific project, based on the details of this project. Finally an accompanying web application and manual were developed to facilitate the use and dissemination of the coaching model in the educational practice.

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