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**Chapter**

# Programme Integrating Courses Making Engineering Students Reflect

*Viggo Kann*

## Abstract

A programme integrating course (PIC) is a special type of course, lasting for several academic years and aiming to strengthen programme coherence, by tying the students, instructors and programme director closer together. The first PIC was started at KTH in 2008. Since then, the concept has been polished and adopted by many engineering and masters of science programmes at KTH and at other universities. The course is built around regular (four times a year) reflection seminars in small cross-grade groups, mentored by a teacher. Each seminar has a topic, for example, study skills, procrastination, exchange studies, generic skills, minorities and equal treatment and ergonomics and mental health. Before the seminar, the students are presented with some material to read and view. Based on the texts and videos, each student should write a reflection document and read and comment some other students' reflections. At the seminar, the students will further discuss the topic and discuss the courses that they are currently taking. PIC has been evaluated and found very valuable by both the students and the teachers acting as mentors. This chapter will review the existing literature on PICs, which is mostly in Swedish.

**Keywords:** programme integrating course, self-regulated learning, programme coherence, reflection, engineering education

## 1. Introduction

### 1.1 Programme coherence and the programme triangle

A vocational education, such as engineering education and teacher education, can suffer from fragmentation [1–3]. Based on interviews with 20 graduated engineers, Nilsson found that the engineers 'view their education as compartmentalized or fragmented, and they lack a main thread in the educational programme' [3]. It may even be the traditional organisation of education that causes this [4]. The gap between theory and practice in education is argued to stem from a situation where, according to Schön, 'the privileged knowledge held in the research university is broken up into territorial units. Each field of subject matter is the province of a department, and within each department, knowledge is further subdivided into courses, the provinces of individual professors' [5]. Teachers/faculty from all departments involved in a study programme will need to cooperate [6], together creating, as Guardini put it, a 'living image of what it means to be a teacher, a man of law, or an engineer' [7, 8]. Jessop et al. [4] proposed 'Taking a programme approach clarifies

the interconnectedness of units of study, emphasizing that an undergraduate degree is subject to a curriculum design process where the "whole is greater than the sum of its parts".'

Within professional education, the concept of *programme coherence* has emerged as a way of understanding and counteracting a fragmented education [9] and to 'bring into focus the complexity of the meaningful interrelationships between theory and practice' [10]. Tatto's starting point of programme coherence still holds as a definition for many subsequent professional educational researchers, stated as 'shared understandings among faculty and in the manner in which opportunities to learn have been arranged (organizationally, logistically) to achieve a common goal' [11].

The Swedish Higher Education Ordinance states that all first and second cycle education should be carried out in the form of courses. Courses form the concrete level in education. It is within the courses the teaching and learning should take place. The two *key actors* in courses are *instructors* and *students*. The courses may be organised into education programmes, and each course should have a course syllabus and each programme a programme syllabus. There should be intended learning outcomes stated for each course and education programme. The Higher Education Ordinance specifies qualitative targets, in compliance with the European Dublin descriptors, for each higher education qualification. The programme syllabus and qualitative targets, together with the learning outcomes of the courses included in the programme, form a formal/written specification of the education. For each education programme, there is often a *programme director* (or a group with the same authority), who is responsible for the abstract specification. This is the third *key actor* in our model.

The formal curriculum may be superficial or quite detailed. Over 100 engineering institutions follow the CDIO initiative, which emphasises the programme perspective [12], with a 'curriculum organized around mutually supporting courses,' represented by a matrix defining the progression of different skills through the courses in the programme. However, as we described above, there is a gap between theory and practice in education that has to be handled.

In the typology of curriculum representations by van den Akker [13], the *intended curriculum* includes both the ideal curriculum (the vision or basic underlying philosophy) and formal/written curriculum, the *implemented curriculum* is the operational curriculum perceived by the instructors, and the *attained curriculum* is the experiential learning of the students.

According to *variation theory*, the object of learning, or what the students need to learn to achieve the desired learning objectives, involves three parts: The *intended*
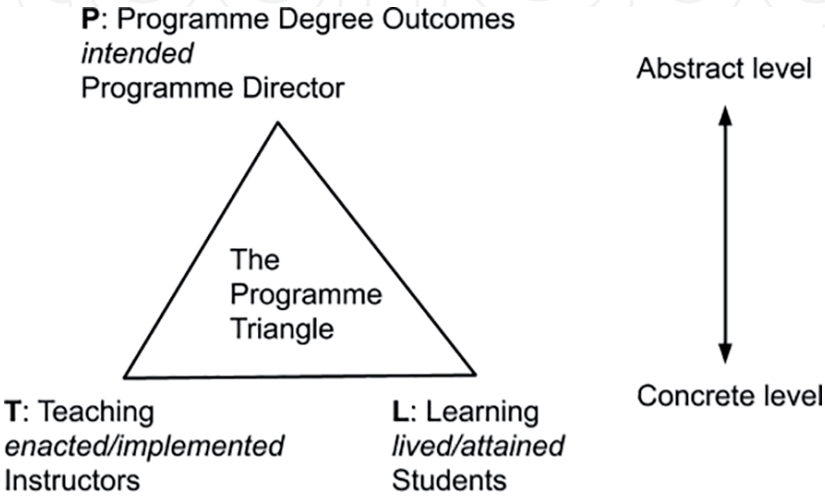


**Figure 1.**
*The programme triangle.*

*object of learning* will be the starting point for a lesson, course or unit. The *enacted object of learning* is the actual possibilities for learning that are provided. The actual learning that takes place in each individual student is referred to as the *lived object of learning* [14]. This corresponds nicely to the intended, implemented and attained curriculum, respectively, from van den Akker's typology, and is used in our new model, called the *programme triangle* (see **Figure 1**).

The programme director tries to influence the instructors and students so that the concrete courses (implemented curriculum) will comply with the programme director's abstract picture of the programme (intended curriculum).

In a *coherent programme* we suspect that the intended curriculum, the implemented curriculum and the attained curriculum are the same or close to the same. The coherence can be improved by making the six relations between the three key actors stronger, i.e. strengthening the edges of the programme triangle.

There are different processes, courses and structures that can be used to strengthen programme coherence. Examples of such activities, and which edges in the programme triangle they are meant to strengthen, are:

- A study skills and study strategies module (strengthening the L ← T relation)

- Student representatives and meetings (T ← L relation)

- Meetings of instructors (strengthening P ← T and T ← P relations)

- Information meetings for the students (L ← P and possibly P ← L relations)

- Course and programme questionnaires, graduate and alumni surveys (T ← L and P ← L relations)

- Academic introduction activities (L ← P and L ← T relations)

- Programme integrating courses (strengthening all six relations)

In this chapter, we will focus on programme integrating courses and show how they strengthen the programme coherence.

## 1.2 Self-regulated learning

*Self-regulated learning* refers to the degree to which individuals can regulate aspects of their thinking, motivation and behaviour during the learning process [15]. It is learning that is guided by *metacognition* (thinking about one's thinking), *strategic action* (planning, monitoring and evaluating personal progress against a standard) and *motivation to learn*. Therefore, self-regulated learning would strengthen the L ← P and L ← T relations in the triangle. There are several studies showing the importance of self-regulated learning for academic achievement, e.g. [16, 17]. Zimmerman [18] states that self-regulated learners use systematic and controllable strategies and concern their responsibility for achieving the learning outcomes. Students who are aware of the long-term goal of their programme, why they are taking the courses that they are taking and how they should study optimally, should be better prepared for their studies.

Another self-regulated process is *reflective practice*, which is the capacity to reflect on action to engage in a process of continuous learning. Schön [5] was one of the founders of this field. Reflective practice contains strategies for teachers to handle the T ← P and T ← L relations in the programme triangle.

1. Technical writing just describing personal experience, events and action in a specific situation

2. Descriptive reflection analysing one's performance, giving reasons for actions taken

3. Dialogic reflection considering alternatives exploring alternative viewpoints and alternative ways to solve problems

4. Critical reflection from a broader perspective thinking about the effects upon others of one's actions, taking society into account

**Table 1.**
*Hierarchy of reflection levels.*

## 1.3 Reflection and levels of reflection

In the programme integrating courses, reflection assignments, orally and in writing, are heavily used as a tool to both strengthen the programme coherence and promote self-regulated learning among the students.

The students are regularly given reflection assignments on different topics, related to Zimmerman's learning strategies mentioned above [18]. The students get feedback on their reflections in several ways: written peer feedback, written feedback from the mentor and feedback in the oral discussions at the seminar. Feedback is important to facilitate self-regulation [19].

We soon noticed that we would need to encourage the students to write deeper reflections. It is known that students may experience difficulties when being asked to reflect on a given topic, which can lead to more descriptive than reflective texts [20, 21]. In order to help students to improve their ability to reflect more deeply, Kann and Magnell developed a model, summarised in **Table 1** [22], based on research by Hatton and Smith [21]. In Section 4.4 we will explain how these levels can be useful in order to support our students to create sophisticated reflections and to use their reflections to improve self-regulated learning.

## 2. Programme integrating courses

The first *programme integrating course,* of the type considered in this chapter, was developed by Björn Hedin and given in 2008, for engineering students in Media Technology at KTH [23]. This course will be denoted PIC1 below. In 2010, a course based on PIC1 was introduced for Computer Science and Engineering students at KTH (denoted PIC2). These courses have the same structure and differ only in some details. We have chosen PIC2 as the reference course in this chapter.

The programme integrating course is not at all an ordinary engineering course; it can be characterised as a meta-course. The intended learning outcomes and aims of the course are presented in **Table 2**.

A Swedish master of science in engineering education takes 5 years. At KTH, the first 3 years (first cycle) of each engineering programme consist mostly of mandatory courses. In year 3, the student chooses a master's specialisation for the last 2 years of their education (second cycle). These master's specialisations are also possible to take as separate master's programmes for external students. The success of PIC1 and PIC2 made us realise the need for a programme integrating course also in the master's programmes. We were even approached by students who had taken PIC2, expressing interest in a continuation of the PIC. In this chapter, we will use the PIC in the Master of Science in Computer Science as the example of such a course. We will denote it PIC3.

The students in each programme integrating course are divided into seminar groups. Each group consists of students from different years of the programme and one mentor, a teacher on the programme. The course is centred around four reflection

Having passed the course, the student should be able to:

- Use academic calendars, course syllabuses, intended learning outcomes and grading criteria to plan their studies in both the short and the long view

- Plan and carry out assignments in stipulated time

- Make well justified specialisation and course choices

- Review critically and reflect on both the setup and implementation of the education as well as their own study achievements

- Reflect on different topics relevant for the education and the professional role, such as progression in subject knowledge and generic skills, plagiarism, own responsibility, study technique, procrastination, internationalisation, health, minorities and equality, student influence and quality of education

- Identify their need for additional knowledge and continuously develop their competence

- Analyse and evaluate social and ethical consequences of computer applications
  In order to:

- Obtain an overall picture of the education and thereby better understanding of the importance of each individual course

- Make informed choices both during the education and thereafter

- Influence the development of the programme

**Table 2.**
*Intended learning outcomes and aims of the course.*

| Course | PIC1 | PIC2 | PIC3 |
| --- | --- | --- | --- |
| Number of years | 3 | 3 | 2 |
| Cycle | First | First | Second |
| Part of education programme | Media Technology | Computer Science and Engineering | Computer Science |
| Year first given | 2008 | 2010 | 2014 |
| Number of groups | 20 | 39 | 24 |
| Number of mentors | 6 | 13 | 12 |
| Number of students per group | 10–12 | 12–14 | 16–18 |
| Length of seminar | 80 minutes | 60–70 minutes | 50 minutes |
| Grading of seminar activity | Yes, point system | Yes, two levels | No, pass/fail |
| Grading of reflection documents | Yes, point system | Yes, two levels | No, pass/fail |
| Peer comments | Yes, within the group | Yes, from 2018 | Yes, within the group |

**Table 3.**
*Data about the three instances of PIC discussed in this chapter.*

seminars each year, each with a dedicated topic, such as procrastination or ethics. Before each seminar, the students are asked to study the topic and write a reflection based on their own experiences. The four-level reflection hierarchy in **Table 1** has been used in PIC1 and PIC2 for several years now. At each seminar, the students also reflect upon recently taken courses. The reflection is shared to the group members including the mentor, who asynchronously discuss the texts online (using either Google Documents or the Peergrade.io system). The topic and the courses are then discussed further at a physical meeting, sometimes in the form of a walking seminar [24], where the group discusses the topic while walking in the woods behind campus.

In different PICs the students' reflections and participation are assessed in different ways and using different grading scales (see **Table 3**).

## 3. Characteristics and functions of the course

In this section, we will describe the programme integrating course through its characteristic features and its functions in the education [22, 25].

### 3.1 Characteristics of PIC

The first function of the programme integrating course, as we will see in the next subsection, is academic introduction. Andersson et al. [26] have identified five key concepts that characterise successful activities for academic integration and improved student completion. We will show that the programme integrating course is characterised by all these key concepts, by going through the five concepts and explaining how PIC2 is characterised by them.

### *3.1.1 An overall perspective*

PIC runs for the whole first 3 years of the education and is mandatory for all students. All categories of staff who are directly involved in the programme are involved in PIC: the programme director, the study counsellor and 13 instructors who are teaching courses in the programme.

Furthermore, PIC ties together the mandatory courses of the programme and guides the students in their choices of elective courses and specialisations. It covers most aspects of the studies: objectives, execution and development of the courses, study skills and personal health, profession and lifelong learning.

### *3.1.2 Student activity*

Four times each year, the students meet in small cross-grade groups. Each student has the same group and the same mentor each time. Before each seminar each student should write a reflection document, read the reflections of the other members of the same group and comment on them. During the seminar, the written reflections are discussed, usually first in small groups and then in the whole group. PIC is permeated by student activity.

### *3.1.3 Personal meetings*

The seminar groups consist of about a dozen students from different years (1–3). In the yearly evaluation, many students emphasise that the meetings with students in other years are especially fruitful. Since the students meet the same instructor as mentor during all 3 years, a mutual trust is developed. At the end of the third year, the mentor meets each student individually for 15 minutes and discusses the important choice of master programme and specialisation. The students also meet the study counsellor once or twice a year within the course.

### *3.1.4 Forward-pointing*

Our aim is that the course participants should become skilled and conscious self-regulating students, aware of the objectives of their education programme, why the courses in the programme are included in the education and how they build on each
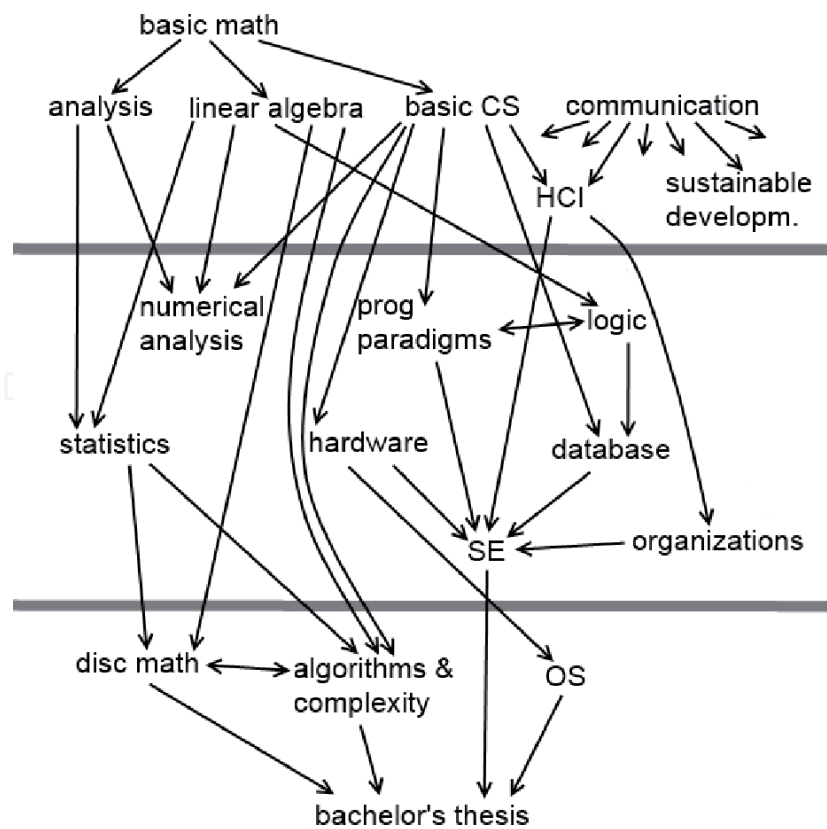
**Figure 2.**
*A graph showing how the mandatory courses of the programme are linked to each other. This picture is shown and discussed at all lectures of PIC2, i.e. twice a year.*

other. Furthermore, the students should be able to make informed choices to get the vocational training and education that they seek. The discussions about current courses, in the second half of each seminar, show younger students what they will meet in their education in 1 or 2 years.

*3.1.5 Discourse awareness*

The very first lecture in the first year of the programme is a PIC lecture, where we show the students how the mandatory courses of the programme are linked (see **Figure 2**), how the programme is run and developed, which course administrative systems exist and where to find answers to questions and get help—knowledge that will simplify life as a student. The textbook used gives further insight into the academic discourse.

Each PIC seminar has a topic that raises the consciousness about some academic discourse, which makes the students aware of many discourses spread out over the 3 years that the course is given. The topics are shown in **Table 4**, in order of popularity according to a survey answered by all third-year students 2019. The topics rotate in a 3-year cycle.

We have shown that PIC meets all five key concepts. Hence, it is likely that PIC is a successful activity for academic integration and improved student completion.

**3.2 Functions of PIC**

The programme integrating course is a multipurpose course. Kann [25] argues that PIC fulfils the following 10 functions:

1. Academic introduction (strengthening L ← P and L ← T relations)

52% Ergonomics and mental health
46% Master programmes
40% Procrastination
34% Minorities and equal treatment
30% Study motivation and study skills
30% Professional life as a CS engineer and lifelong learning
25% Quality in the education—what is that?
23% Studying and working abroad
11% Plagiarism and responsibility
8% Learning outcomes, criteria and assessment

**Table 4.**
*Results of the evaluation question: 'Which three seminar topics do you think were most fruitful?'*

2. Increased understanding of the programme (L ← P relation)

3. Connections between teachers and students (T ← L and L ← T relations)

4. Exchange of experiences between students from different years of the programme (L ← L, L ← P and L ← T relations)

5. Training in written and oral communication and reflection (curriculum)

6. Information about elective courses and studies abroad (L ← P relation)

7. Follow-up of academic results (T ← L relation)

8. Covering subjects that other courses are not covering (curriculum)

9. Education of the instructors involved (T ← P and T ← L relations)

10. Quality enhancing evaluation of the programme (all L ⇄ T ⇄ P relations)

The motivation of function 1–7 should be clear from the above characterisation. Let us motivate the last three functions.

There may be important but small subjects that are parts of the overall objectives of the programme but are not included in any ordinary course. This was the case for us for ethics, plagiarism, computer science history and the computer in the societal development. Therefore, we extended PIC with an ethics module and a computer history model and added plagiarism as a seminar topic. This is an example of the eighth function of PIC.

Function 9 concerns the education of the instructors who are acting as mentors, which is of two kinds: First, PIC gives knowledge about the programme, its objectives, contents and courses to the students, but the mentors need to read the preparation material before each seminar, so they will get the same knowledge. Second, the mentors will learn, by reading reflections and listening to the discussions at the seminars, how the students experience their studies and how they study and prioritise. The mentors can then use this knowledge to improve their own courses and make them more suited to the programme.

Regarding function 10, there are several common problems with ordinary course evaluations that PIC solves. Many course surveys have low participation, but in PIC the surveys are mandatory. This is possible because the fourth intended learning outcome of the course is 'review critically and reflect on both the setup and

implementation of the education as well as their own study achievements' (**Table 2**). Another feature of the surveys in PIC is that questions can have a programme perspective, which is not possible or at least not that easy in a survey in a singular course.

Last, but not the least, the course reflections at the end of each seminar give direct feedback on the ongoing courses, independently of which department they belong to. The mentor collects the feedback and presents it to the other mentors (including the programme director) at a short meeting over a cup of coffee the day after the seminars. This allows for acting on the feedback swiftly.

## 4. Analysis of the effects of the programme integrating courses

The effects of programme integrating courses have been analysed in a sequence of publications, several of them only published in Swedish [22, 25, 27–30]. In this section, the results of these publications will be summarised.

### 4.1 Methods of evaluation

Six different methods for collecting data have been used in the evaluations:

- *Mandatory surveys*: at the end of each academic year, all PIC2 and PIC3 students should answer a mandatory survey. This is one of the ways that the students show fulfilment of the fourth of the intended learning outcomes in **Table 2**, as explained in Section 3.2. These surveys are used both to evaluate the course itself and the programme, but they can also be used for other purposes, as shown in Section 5. Many questions have been the same for several years, so it is possible to compare answers to the same questions from both different years of students and different years of the survey. At some seminars, we have given the students surveys of specific topics, such as study skills (see Section 4.3), procrastination or learning strategies (see Section 5.4). We always make a summary of the results available to the students, often as a basis for reflection and discussion.

- *Interviews with students*: students, 22 in total, of different PIC courses (PIC1, PIC2 and PIC3) and years have been interviewed by the doctoral student Emma Riese in 2018. The questions were mainly about the experience of PIC. The interviews have been transcribed and analysed.

- *Interviews with mentors*: six teachers working as mentors in different PIC courses have also been interviewed by Emma Riese, mainly about experiences of PIC. The interviews have been transcribed and analysed.

- *Survey to mentors*: a survey was sent to all mentors of PIC1, PIC2 and PIC3 in 2018. Of 25 mentors, 22 did answer the survey.

- *Document analysis*: the PIC2 reflection documents handed in by the students 2010–2016, many thousands of documents, have been automatically analysed by a language technology-based system, in order to study the progression of reflective ability and the language quality (see Sections 4.4 and 5.2).

- *Number of students studying abroad*: in order to study the influence of the seminar on the topic *studying and working abroad*, we have collected the numbers of exchange students during 5 consecutive years (see Section 4.5).

### 4.2 Experiences of the course

How do the students and mentors experience the programme integrating courses? Some results from the mandatory survey of PIC2 at the end of the academic year 2018/2019 are shown in **Table 5**. In each of these five questions, the students should answer on a Likert scale from 1 to 7 whether they agree or not to a statement. In the scale, 1 means *totally disagree* and 7 means *fully agree*. The same questions have been asked for a sequence of years, and the results are almost stable.

We can see that already from year 1, the students understand the aims of the seminars. They also, throughout the 3 years, appreciate listening to elder or younger students. The interviewed students confirmed this and even expressed that sharing an experience that could evoke change was the main benefit of the course.

The students value the programme integrating course more and more during the course of the course. At the end of the course, a majority of the students rank the fruitfulness of the course to 6 or 7 on the Likert scale. Increase of the knowledge of the education through PIC is also something that students rank higher in the third year than in the first year.

The student interviews showed that discussing the courses of the programme and how they link to each other was considered to be an important part of PIC, where the mentors were seen as gateways to change things. Some interviewed students considered some seminar topics to be nontechnical and far from what they chose to study and therefore not that valuable. The interviewed mentors confirmed that a few students' attitudes towards some topics were disappointing. Some mentors expressed that discussing these topics could be out of their own comfort zone. The proportion of students answering below 4 (i.e. were negative) to the fruitfulness of the 8 first seminars of the course varied between 8% (master programmes topic) and 28% (learning objectives, criteria and assessment topic).

Some of the interviewed students expressed that timing of the reflection assignments always was the worst possible—when all parallel courses had assignments due. One should note that the students get the assignment about 10 days before the deadline and that the assignment will take about 3 hours to complete.

Experienced mentors expressed that they were fortunate to be able to follow the development of their students throughout the 2 or 3 years of the course, to be able to learn their names, which is often not possible in the ordinary courses where the number of students is often over 200.

| | Year 1 | Year 2 | Year 3 |
|---|---|---|---|
| I understand the aims of the seminars and activities of the programme integrating course | 5.8 | 5.9 | 6.1 |
| I feel that I am better at writing reflections now than when I started the programme | 3.8 | 4.4 | 5.2 |
| It has been interesting and rewarding to listen to students from other years at the seminars | 5.9 | 5.9 | 6.0 |
| My knowledge of the education has increased considerably through PIC | 4.4 | 4.8 | 5.4 |
| Overall, the programme integrating course has been fruitful | 4.8 | 5.0 | 5.6 |

**Table 5.**
*Results from the survey 2019. The students were asked how well they agree with a set of statements on a Likert scale from 1 (I totally disagree) to 7 (I fully agree). The mean values of the answers are shown in the table.*

The students often described a good relationship with the mentor, a relationship of trust. However, not all mentors seem to be engaged to the same extent in the course. Many more experiences of PIC are reported in [28, 29].

## 4.3 Improving study skills

Hedin and Kann [30] have studied the effects of the programme integrating course PIC2 with respect to study skills. The course starts with a learning-to-learn module, consisting of the following parts:

1. The students are instructed to look at least four of nine short videos, where Björn Liljeqvist, a young specialist in study skills, explains and motivates the use of a number of study skills. They are also instructed to read a short book on how to study.

2. The students write a reflective text about their own study habits and choose at least one new study skill to try for the next months.

3. The students read each other's texts within the group.

4. The students in the group meet and discuss the topic and their reflections in a one-hour seminar.

5. About 6 weeks later, the students write a new text, reflecting on how the attempt to try a new study skill fell out, and discuss this at a new seminar.

The evaluation shows, among other things, which effects the students believed the study skills had after trying them (see **Table 6**). No significant change was found in how satisfied the students were with their overall study technique immediately after the initial module, but in the long-term, 77% of the students believed the course had promoted their ability to analyse and adapt their study habits [30]. The proportion of students who believe that PIC has promoted this is largely the same in different years and in different surveys.

## 4.4 Progression of reflection

We wanted the students to improve their ability to reflect more deeply. Therefore, we in 2012 developed and introduced a four-level model for reflections

| What is your perception of the effects on your learning of | Obvious effect (%) | Most likely effect (%) | No noticed effect (%) |
|---|---|---|---|
| Preparing before lectures? | 23 | 69 | 8 |
| Taking smart notes at lectures? | 23 | 57 | 21 |
| Going through the previous day's and week's teaching? | 23 | 63 | 15 |
| Planning my studies the upcoming week? | 49 | 40 | 11 |
| Maintaining a study diary? | 23 | 45 | 32 |
| Reading the course literature in three steps? | 44 | 37 | 19 |
| Trying to stop procrastinating? | 59 | 31 | 10 |
| Doing some other change? | 43 | 57 | 0 |
| In total (mean values) | 35 | 51 | 14 |

**Table 6.**
*Results from the postquestionnaire on the effects on the students' learning.*

(see **Table 1**) [22]. The reflection documents are graded in two passing grades, and from 2012 we required that the reflection should reach level 3 and 4 for students in years 2 and 3, in order to receive the highest grade. Since the students are reading each other's reflection documents, the first-year students could learn how to reflect more deeply when reading the reflections of the older students.

We developed a language technology-based system that is able to measure the depth of a reflection, according to the model in **Table 1** [28]. When comparing the mean reflection level of the reflection documents by the same students in the beginning of year 1 and in the end of year 3, we can see that the mean reflection level is raised from year 1 to year 3 for every student group and that the increase became larger after the introduction of the four-level model [28].

Thus, introducing the four-level reflection model and assessing the students' reflection documents using this model improved the mean progression of reflection from the beginning of the course to the end of the course.

The students are aware of this progression. When we ask them if they feel that they are better at writing reflections than when they started the programme, the students at the end of their first year do not see any clear improvement, but after year 2, and even more after year 3, the improvement is evident (see **Table 5**).

### 4.5 Inspiration for exchange studies

Before the seminar *studying and working abroad*, each student has to read about how exchange studies work and read three travel reports from students who have studied abroad. Then each student should reflect on exchange studies and discuss with the other students in the ordinary PIC way. Our hypothesis was that the introduction of this seminar should increase the number of students studying abroad. The number of students studying abroad almost doubled after the introduction of the seminar, which might indicate a correlation [28].

## 5. Usage of the course

Mandatory surveys in the course (see function 10 in Section 3.2) are an important and versatile tool. In this section, we will look at five examples of how submitted reflection documents and mandatory questions to all students in all years can be used.

### 5.1 Student-based programme development

In the mandatory questionnaire in PIC2 and PIC3 in 2016 (and again in 2019), we asked the following question: 'Give at least one proposal for how the master's programme in computer science and engineering could be improved.'

Almost 800 suggestions for improvements were received, at least one from every active student. We manually sorted and categorised the suggestions into 25 categories, with respect to what each suggestion aims to improve.

We then prioritised the suggestions: already implemented, should be implemented immediately or when possible, needs further work to become useful, save for future consideration or reject.

We selected 24 suggestions that would be possible to implement and presented them to two student representatives, who prioritised which suggestions we should proceed with in the next stage.

We proceeded with 14 suggestions. In a new mandatory questionnaire in PIC2 and PIC3, we now asked each student to evaluate each suggestion on a seven-point

scale and, optionally, comment. Finally, we analysed the evaluation and started to implement the suggestions approved by the students into the programme.

We found that it is possible to collect suggestions for improvement and opinions on them from all students that most suggestions were realistic and well founded.

Furthermore, we could see what support and what opposition each suggestion would meet if implemented. For each suggestion, we got comments showing possible positive effects or obstacles that we did not think of ourselves.

This approach, which we call *student-based programme development*, thus gives us a very good foundation for deciding whether and when the suggestions should be implemented [31].

## 5.2 Studying language quality

In Sweden, there has since 2013 been a debate in public media, where university professors, mostly from departments of history, have argued that today's students entering university are much less accomplished than earlier students when it comes to basic Swedish language skills. According to the debate, both the spelling and grammar of Swedish students are weak. The first signs of these are said to have been observed in 2010. In order to objectively study the language skills of Swedish first-year university students, we constructed an automatic tool, based on language technology, which measures the language skills that, according to the critics, have been deteriorating. We used the tool on the PIC2 reflection documents from the first seminar from seven different years, 2010–2016. The results show, surprisingly, that the language skills of the studied groups of students have not deteriorated during the period. If anything, the skills have slightly improved regarding the level of complexity of the language [32].

## 5.3 Studying competencies

The next example is an effort to find out which competencies the students had attained through studying the programme ('attained competencies') and compare these to the competencies that the programme director has stated that the programme should result in ('intended competencies').

In the mandatory questionnaire, we asked the students 'Which competencies do you think are the most important that you have developed/will develop during your studies at KTH?'

From the answers of the first-year students and fourth-year students, we built two separate sets of competencies, by clustering the student stated competencies and formulating aggregated competencies describing the simple competencies in each cluster.

When comparing the two sets to each other, we found no large differences. And when comparing the sets of competencies to the programme objectives defined by the programme director, they were unexpectedly similar. Thus, the students' collective view of the programme objectives seen as competencies was quite close to the programme director's view. This shows a good programme coherence with respect to the P $\rightleftarrows$ L edge in the programme triangle [33]. This is in contrast to Nilsson's interviewed engineers, who consider the educational and professional competence bases to be only loosely coupled [3].

## 5.4 Studying learning strategies

There are different tools for measuring learning strategies, such as deep, surface and strategic learning strategies. In mandatory surveys in PIC1 and PIC2, we have

| How often do you feel stressed because of your studies? | Uppsala | KTH Computer Science and Engineering | | | |
|---|---|---|---|---|---|
| | | Year 1 | Year 2 | Year 3 | All |
| Never | 1% | 5% | 4% | 6% | 5% |
| About every month | 12% | 30% | 28% | 19% | 12% |
| About every week | 32% | 41% | 40% | 47% | 43% |
| About every day | 55% | 24% | 28% | 29% | 27% |

**Table 7.**
*Results from Uppsala University and KTH of a stress survey question.*

used two such tools, ASSIST and RSPQ. The individual result was sent as feedback to each student, together with the summarised results of the whole group.

On group level, there are no large differences between the programmes or between the years of the students. However, there were quite large differences between the tools, especially for some individuals. Therefore, students testing their learning strategies by using one of these tools should not trust the results [34].

### 5.5 Studying stress and health

In the final example, Kann and Lundkvist [35] used the mandatory survey to replicate a study of the experience of stress among students, which had been performed at Uppsala University some months earlier. The same questions on stress were given to the PIC2 students from year 1–3:

- How often do you feel stressed because of your studies?

- If you feel stressed of your studies, what do you think are the reasons?

- To which degree do you estimate that stress is a problem/obstacle for you in your studies?

We compared the answers of the students from different years and to the Uppsala students (see **Table 7**). The most common reasons for stress among the PIC2 students were nervousness before the exams, high (own) performance demands and that leisure activities are prioritised before studies. For about half of the students, the stress is sometimes a problem.

The PIC2 students got the compiled results as a part of the reading to the seminar about *ergonomics and mental health*. This seminar was appreciated by the students—it was in fact the most popular seminar (see **Table 4**).

## 6. Discussion

The programme integrating course was given in 2008 for engineering students in Media Technology, and in 2010 the course was introduced for Computer Science and Engineering students. Thereafter the course has spread rapidly, both to other engineering programmes and to master's programmes. In 2013 it was adopted by two engineering programmes at Linköping University [36]. In 2019, there exist at least 20 successful implementations of the course in different programmes at KTH and Linköping University. The basic structure of all these courses is the same, but there have been local modifications, both in topics and in add-ons to the seminar and reflection part of the course.

There have also been a few unsuccessful attempts to start a programme integrating course, where the course has had to be removed, since it did not work. The reasons might be that the involved instructors did not believe in the course themselves and that the students got an initial bad impression of the course, which was difficult to change.

Many students express that the best part of the course is the sharing of experiences with other students, especially students from other years, at the seminars. Discussing the courses of the programme and how they link to each other was also considered to be an important part of PIC, where the mentors were seen as gateways to change things.

At a technical university, many students are sceptical to the elements of the education that they consider to be nonscientific or irrelevant to their future profession. The focus of the programme integrating course is on practicing soft skills, dispositions and attitudes, which makes it a target for such scepticism [29]. Therefore, we take care to show the direct or indirect benefit related to the engineering profession, for every topic that we introduce to the students. This is also in line with the course, since the programme objectives and the professional role are central parts of the course.

The surveys in the programme integrating course are mandatory. A high response rate is important for the quality of the results of the survey [37]. However, by forcing students to answer a survey, the quality of the answers might drop. Since the surveys are anonymous—the survey system is hiding information on who has answered what—students could write a nonsense answer to an open question without being held responsible for this. In our experience, this is not the case. It is extremely uncommon that answers are noticeably unserious. However, we do not know how often answers look serious but are untruthful. We try to make the students take the surveys seriously by asking relevant questions, by explaining the importance of the survey and by showing that former surveys have had an influence on the programme, the course itself or other courses.

From the perspective of the programme, the greatest benefit of the course is probably that it makes the student reflect regularly and with high quality, which will improve the self-regulated learning, identify problems in courses and the programme that can be swiftly handled, etc.

As shown above, the programme integrating course improves the programme coherence, which is important for a prosperous educational programme. However, Hammerness emphasises that coherence should not be viewed as an end product but rather a process 'as part of the steady work of such programs, a continuing and necessary effort of adjustment, revision and calibration' [2]. The programme integrating course has been shown to not just improve the programme coherence but also to have many other functions.

Further research should investigate the concept of programme coherence more deeply and study other ways of improving the programme coherence, besides programme integrating courses. Another area needing more research is the effect of different forms of reflection seminars, such as the full-group seminar, the split group seminar and the walking seminar [24]. The question why some attempts to introduce programme integrating courses fail while others (a clear majority) are successful would also be valuable to study in more detail.

## 7. Conclusions

In this chapter, we have explained how a *programme integrating course* can strengthen the six different relations involved in the programme triangle (**Figure 1**), between the students, the instructors and the programme director, in short improve the *programme coherence*.

In Section 3, we presented 10 important functions of the course, for example, academic introduction, increased understanding of the programme, connections between teachers and students, exchange of experiences between students from different years of the programme, education of the instructors involved and quality-enhancing evaluation of the programme.

We have seen that the students in general understand the aims and activities of the course, appreciate meeting and learning from students from other years at the seminars and overall think that the course is fruitful. As the course advances for three academic years, the students increase their knowledge about their education, improve their ability to reflect and improve their study skills. Their appreciation of the course grows for each year. We can see that the students develop in each of the three dimensions of self-regulated learning: metacognition, motivation and good habits. We have also seen that a topic at a single seminar can have a clear effect, since the number of students studying abroad almost doubled after the introduction of a seminar on studying and working abroad.

Finally, in Section 5 we showed that the course can also be used as a vehicle for student-based programme development and studies of different student related variables, such as language skills, learning strategies and stress.

A programme integrating course could be a valuable addition to any engineering education programme. The course takes very little space in the curriculum (the reflection seminar part of the course can fit in as little as 1 ᴱᶜᵀˢ credit per year) and the gains from introducing the course can be substantial, especially for programmes where the programme coherence is weak or where the academic introduction is unsatisfactory. The topics of the seminars should be chosen to fit the current needs of the specific programme.

We suggest that every programme director of an engineering educational programme should seriously consider starting a programme integrating course, based on the general model described in this chapter and adapted to the local situation at the university and of the specific programme.


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## References

[1] Sedlak MW. Tomorrow's teachers: The essential arguments of the Holmes group report. Teachers College Record. 1987;**88**:314-325

[2] Hammerness KM. From coherence in theory to coherence in practice. Teachers College Record. 2006;**108**:1241-1265

[3] Nilsson S. On the meaning of higher education in professional practice: The case of physicians and engineers. Journal of Education and Work. 2010;**23**:255-274. DOI: 10.1080/13639080.2010.486397

[4] Jessop T, El Hakim Y, Gibbs G. The whole is greater than the sum of its parts: A large-scale study of students' learning in response to different programme assessment patterns. Assessment and Evaluation in Higher Education. 2014;**39**:73-88. DOI: 10.1080/02602938.2013.792108

[5] Schön DA. Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions. San Francisco, CA: Jossey-Bass; 1987

[6] Boud D, Falchikov N. Aligning assessment with long-term learning. Assessment and Evaluation in Higher Education. 2006;**31**:399-413. DOI: 10.1080/02602930600679050

[7] Guardini R. Die Verantwortung des Studenten für die Kultur. In: Die Verantwortung der Universität. Würzburg: Werkbund Verlag; 1954

[8] Buchmann M, Floden RE. Coherence, the rebel angel. Educational Research. 1992;**21**:6-9. DOI: 10.3102/0013189X021009004

[9] Grossman P, Hammerness KM, McDonald M, Ronfeldt M. Constructing coherence: Structural predictors of perceptions of coherence in NYC teacher education programs. Journal of Teacher Education. 2008;**59**:273-287. DOI: 10.1177/0022487108322127

[10] Smeby J-C, Heggen K. Coherence and the development of professional knowledge and skills. Journal of Education and Work. 2014;**27**:71-91. DOI: 10.1080/13639080.2012.718749

[11] Tatto MT. Examining values and beliefs about teaching diverse students: Understanding the challenges for teacher education. Educational Evaluation and Policy Analysis. 1996;**18**:155-180. DOI: 10.3102/01623737018002155

[12] Crawley E, Malmqvist J, Östlund S, Brodeur D. Rethinking Engineering Education: The CDIO Approach. Boston, MA, US: Springer; 2007. DOI: 10.1007/978-0-387-38290-6

[13] van den Akker J. Curriculum perspectives: An introduction. In: van den Akker J, Kuiper W, Hameyer U, editors. Curriculum Landscapes and Trends. Dordrecht: Springer; 2004. pp. 1-10. DOI: 10.1007/978-94-017-1205-7

[14] Ling Lo M. Variation theory and the improvement of teaching and learning. In: Gothenburg Studies in Educational Sciences. Vol. 323. Göteborg: Acta Universitatis Gothoburgensis; 2012

[15] Pintrich PR, Zusho A. Student motivation and self-regulated learning in the college classroom. In: Smart JC, Tierney WG, editors. Higher Education: Handbook of Theory and Research. Dordrecht: Springer; 2002. pp. 55-128. DOI: 10.1007/978-94-010-0245-5

[16] Bail FT, Zhang S, Tachiyama GT. Effects of a self-regulated learning course on the academic performance and graduation rate of college students in an academic support

program. Journal of College Reading and Learning. 2008;**39**:54-73. DOI: 10.1080/10790195.2008.10850312

[17] Torenbeek M, Jansen E, Suhre C. Predicting undergraduates' academic achievement: The role of the curriculum, time investment and self-regulated learning. Studies in Higher Education. 2013;**38**:1393-1406. DOI: 10.1080/03075079.2011.640996

[18] Zimmerman BJ. Self-regulated learning and academic achievement: An overview. Educational Psychologist. 1990;**25**:3-17. DOI: 10.1207/s15326985ep2501_2

[19] Nicol DJ, Macfarlane-Dick D. Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. Studies in Higher Education. 2006;**31**:199-218. DOI: 10.1080/03075070600572090

[20] Cajander Å, Daniels M, McDermott R, Von Konsky BR. Assessing professional skills in engineering education. In: Proceedings of the Thirteenth Australasian Computing Education Conference. Vol. 114. Australian Computer Society, Inc; 2011. pp. 145-154

[21] Hatton N, Smith D. Reflection in teacher education: Towards definition and implementation. Teaching and Teacher Education. 1995;**11**:33-49. DOI: 10.1016/0742-051X(94)00012-U

[22] Kann V, Magnell M. Reflektionsseminarier som håller ihop och utvecklar programmet. In: Proceedings of 4th Development Conference for Swedish Engineering Educations. Umeå University; 2013

[23] Hedin B. Program integrating course: A tool for reflection and quality management. In: Proceedings of the 2nd Development Conference for Swedish Engineering Educations. Lund University; 2009. pp. 138-139

[24] Bälter O, Hedin B, Tobiasson H, Toivanen S. Walking outdoors during seminars improved perceived seminar quality and sense of well-being among participants. International Journal of Environmental Research and Public Health. 2018;**15**:303. DOI: 10.3390/ijerph15020303

[25] Kann V. A program integrating course with many functions (in Swedish). In: Proceedings of the 3rd Development Conference for Swedish Engineering Educations. Linköping University; 2011. pp. 153-156

[26] Andersson S, Andersson Chronholm J, Victor B. Working actively with student integration and retention. In: Proceedings of the 3rd Development Conference for Swedish Engineering Educations. Linköping University; 2011

[27] Kann V. Using reflections in a program integrating course. In: Proceedings of the 19th Annual ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE'14), Uppsala. New York, NY: ACM; 2014. p. 350. DOI: 10.1145/2591708.2602664

[28] Kann V, Högfeldt A-K. Effects of a program integrating course for students of computer science and engineering. In: Proceedings of the 47th ACM Technical Symposium on Computing Science Education (SIGCSE'16); Memphis. New York, NY: ACM; 2016. pp. 510-515. DOI: 10.1145/2839509.2844610

[29] Riese E, Bälter O, Hedin B, Kann V. Programme integrating courses fighting to get engineers to reflect on non-technical topics. In: Proceedings of the 24th Annual ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE'19), Aberdeen, UK, New York, NY: ACM; 2019. pp. 133-139. DOI: 10.1145/3304221.3319754

[30] Hedin B, Kann V. Improving study skills by combining a study skill module

and repeated reflection seminars. Education Research International. 2019;**2019**:8 Article ID 9739854. DOI: 10.1155/2019/9739854

[31] Kann V, Ekeberg Ö. Student based program development. In: Proceedings of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE'18), Larnaca, Cyprus. New York, NY: ACM; 2018. p. 379. DOI: 10.1145/3197091.3205818

[32] Kann V. Blir studenternas språk sämre? In: Proceedings of the 6th Swedish Language Technology Conference (SLTC). Umeå University; 2016

[33] Frezza S et al. Modelling competencies for computing education beyond 2020: A research based approach to defining competencies in the computing disciplines. In: Proceedings Companion of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE'18). New York, NY: ACM; 2018. pp. 148-174. DOI: 10.1145/3293881.3295782

[34] Bälter O, Colareti Tosti M, Kann V, Svedin M. Lärstrategier på längden och tvären. In: Proceedings of 5th Development Conference for Swedish Engineering Educations. Uppsala University; 2015

[35] Kann V, Lundkvist E. Studenters stress studeras och skärskådas. In: Proceedings of 2nd Scholarship of Teaching and Learning Conference. KTH; 2019

[36] Heintz F, Berglund A, Hedin B, Kann V. Proceedings of the 5th Development Conference for Swedish Engineering Educations. Uppsala University; 2015

[37] Nulty DD. The adequacy of response rates to online and paper surveys: What can be done? Assessment & Evaluation in Higher Education. 2008;**33**:301-314. DOI: 10.1080/02602930701293231