Course Integration as Learning Environment for Increasing Competence

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Abstract

Creating a realistic learning environment for Systems Analyst and Design (SAD) students is a challenge. Integrating discipline-oriented courses is one way of creating such an environment. This paper discusses a possible integration between two courses where the courses provide a basis for experiences that enrich the learning environment and give the students important competence in the IS field. The paper describes levels of integration and some consequences for students and lecturers. The discussion ends in a proposal for integration of the two courses. The integration of the courses will be on a so-called temporal co-ordination level where the main contributory factors are deliverables and the co-ordination of time allotted to the courses. The question of course integration is seen both from the lecturers' perspective and the students' perspective. The integration was tried out in the spring term 2002.

Keywords: Competence, interdisciplinarity, learning environments, course integration

Introduction

The final year of the IT and information systems (IS) undergraduate study at Agder University College (AUC) includes a 2.5 credit course in project work and quality assurance (QA), and a 5 credit project based course in application development. In this paper we sketch a possible integration of these two parallel courses, creating a learning environment based on the simultaneity and complementary objectives and content of the two courses.

We aim at answering the following question: How can an integration of the two courses provide a better learning environment for the IS students?

Students that attend the two courses are educated to become Systems Analysts and Designers (SADs). The courses are designed to contribute to building their competence in developing information systems (IS).

In the paper we discuss course objectives, include a competence perspective, present concepts of interdisciplinarity and integration, and propose a feasible integration of the two courses. The integration is based on the competence and integration models presented.

Course Objectives

The integration is based on the learning objectives of the two courses. In the following we present the objectives of the courses and discuss the integration of them. We discuss the possibilities of reaching these objectives at the end of the paper.

IS-3000 Project - Application Development

The course aims at

- providing an overall understanding as well as practical experience in computer-based information systems development
- providing students with an opportunity to apply, integrate and reflect on acquired skills in the course
- developing professional communication and collaboration skills

IS-3200: Project Work and Quality Assurance

This course introduces

- the significance and function of quality assurance (QA). A comprehensive understanding of quality is emphasised
- an efficient project management (PM) which is essential to control and co-ordinate the different development and QA activities in a systems development project
- different theories, principles and techniques of the QA field

Compatibility of the Course Objectives

The objectives of the two courses are complementary. There is no inherent contradiction to dissuade us from attempting course integration. And there are arguments for integration, to be presented later.

The IS-3000 course is a practical project in developing IS. The course integrates knowledge that the students have acquired earlier in the study programme. A practical project is a common way of integrating different subjects.

As for IS-3000 the IS-3200 course expands the realistic practical experience in developing computer-based IS, by providing guidelines for PM and QA.

IS-3000 provides an arena for practising theories learnt in IS-3200 as the latter course aims at securing quality in the development process and in the finished product. The students can to some extent test the theories they learn in IS-3200 on their work in IS-3000.

The following topics are related to both courses:

- Project management (estimates, planning, tracking)
- The systems development process (analysis, requirements, controlling changes, inspections, testing, process improvement)

The following topics are only related to IS-3200:

- Overview of QA methods (TQM, ISO 9001, CMM)
- Vendor relationships
- Configuration management

The following topics are only related to IS-3000:

- SW development tools

For a more complete description of the interface between the two courses, we will later present a list of deliverables (Table 2). The courses are compatible and their objectives may benefit from integration. When presented with an outline of an integration of the two courses, former students felt that integration would benefit both courses. A possible disadvantage may be that practical projects consume time. The students have to cope with the nitty-gritty details of the projects. That may "steal" time from the more theoretical learning process. A limitation is the small scale of the projects, 1100-1400 hours.

Course Objectives and the IS Field

Dahlbom and Mathiassen (1997) discuss the computer science profession. One part of their conclusion reads as follows: "Over the years, the focus of our profession has shifted from numerical analysis to programming to software engineering to human-computer interaction to networking." This expresses that the profession is arriving at a more holistic view consisting of an artefact focus, a culture focus, and a power focus (Dahlbom and Mathiassen, 1997).

Dahlbom and Mathiassen are discussing the computer science profession, we are discussing the IS field. Use of IT is spreading to every trade and used for many different purposes. That should call for a more holistic perspective on developing IS. At the same time different parts of an IS get more and more complex requiring specialists that know these parts in detail and thereby may loos the holistic perspective. By integrating courses we hope to move our students towards a more holistic perspective on IS development, with a practical project being a substantial means for learning.

The SAD will need different skills to master the daily tasks in ever changing environments. That does not necessarily imply that every SAD need the same skills, but it certainly implies that any given group of SADs need to master the competencies necessary to develop successful information systems. Both courses' objectives contribute to this goal.

Let us take a closer look at competence and how to obtain it.

Competence

Competence as a concept is demanding to define. We will therefore attempt to approach competence from different perspectives. The first entry under competence in Webster (1993) reads: "a sufficient supply; SUFFICIENCY". The Concise Oxford Dictionary (Sykes, 1982) defines competence as "ability to do" something or "ability for a task". Competence has a practical dimension in that it gives the holder sufficient ability to carry out something.

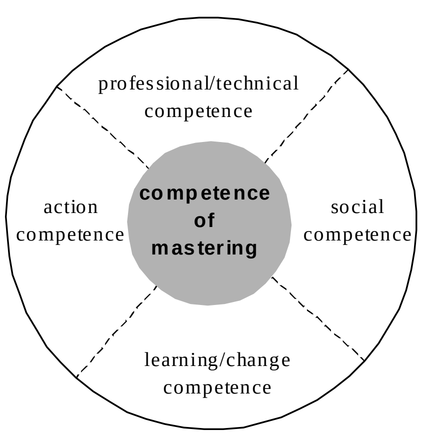

Figure 1: Competence of mastering

Competence will always be used in a context. Some types of competence are more general and may be valid and useful in different contexts. Developing IS calls for a competence of mastering, that a person/organisation have sufficient competence to master the daily tasks needed for systems development. The competence of mastering is a generic competence that consists of other competencies (Borgen), Figure 1.

All these competencies are necessary to master the systems development process. Depending on the actual task, the optimal mix of these competencies may differ, i.e. in a situation where human communication is important, the social competence is more important. In other situations technical competencies may be more important. The SA has to work with different actors demanding unique mixes of competencies.

The world is complex. We create models to understand the world. Ciborra (1998) states that using a model to describe the world requires knowledge of the world, or the situation, in order to understand and interpret the model. The consequences in the IS field is that the SA must know, at least to a certain degree, the actual organisation in order to apply models for developing the IS. To obtain knowledge about the organisation, the people working there, routines etc., the SA needs to communicate with an open mind focusing on people, instead of his methods or tools, especially in the early phases of the development process. In such situations it is important to keep both artefacts, culture and power focus.

This calls for organisational competence. Organisational competence is learnt in an organisational learning environment and may imply interdisciplinarity. Our understanding of IS follows Checkland and Holwell (1998), regarding IS as IT used in a context. The context is normally an organisation or an organisational unit, and is represented by the users of the application (Dahlbom and Mathiassen, 1997).

We assume IS competence to be a kind of integrated or interdisciplinary competence. Hager and Gonczi (1996), argue that the concept of integrated competence may be conceptualised as interpersonal skills, cognitive skills, affective attributes and technical skills in the context of professional tasks. This also fits with the view of user competence as the user's potential to apply technology to its fullest possible extent (Marcolin et.al., 2000).

To emphasise IS competence as opposed to IT competence can be said to conform to the more recent understandings of computer literacy. According to Gripenberg (1998), the concept of computer literacy has moved from focusing on special knowledge domains with pre-specified levels of competence, to a more functional view that focus more on if and how well people can perform with the computer in a context where they can solve their primary tasks. Dahlbom and Mathiassen (1997) also support this change of focus.

The competence model presented is a general competence model. When it is used in the IS field and filled with specifics of IS, it will be contextualised and contain more IS specific competence.

We believe that projects are good learning environments for students to build competence. The IS field is complex and diverse. Different actors exercise power in the process and may have their own agenda in the development of the IS. These agendas may be different from the main agenda for the development project, if such agenda exists. These differences may surface in an actual setting and provide an important aspect of the learning environment.

Integration of the two courses in this case provides at least a more complex environment for the students. The objective of integration is to provide a learning environment where the students can get competencies that are not obtainable by running the courses separately. Competence in integrating disciplines is one example. Such integration will also provide a rich environment for reflection.

Before we discuss the practicalities of the integration between the two courses it is necessary to discuss and decide on the kind of integration that is possible and acceptable.

Course Integration

Courses or subjects are integrated to reach some objectives. These objectives will influence the type of integration and may involve two basic forms of integration, namely multidisiplinarity and interdisciplinarity. We will discuss these two forms in relation to our courses.

Discipline may be defined as a branch of learning or a field of study characterised by a body of intersubjectively acceptable knowledge, pertaining to a well-defined realm of entities (Kockelmans, 1979). In our case the two courses represent partially overlapping subjects consisting of features from many distinct disciplines.

Interdisciplinarity may be seen as bringing together distinctive components of two or more disciplines (Nissani, 1997). The term interdisciplinary implies a synthesis or integration, so we may also use the term integrated. Klein (1990) uses the two terms interchangeably.

The term interdisciplinary needs to be distinguished from multidisciplinary. Kockelmans (1979) describes multidisciplinary as related to more than one discipline, although there may be no connection at all between the disciplines involved. Multidisciplinarity can be seen as a juxtaposition of established disciplines, it is essentially additive and not integrative (Klein, 1990). These concepts are not to be confused with transdisciplinarity, a quest for unified knowledge that is outside our focus of interest.

Two alternative ways of illustrating interdisciplinarity is Figure 2 (inspired by Klein, 1990) and Figure 3 (from Harden, 2000). Both emphasise the integration of competencies (A, B, and C) that leads to new competence (D).

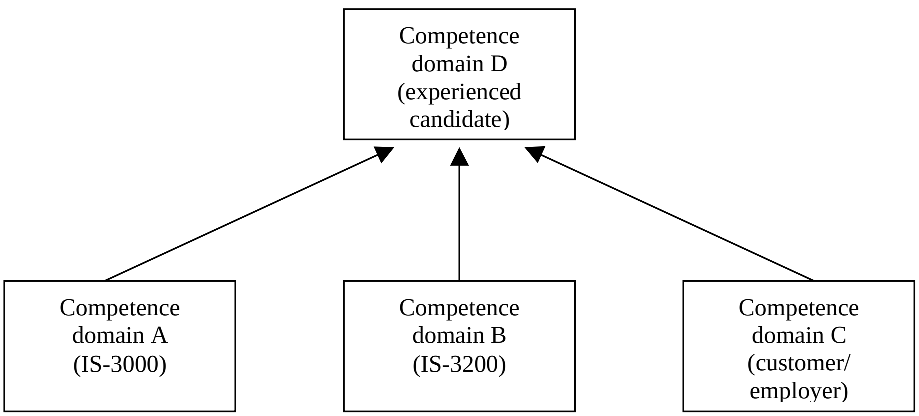

Figure 2. An illustration of interdisciplinary competence

According to Nissani (1995) one may describe interdisciplinarity by weighing 4 variables: the number of disciplines, the distance between them, the degree of novelty, and the degree of integration.

If we look at the IS profession itself, it is by nature interdisciplinary. The study of Lee and Trauth (1995) shows that to be an IS professional demands knowledge and skills in technology, management and interpersonal relations. Their study shows that this requires co-operative efforts and multidisciplinary or even interdisciplinary approaches to IS education. In their own words:

> "our results also indicate that IS graduates will require both more breath and depth of
>
> education across the dimensions of technology, business, and human relations".

We can easily relate these three dimensions to our competence domains in Figure 2 and 3.

Systems development projects imply at least multidisciplinarity. We may regard IT development project teams as largely multidisciplinary, involving team members from several disciplines. But the IT system itself may be re-

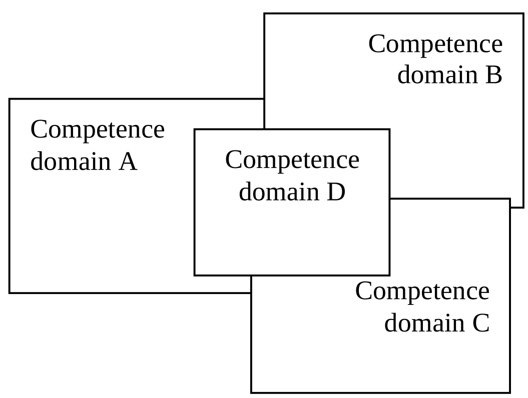

Figure 3. An alternative view of interdisciplinary competence

garded as interdisciplinary; it represents an integration that is more than the sum of its parts.

The course integration planned in this case, will hopefully imply that a project (IS-3000) with better process and product quality is carried out, and that the practical consequences of QA (IS-3200) is experienced in real life. This could hardly be accomplished if the two courses were run in isolation.

Integration: A Balance between Ambition and Benefits

A finer distinction than the multi/interdisciplinary distinction given previously is found in Harden's (2000) article. From a medical education viewpoint he formulates what he calls an integration ladder. This ladder consists of 11 steps moving from discipline based to integrated teaching and learning (See figure 4).

In the first 4 steps (isolation, awareness, harmonisation, nesting), the emphasis is on the distinct subjects or disciplines. Moving up the integration ladder, the last 7 steps emphasise integration across several disciplines (temporal co-ordination, sharing, correlation, complementary, multidisciplinary, interdisciplinary, and transdisciplinary). This fine-grained taxonomy proposed by Harden (2000) may be useful for classifying and planning IT/IS competence development in itself, as well as developing the application domain competence that is so crucial to business. Nevertheless we may well have in mind that Berger (Apostel, 1972) warns that hierarchies are ill advised in the absence of well-developed theory.

Using Harden's (2000) integration ladder as a curriculum-planning tool, we will discuss feasible integration options (see Figure 4) and the possible integrated competence the students may get.

Beginning from the bottom of the ladder, isolation (step 1) would mean that each of the two courses was taught independently, paying no attention to the other course. In the case of awareness (step 2), one lecturer would be aware of the contents of the other course, and be able to avoid any overlap between the two courses. Moving up to harmonisation (step 3) would imply a communication and consultation about the two courses, adapting to each other's curricula. Nesting (step 4) the two courses means targeting skills related to the other course, so that teaching is related to the broader curriculum outcomes of the sum of the two courses.

At present we focus on a possible integration at step 5-7 and will therefore give more details on these steps. In temporal co-ordination (step 5) each course is responsible for it's own teaching. But a temporal co-ordination of the two courses would include adjusting the dates when different topics are taught. The students themselves are expected to uncover the relationships between the two parallel courses. Very often the so-called 'integrated teaching programmes' are in practice temporally co-ordinated programmes.

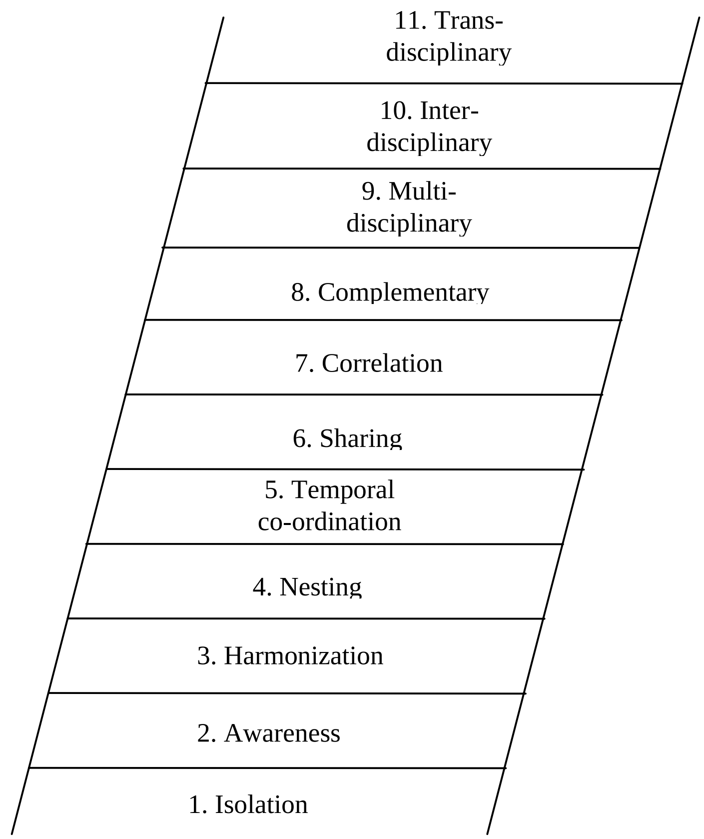

Figure 4. Harden's integration ladder

A sharing (step 6) would imply joint teaching in the two courses, with a focus on the shared concepts, skills and attitudes. Typically this would be a situation where two departments share parts of a common course, and the course is considered an end in itself. Moving further towards integration, we could try correlation (step 7). This means that emphasis would still be on the different courses, with discipline-based courses taking up most of the time. But in addition integrated teaching sessions would be introduced, to bring together areas of common interest to each of the courses.

Moving on to a higher degree of integration, a complementary programme (step 8) would have some subject-based teaching, but the common or integrated sessions would constitute the dominant part of the courses. The higher integration steps (9-11) were included in our preceding discussion of course integration concepts.

Our focus on the level or degree of course integration needs to be put in perspective. The degree of integration is the only independent variable we consider here, and we assume that it is important for the learning outcome. This is illustrated in Figure 5.

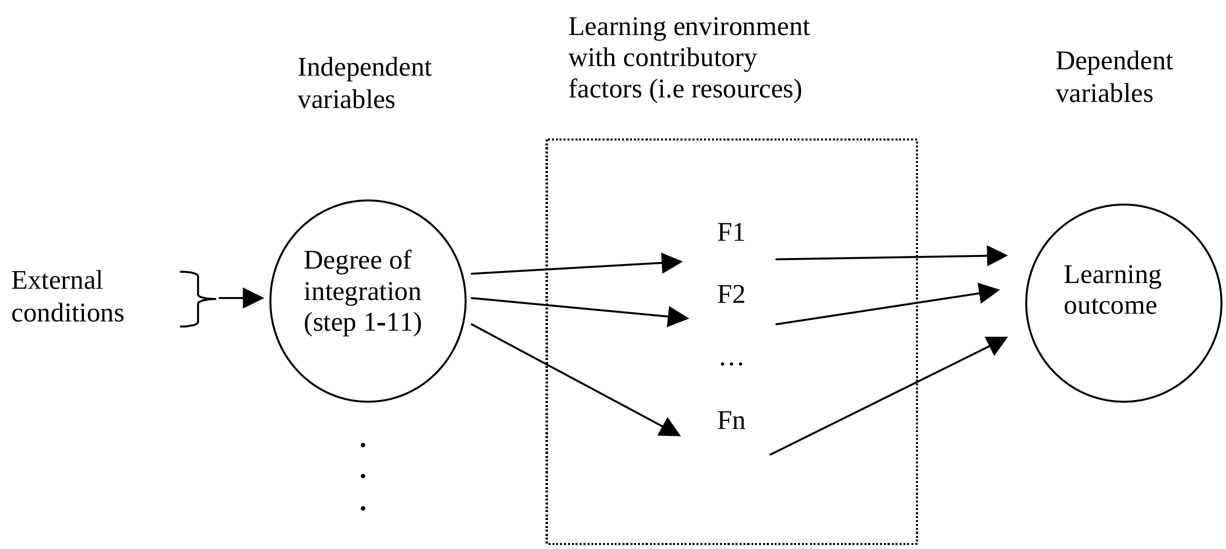

Figure 5. Relationship between degree of integration, resources and learning outcome

In the following we will discuss the most important contributing factors. Harden (2000) is mainly focusing on course integration from the lecturers' point of view. As we include the learning outcome in our framework we need to consider contributing factors for the students' part as well. Harden's ladder that we use from the lecturer's perspective has the contributing factor: parallel or concurrent teaching with co-ordination of similar elements in the different courses (step 5).

In IS-3000 there is no lecturing at all. In our integration we have therefore used deliverables like plans and reports to co-ordinate activities. These deliverables are designed to apply knowledge from one course to perform activities in the other course i.e. the quality plan to be delivered in IS-3200 is based upon the actual project in IS-3000.

In IS-3000 project supervision is a contributory factor for the lecturers' part. It is supposed to function as a practical help in the project and is carried out in a group setting. Students are prepared for the actual systems development through courses earlier in their study.

So far we have discussed the lecturer's perspective in the integration, i.e. course integration. The student's perspective is considered to be integration of knowledge and thereby increased competence. The following factors are considered as important for integration on the student's part:

- project
- integration of discipline knowledge
- use of different competencies
- experiences
- reflection
- receive supervision.

The basic learning environment is project work. The students are required to do projects that require integration of different discipline knowledge. These factors are therefore not regarded as course integration factors, but as knowledge integration factors. This is the basic reason for organising the IS-3000 course as a project. In this learning environment we find that integration for the student's part in fact may reach as high as step 8 in Harden's ladder. Even though Harden does not describe students' knowledge integration, we assume an improved learning outcome.

	Course integration (Lecturer part)	Knowledge integration (Students part)
Contributory factors	Parallel/concurrent teaching Co-ordination of deliverables Supervision of projects	Project Integrate discipline knowledge Use of different competencies Experiences Reflection Receive supervision
Level of integration	Step 5	Step 8

Table 1. Contributory factors of the learning environment

As lecturers we attempt to integrate the courses at step 5, temporal co-ordination. Due to the project in IS-3000 and the contributory factors we expect the integration for the students' part to be at a higher level than the lecturers' temporal co-ordination (step 5). Table 1 gives an overview of the integrating factors.

The contributory factors are important for the following affected interest groups: students, lecturers, potential employers and the college. In figure 6 we display the relationship between the students and lecturers as the two major interest groups, the contributory factors, and degree of integration.

The factors in table 1 are expected to contribute to increased competence. In the following we will discuss some of factors in the implementation of the courses. The details will be discussed later under the chapter: Plans for a pragmatic implementation.

Lecturers' Contributory Factors

We follow Harden's ladder and add supervision. Supervision is to some extent a substitute for the lecturing in IS-3000.

Students' Contributory Factors

The frame for the students' activities is the project. Within the project context the other activities will take place.

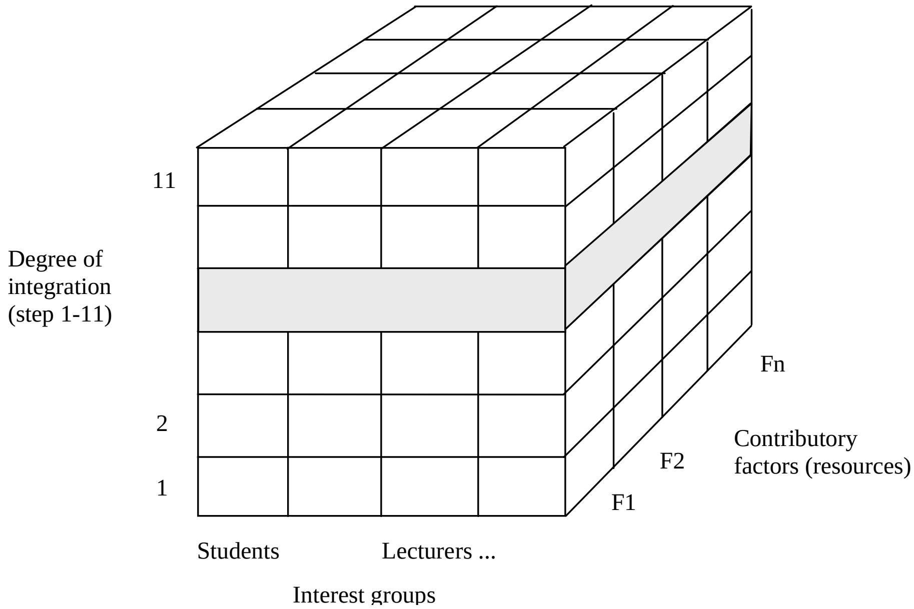

Figure 6. Interaction between interest groups and contributory factors

The students have to apply knowledge from different disciplines, both from IS-3200 and previous courses. This knowledge has to be integrated in the project and its context. The students have to master their development task and thereby utilise the four different types of competence, namely the social competence, professional competence, action competence and learning/change competence. Although it is difficult to establish a direct relationship between the use of these competencies and the end result, it is assumed that the quality of the result, i.e. the developed IS will depend on the use of these competencies. In our context the students have to write reports, present their work orally and have their work assessed. We assume that the assessment activities will reveal an increased competence. The students themselves will document some of the increase of competence as they are expected to reflect on the experiences they encounter during the project work.

The basic elements of our implementation are projects, group work, deliverables and assessment.

Projects

Projects are useful as interdisciplinary learning environments especially if they contain problem solving requiring different disciplines. In our case the project integrates the systems development exercise with the quality assurance discipline. The students have to practice quality assurance and are measured according to their competence to implement quality in their projects. In the IS-3000 course the projects are not approved before they reach a certain complexity. That means the students have to handle complexity. The introduction of the quality aspect increases complexity and thereby an experience not achieved if the courses were run separately.

Project groups give the students opportunities to practice the skills of communication both internally in the group and externally.

Deliverables

Some of the deliverables are common for the two courses. The students have to consider how to satisfy requirements from both courses and thereby get experiences in communication with focus on integration.

Some of the deliverables require a reflection that demands interdisciplinary thinking.

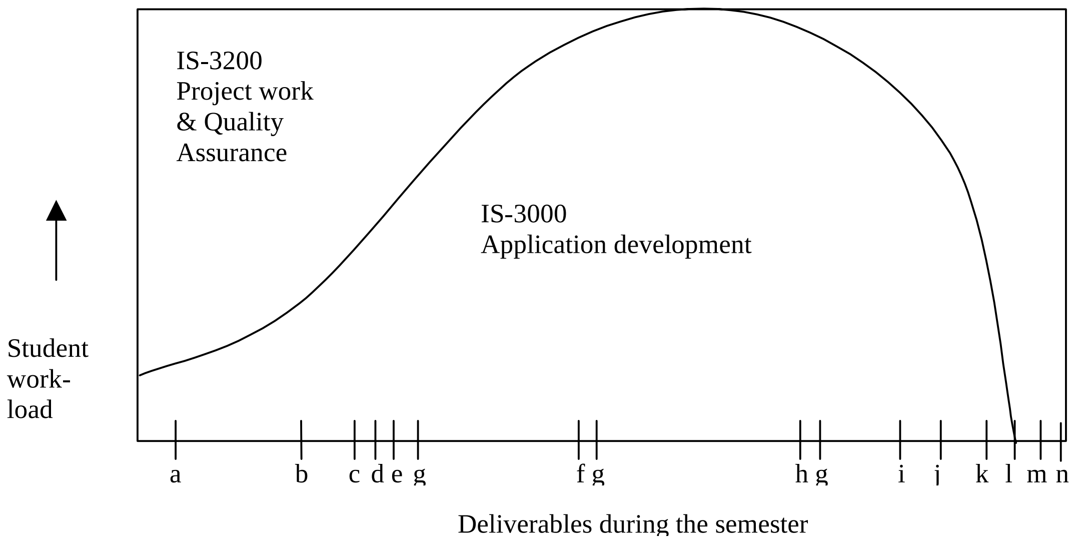

Figure 7. Suggested course integration with deliverables

Student Assessment

The ways the students are assessed will indicate what the lecturers deem important. Our experience is that students are eager to solve the technical problems. They are less competent in communication and designing their own development process to fit the actual context. We therefore emphasise communicative competence and the competence to reflect on the different problems the students meet during the project work. The students must integrate the quality assurance disciplines with the systems development exercise and be able to reflect on this integration. This reflection is recorded in a study report.

Provision of this learning environment can not guarantee increased competence. The actual increase in competence depends on the students' own efforts.

A Pragmatic Implementation

For the lecturers' part we integrate at the temporal co-ordination level. To move further up the integration ladder would require extensive and time-consuming syllabus changes. We will not discard further integration in the future, but we prefer a cautious and stepwise integration where the effects can be evaluated. This also fits well with the quality reform of higher education to be implemented in 2003.

Most of the contributory factors for the lecturers' part are integrated in the courses by co-ordinating deliverables and teaching as illustrated in Figure 7. The teaching in IS-3200 is adjusted to contribute to the progress of IS-3000.

Deliverables a-n are listed in table 2. In the beginning of the semester IS-3200 occupies much time for providing the theory for the QA aspects of the project. The theoretical knowledge for IS-3000 is provided in earlier semesters. Later in the semester more time is provided for the project work. After the project is finished and the deliverables in IS-3000 are all handed in, the students will have time to finish the required deliverables in IS-3200.

For the students' part the contributing factors may provide learning through the actual project work and production of reports. Plans/reports mentioned as items a, b, c, d, l, and m can only be produced successfully by integrating knowledge from the two courses and relying upon the experiences from the project work. Reports j, n, and i cannot be successfully completed without the students integrating experiences from the project with the theories they base their development on.

We will in the following discuss changes in the assessment and deliverables. Finally we will briefly mention other elements in the courses.

Assessment of Learning Outcome

To assess the learning we examine the students. In IS-3000 the assessment will be arranged as described below. The exam is inspired by practices at Aalborg University, Denmark.

Assessment will be based on written reports and an oral group exam. The student groups shall deliver the following written reports:

1. A systems development report that describes the development, the choices, successes and failures in the work they have done and the result of the work.
2. A study report that reflects on the work done in the project. The students have to choose some theories to reflect from and compare their experiences with.
3. A report describing the co-operation in the group. This report will also contain reflections of why the co-operation developed as it did.
4. A short individual evaluation of the other students in the group.

The students will participate in an oral group exam where they present the project and are examined both in the product they have produced and the reports they have written. This examination will include reflection on their work and presentation of different perspectives both on the reports and the product/application.

The assessment results in an individual grade and will be based on the written reports, the oral group ex-

Deliverables	IS-3000	IS-3200
a) Preliminary project plan	X	X
b) Quality plan I (without test plans)		X
c) Revised project plan	X	X
d) Quality plan II (test plans)		X
e) Analysis documentation	X	
f) Design documentation	X	
g) Steering committee documents	X	
h) Implementation documentation	X	
i) Systems development report	X	
j) Study report	X	
k) Group work experience report	X	
l) Quality evaluation report		X
m) Project tracking and evaluation report		X
n) Self and group evaluation for the exam	X	

Table 2. Deliverables

amination and the students` evaluation of themselves and each other.

These elements require the students to communicate and understand that good communication is dependent upon competencies given in the competence model. The exam itself will also be a learning situation where the students can practice the competence they have obtained and integrate the different subjects to form a holistic view of both their work, the result of their work, the users' needs and their own group process.

Required deliverables are described in table 2. These deliverables constitute the reports mentioned above.

The project management evaluation report includes reflecting on how successful the project (IS-3000) was, compared to the theory (IS-3200). Reflection and evaluation on how useful the theoretical quality (QA) and project (PM) subject matter (IS-3200) was for a successful real life project (IS-3000) are included in the study report in IS-3000.

Figure 8 illustrates a co-ordination of these deliverables based on time elapsed in the project.

Groups and Responsibilities

The project is carried out by groups of 4-6 students.

The students are responsible for finding the projects. Students are encouraged to utilise their network to find projects in ordinary companies. Hopefully they get access to project partners that are willing to use time on the project. The projects have to be approved by the lecturers assuring that the projects have the complexity and variety required.

The groups will receive supervision during the project work, both in the development of the system and in the group processes.

Groups provide an environment for communication and therefore opportunities for building competence in that field. It also provides a more complex environment that the students will have if they work individually. A group of 4 to 5 students has capacity to solve more complex problems contributing to more learning. The group organisation will give the students a feel for the need of organisational competence. The relative close co-operation with companies will also build some organisational competence.

Evaluation of the Course Integration

An ideal evaluation would include a control group, but this is not possible because of limited resources. Instead we will interview former students and use their retrospective reflection, and compare with evaluations from previous years with no course integration. After one semester we will evaluate whether course integration gives the expected benefits. In this semester the evaluation will mainly be based on the students self report and our evaluation of the courses.

Conclusion

The two courses described lend themselves to integration as the theoretical IS-3200 can use the IS-3000 project as a practical case, and IS-3000 will be even more realistic as the element of quality is integrated and followed up throughout the project. There are no conflicts in the objectives of the two courses in relation to the integration and the expected learning results. The hard work in the integration process will probably be the practical work of putting the plan into practice.

Students taking the courses can build and test their competencies in each of the two disciplines. The learning environment provides opportunities to integrate the two courses and experience the resulting opportunities and problems. These learning opportunities continue until the assessment is conducted.

Integration of the two courses provides, in our opinion, a better and more realistic learning environment for the students, and is more inspiring for the lecturers.

The final test of the integration and the creation of a better learning environment rest with the lecturers, the students and the implementation of the proposed plan. It can only be tried out and measured afterwards.

The feedback from the students on the integration will be input to a discussion whether further integration might provide an even better learning environment. Contrary to our expectations, the student feedback may even indicate a lower learning outcome of the integration than two isolated courses.

In future research it could be interesting to see whether teaching at step 5 can enable students to integrate knowledge at even higher steps, such as step 8 on the integration ladder. Testing the possible knowledge integration is another future challenge.

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Biographies

Stig Nordheim (M.Sc.) has industrial and academic experience with different teaching methods. Current research interests include IS competence.

Hans Olav Omland is researching competence needed for Systems Analysts and designers to design Information Systems. Current research interests include both IS professional competence itself and competence needed to use the IS competence.