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# Teaching Object-Oriented Design with UML – A Blended Learning Approach

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The institute transfers innovative software development techniques, methods and tools into industrial practice, assists companies in building software competencies customized to their needs, and helps them to establish a competitive market position.

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## Abstract

With the rapid rate of innovation in object-technology, teaching, learning has become the most challenging issue. Software organizations have to systematically train and educate their developers in order to benefit from object-technology. However, tight project schedules and short development cycles often prohibit traditional class-room education. Therefore, e-learning approaches are becoming more and more popular, although these have a lack of social communication. This paper describes a blended learning approach, which mixes traditional classes and online courses. Although, both approaches have their strengths and weaknesses the synergy effects when used in combination clearly outweighs the isolated benefits of the approaches.



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# 1 Introduction

Long-term success in software development is becoming increasingly challenging. Development organizations must not only reconcile the demand for more powerful, higher-quality applications with the market pressure for increasingly rapid development schedules and reduced costs, but must also contend with the ever-growing range of technologies. The software industry is therefore increasingly turning to object-oriented and component-based software development approaches which, if correctly applied, promise to provide benefits such as improved reuse, short development cycles, and a larger than normal return on software development effort. However, to really benefit from object- or component-technology it has to be applied correctly. Therefore, developers do not only have to “think in objects” but also have to be well educated in the relevant technologies. Education becomes even more important when thinking about modern modeling languages, such as UML [OMG01], since these provide even more constructs/principles to consider.

Unfortunately, “traditional” education using class rooms and technology experts is not only cost intensive, but also time consuming [BrGa99]. Especially small and medium-sized enterprises, which often have tight development schedules and short release rates, often cannot afford such a training. Furthermore, trainers often have the problem on how to prepare compact but interesting course material, how to motivate trainees or students, or how to encourage active participation. The recent advent of computer-based training courses seemed to have solved that problem due to the possibility of training on the job or at home. However, such courses often require cost-intensive and effort-consuming projects for their development, which requires a large audience to be cost-effective. Furthermore, they often lack in social communication (i.e., trainees are learning in isolation) and often do not provide any guidance or expert help. In the context of web-based training the latter two may be no problem at all, however, online support and guidance requires additional staff (i.e., trainer), which increases the effort to be spend. Another problem of courses is their heterogeneous audience. Often trainees at various levels of experience, ranging from novices to experts, who want to get the latest update, are participating the same course. This situation is extremely difficult to handle since either the course is too advanced for the inexperienced or too easy for the experienced. In summary, online course can be characterized as follows:

<b>Advantages</b>	<b>Disadvantages</b>
Enables cooperative and collaborative learning	No face2face interaction
Improves active participation	Possible high drop-out rates
Communication and collaboration is electronically supported by creating online communities	Teamwork may require synchronous learning of multiple trainees/students
Independence from a specific location	
Learning is possible at any time	
Multimedia	Possible restrictions due to low-bandwidth connections
Enables to provide and check tests and task online	Requires cost and time intensive support by tutors/teachers Tutors have to be experts in their topic as well as in pedagogies
Complex, cost intensive, or possibly dangerous activities can be simulated	Requires cost-intensive development [Iss97]
	Development of online-course requires a multidisciplinary team [GPRO2]

Table 1

Characterization of Online-Courses

In order to overcome the above mentioned problems, we propose a blended learning approach, which mixes traditional classes and online courses. In this sense, online courses are used in the beginning of a training to leverage knowledge and skills, which makes traditional classes, or learning in general, more effective and efficient [Kerr02]. Traditional classroom education can be used for teaching advanced concepts as well as for performing group work, and practical exercises. This blended learning strategy does not only establish social communication (i.e., trainees know each other as well as their trainer) but also reduces development time and effort for the complete course.

The remainder of this paper is structured as follows. Section two and three describe a strategy for blended learning, developed by Fraunhofer IESE and a practical example. Finally, section four concludes.

## 2 The IESE curriculum for teaching object-oriented design with the UML

Fraunhofer IESE often performs transfer projects in order to introduce object-technology or to improve existing object-technology development processes of customer software-organizations. These transfer projects always comprise a professional training to educate developers in applying the technology to be transferred. In order to make the know-how transfer effective and efficient, we developed a blended-learning curriculum for teaching object-oriented design with the UML. A transfer program developed according to this curriculum consists of the following phases:

1. Kick-off meeting of all participants, their teachers, and tutors
2. Online learning phase to provide knowledge and skills in applying the UML
3. Traditional course on object-oriented design with the UML
4. Final project work

A transfer program always starts with a kick-off meeting. The goal being that participants get to know each other, as well as their tutors and later trainers. Furthermore, it is used to introduce the curriculum, schedule, and individual tasks to the participants, as well as to discuss any problems or questions the participants may have.

The goal of the online learning phase is to leverage the knowledge and skills of the participants in applying the UML, which is a prerequisite for the following traditional class. Concerning the UML example, we use the online-course "UML interactive for software designers", developed in the context of the "Fraunhofer Knowledge & Learning Network (FKN)" (see Fig. 1). This course comprises about 25 online learning hours and 10 practical exercise hours, which are normally distributed over four weeks. It provides several navigational strategies and different entrance points in order to meet the requirements of the heterogeneous group of participants (e.g., inexperienced participants can follow a guided tour). Furthermore, participants can select one out of four modules according to their already acquired knowledge as starting point for dealing with a particular UML topic.



Fig. 1 Starting Page for UML Interaktiv

In general, every participant has to study only those modules, required for reaching a specific level of knowledge and providing knowledge and skills he/she still lacks. Modules are defined as parts of a virtual project to show the practical usage of the provided content. Participants are part of the project team and have to support their virtual “supervisor” in developing UML diagrams. The “supervisor” supports participants in learning UML through the provision of expert knowledge as well as questions and exercises for self-control (e.g., every participant has to solve a modeling task and has to submit his solution for feedback). The results of practical exercises are then regarded as a pre-test for the following class.

The following class on object-oriented design with UML is organized as a mix of both presentations and group work. Typically, advanced elements of the UML and their application in software design are presented in the context of a realistic example, which may be adapted to the participant’s background and context. These elements are then practically applied in small groups consisting out of three to four participants, whereby the group-worked is also based on the example already introduced by the online-course. Finally, participants are asked to perform, alone or in a small group, a specific project-work as a final exam. The results are evaluated by the same tutors/ trainers who also play the role of guides and experts.

### 3 Practical Experience

The application of the knowledge transfer strategy described in the previous section has been performed in the context of training technical managers in using UML. Today 260 persons have registered, whereby approximately 60% are actively using the online-course. First feedback showed that the main problems of these participants are due to not having specifically assigned tutors, and missing facilities for sharing experience between participants. However, nearly all participants like the way UML knowledge is presented and the possibility to learn whenever they have a spare moment and that they can actively work together, at the same level of knowledge, in the subsequent class room training.

Another experience we made is that the development of training based on the blended learning strategy is more cost-effective. Especially, the possibility to teach more participants at the same time using an online-course systematically developed with the IntView methodology [GPR02, GPR01], and to build upon a common knowledge base (classroom) are the most influencing factors.

## 4 Summary & Conclusions

With the rapid rate of innovation in object-technology, teaching/learning of that technology has become the most challenging issue. Classroom training and online-courses both have their strengths but are often cost-intensive or not specifically adapted to the needs of a specific organization. This paper has briefly outlined a blended learning approach, in the context of teaching the UML, which promises highly effective and efficient training of software professionals in object-technology.

By using online-courses in pre-training phases it can be assured that all participants have the same minimum experience level in UML before the classroom training starts. Thus, efficient teaching and learning is enabled. This blended approach also solves typical problems of classroom and online education. By having an equal level of knowledge the duration of classroom training can be shortened. Furthermore, social communication is enabled since trainees know their trainers as well as other trainees. This enables not only communication and collaboration but also support and guidance. In summary, both approaches have their strengths and weaknesses but the synergy effects when used in combination clearly outweigh the isolated benefits of the approaches. We currently plan empirical studies to investigate the return on investment of the suggested strategy. Moreover, we are looking for tools to support it. Both are necessary ingredients to drive the adoption of the approach in practical situations.

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