An Online Course for Teaching Model-based Engineering

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***Abstract*—Online courses and incorporation of e-learning elements in traditional courses are becoming increasingly popular. Switching to an online format is often seen as beneficial to students and educators alike. However, online courses often struggle with teaching complex topics where solutions are not either correct or incorrect but come in different degrees of appropriateness. While models created for model-based engineering must fulfill various rules to be considered suitable, usually various, often equally well suited alternatives exist. In this talk we report our experience from creating and teaching an online course for model based engineering and explain how we handled the need for individualized feedback to modeling exercises.**

***Index Terms*—computer science education, conceptual modeling, online courses**

I. Introduction

In this talk, we present an approach for online courses that is capable of coping with the need for individualized feedback. Particularly, tutorial videos are designed to intensely discuss potential solutions, differences among them, and make students aware of possible acceptable solutions. It has shown that this approach raises students' ability in assessing their own solutions and considerably reduces the need for individualized feedback and personal student teacher instruction. More details on the approach and its application in an industry as well as an university setting can be found in [1].

Recently, blended learning and the flipped classroom have gained much interest and the use of e-learning materials in traditional university courses and industry training is increasing [2]. The reduction of traditional course elements that require attendance in class allows students to better align work, study, and personal life. Additionally, recent studies have shown that the use of e-learning elements aids students' learning experience and motivation as well as students' performance [3].

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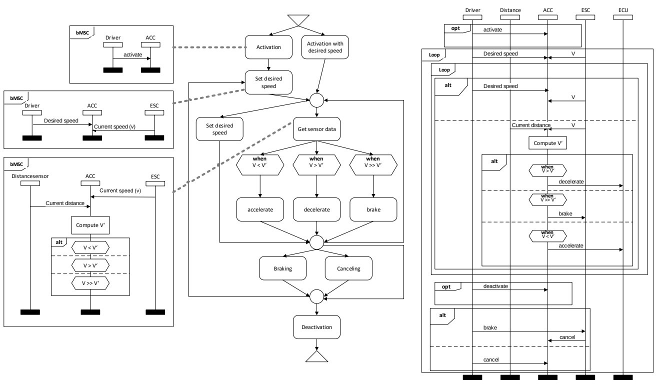
However, drawbacks also exist. Particularly, students' needs for individualized feedback for exercises is mentioned [4], which results from a commonly mentioned lack of interaction between students and teachers [5], which hinders some students in their learning progress. To overcome these shortcomings, e.g., interactive elements such as class meetings, online webinars, the use of forums and chats, or even the implementation of interactive online courses have been proposed. Additionally, the use of automated assessment and feedback generation for handed-in exercise solutions has widely been suggested [6]. However, the proposed solutions are not always feasible, when the use of online courses is desired.

II. Problem

In conceptual modeling automated assessment of handed-in solutions is not feasible [6]. A given content can be typically modeled in the same language using different modeling elements and different compositions thereof. Consequently, a modeling task given to students must either be prescribed very precisely (to allow only one correct solution), or different solutions are possible for the given modeling task.

For example, one issue arising in conceptual modeling is how to slice large models into diagrams. In the context of Message Sequence Charts (MSC), this manifests itself in the distinction between high-level MSCs (hMSCs) and basic MSCs (bMSCs). bMSCs are used to define the interaction steps in a scenario, while hMSCs are used to order bMSC thus allowing modelers to divide large scenario specifications into small chunks as opposed to having one enormous diagram. While this feature of MSCs obviously enables the modeling of semantically identical models in many different ways that all represent the correct scenario steps, some ways of slicing will be more reasonable than others. Defining smaller chunks and integrating these through the hMSC is beneficial for reducing redundancy of the specification and placing more emphasis on the structure giving hMSC.

Fig. 1 gives an example for two different yet equally correct solutions to the same modeling exercise. In Fig. 1(a) a modeling approach is chosen that heavily relies on an hMSC and uses very simple and trivial bMSCs. In Fig. 1(b), the same situation is depicted using one single bMSC. While both models are correct specifications for an initial specification of an adaptive cruise control, there are different benefits to both solutions. Consequently, the students shall become aware of this and thereby understand that even further solutions are possible and acceptable.



(a) Correct solution within one hMSC referencing multiple trivial bMSC

(b) Correct solution within one single bMSC

Fig. 1. Scenario modeling with hMSC vs bMSC

III. Building Blocks of Our Solution

We propose a solution concept based on the idea of actively increasing students' awareness for different potential solutions and hone their ability to assess their solutions on their own. Therefore, we use a combination of different online materials such as lecture notes, instruction videos, as well as solution and FAQ videos, which explicitly discuss varieties of potential solutions, possible benefits, and shortcomings to enable the students to assess their solution on their own. For example, we defined instruction videos that explain the use of MSCs for scenario modeling in general. Furthermore, exercises with multiple correct solutions like shown in Fig. 1 are given and explained in detail in solution viedos. Additionally, short FAQ videos explain commonly made mistakes and misconceptions regarding general solution approaches for scenario modeling with MSCs.

We implemented the solution idea by designing an online course for conceptual modeling focusing on requirements engineering. The online course is designed to be used in a Master level requirements engineering course at university as well as in industrial in-house training for industry professionals.

We defined different building blocks of teaching materials for the online course. Among others, the online materials comprise lecture notes, videos in classical lecture-style, assignments, and whiteboard-style videos discussing potential solutions and benefits of different solutions. Next, we briefly highlight the main elements that are specifically designed to teach learners the ability to assess exercises on their own:

- *Lecture notes.* Mainly structure-giving for the course are the lecture notes, which introduce the instructed material. The lecture notes introduce the lecture-style videos as well as suggested exercises at appropriate places.
- *Instruction videos.* Online lecture-style instruction videos are used to replace classical lectures in giving comprehensive information on the instructed material.
- *Assignments.* Smaller assignments are given to deepen the understanding of modeling constructs or analysis approaches. In addition, larger assignments are given as integrating exercises of realistic size and complexity.
- *Solution videos.* Assignments are accompanied by whiteboard-style solution videos that do not show one single solution but place emphasis on the differences between various acceptable solutions as well as purpose-specific benefits. Also the impact of potential industry or company specific approaches for conceptual modeling is discussed.

IV. Conclusion

We have proposed an online course design to cope with students need for individualized feedback for settings where the use of automated exercise assessment is not feasible. For teaching conceptual modeling, among the learning goals are for example, awareness for the existence of a multitude of correct solutions with different purpose specific degrees of benefits and shortcomings. Hence, there is commonly no finite set of correct solutions, which can be used for automated exercise assessment. We proposed the setup of an online course, which makes use of lecture-style videos and whiteboard-style videos, which show how solutions to exercises can be derived and discuss different ways of reaching correct solutions as well as their benefits and shortcomings. Application in an industrial and an university setting have shown that this can decrease the amount of interactive sessions needed and that students feel less need for individualized feedback as they are enabled to assess the strengths and weaknesses on their own.

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