An agile approach to teach introductory programming in the hybrid classroom

Nyborg, Mads; Valente, Andrea

Published in:

Proceedings of 21st IEEE International Conference on Advanced Learning Technologies

Link to article, DOI:

[10.1109/ICALT52272.2021.00020](https://doi.org/10.1109/ICALT52272.2021.00020)

Publication date:

2021

Document Version

Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Nyborg, M., & Valente, A. (2021). An agile approach to teach introductory programming in the hybrid classroom. In *Proceedings of 21st IEEE International Conference on Advanced Learning Technologies* (pp. 40-41). IEEE. <https://doi.org/10.1109/ICALT52272.2021.00020>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

An agile approach to teach introductory programming in the hybrid classroom

Mads Nyborg

Department of Applied Mathematics and Computer Science
Technical University of Denmark (DTU)
Lyngby, Denmark
manyb@dtu.dk

Andrea Valente

Game Development and Learning Technology
Maersk Mc-Kinney Moller Institute
University of Southern Denmark (SDU)
anva@mmmi.sdu.dk

Abstract—Teaching introductory programming in university is a challenging task, involving high heterogeneity of students’ skills, need to balance theoretical and practical tasks, and the recent, quick-paced move towards the hybrid classroom. We outline the requirements and design of a novel agile tool for semi-linear presentations that can deliver individualized content, trace students’ activity and support dynamic formation of groups.

Keywords—Teaching/learning strategies, hybrid classroom, agile content delivery

I. INTRODUCTION

In this article, we want to restrict the focus from orchestration and individualization of generic material, and consider instead the specific practices and problems of teaching introductory programming courses, in the context of hybrid classroom. The main area of interest will be the issues and strategies to cope with the heterogeneity of students’ proficiency levels, seen from the teachers’ perspective. Teaching introductory programming in university is a challenging task: in Denmark for instance, the students’ prerequisites from the secondary schools are not well defined and typically based on elective courses on the subject; students often have spent time in afternoon clubs, on free-time activities involving programming. As a result, their knowledge in programming before enrolling is very diverse. Moreover, programming is a complex subject, comprising both theoretical and practical aspects. Some students need more detailed explanation and others will benefit from being challenged with more advanced stuff. The challenge of the teacher is to orchestrate this and make it happen at the same time during a lecture. From [7] we know that university lectures are typically organized around slide-based presentations, with practical programming tasks and sometimes quizzes.

Various blended learning models for introductory programming courses have been proposed [2], but they generally lack support for orchestration of individualized content. In [3] the Agile Manifesto, originally created for software development, is mapped to the classroom environment. We agree with its principles, but the *educational agile manifesto* considers traditional, face-to-face classroom.

We want to keep in the spirit of “favoring students over tools” even in the hybrid programming classroom, where tools are inevitable, at the very least for video-lecturing and for programming. An e-learning platform for the hybrid programming classroom should be able to manage and keep track of all relevant historical information, while the teacher and learners focus on “working projects” [3]. This would free teachers and let them focus on feedback and facilitation (other principles from [3]). Agile methods warn against over-planning, however hybrid lectures might require more planning than face-to-face lectures. Therefore, this paper proposes a middle ground between linear presentations (which represent the *plan* in [3]) and a free, un-scripted performance by the teacher, supported by a novel *semi-linear* format for teaching materials. The hybrid classroom also offers an opportunity to form peer instruction groups ([5], [6]) based on skill levels, regardless of learners’ physical location.

II. PROPOSAL OF A NOVEL ORCHESTRATION TOOL

In order to investigate the practices, problems and coping strategies that teachers have developed, in their experience with introductory programming courses, a questionnaire was designed, and distributed among teachers representing major Danish educational institutions. The purpose of the questionnaire was to collect qualitative data on the current situation, with focus on the heterogeneity of students’ proficiency levels in introductory programming courses. Early analysis of the data let us to formulate a working hypothesis, that teachers would prefer (and be more efficient with) a more integrated tool, that lets them declare more explicitly the sequence of activities they want or could perform during a hybrid programming lecture. According to our data the hybrid classroom requires at the very least a video-lecturing tool, a slide presentation tool, a way to deliver exercises and retrieve solutions from the students, and possibly tools for feedback-collection and/or assessment (such as quizzing tools). We believe that a single, more specialized, integrated tool would be preferable to this toolbox.

The novel tool we propose allows for the definition of individualized content, delivery, dynamic group management, and supports close, automatic monitoring of students. The main idea is to move beyond a linear presentation structure, and allow instead a semi-linear structure, using slides or

information cards. In a semi-linear presentation, some sections will be linear slides, while other will be alternatives, i.e. differentiated versions of the same contents, to be accessed non-linearly by different students or groups. In our scenario of use, we propose linear teacher-paced parts, spanning relatively short intervals followed by student-paced non-linear parts. The student-paced part should be triggered for instance by questions; answering the question wrongly should lead students to a more in-depth explanation, while a correct answer could be followed by a more challenging example (Fig. 1). The subject ("T") represents a number of slides presented in a linear fashion (teacher paced), while the "D" slides and the "C" slides represent student paced detailed and challenging slides. The path taken depends on an initial assessment of the topic.

Fig. 1: An example of use of the DSL for orchestration declaration.

A *slide editor* is also provided, for the teacher to define and organize the slides in different panes (an extended MS PowerPoint slide sorter). Since quizzes and exercises' delivery will be integrated in this tool, the students' progression can be recorded by the tool in real-time. This allows the teacher to use the real-time data to adapt dynamically and possibly chose different grouping strategies during the lecture, based on real-time students' performance and/or struggles (Fig 2).

Fig. 2: The progress view

In this way the system provides an agile content delivery of relevant material for different groups of students and acts as a kind of orchestration control room for individual content delivery and monitoring. The system utilizes the flexibility of

the hybrid classroom [1], i.e. a learning environment which includes a mix of students who are present in the physical classroom and also participants joining the class virtually. This setup has already been used during the COVID-19 pandemic and is likely to be used in the future as well.

III. CONCLUSION AND FUTURE WORK

The challenges of managing introductory programming courses in hybrid classroom settings are discussed, and the design of a novel tool is proposed, based on agile educational principles. From our questionnaire, we discovered a spectrum of strategies for orchestration in classes with high heterogeneity of skill levels, as well as grouping strategies. The design of our novel tool supports individualized content delivery, and addresses group-work dynamically; the proposed automatic monitoring, while being ethically and respectful of learners, allows teachers to respond early to struggling students, and adapt delivery strategies based on real-time data. More systematic testing of the concept is needed, and better exemplars of semi-linear slides must be developed and tested. A prototype of the novel tool is currently under construction, based on a variation of the architecture used in [7]; that tool is already capable of forms of individualized content delivery, and has proven usable in early user testing, however, it is not aimed at programming courses. Finally, we have formed a focus group of experts (composed by some of the respondents to our questionnaire) and we are considering a co-design approach [4] to develop our prototype.

REFERENCES

- [1] A. Raes, P. Vanneste, M. Pieters, I. Windey, W. Van Den Noortgate, F. Depaepe, "Learning and instruction in the hybrid virtual classroom: An Investigation of students' engagement and the effect of quizzes", *Computers & Education*, Volume 143, January 2020, DOI: 10.1016/j.compedu.2019.103682
- [2] A. Alammary, "Blended learning models for introductory programming courses: A systematic review", *PLoS ONE* 14(9): e0221765, September 2019, DOI: 10.1371/journal.pone.0221765
- [3] J. C. Stewart, C. S. DeCusatis, K. Kidder, J. R. Massi, K. Anne, "Evaluating Agile Principles in Active and Cooperative Learning", *Proceedings of Student-Faculty Research Day, CSIS, Pace University*, May 8th, 2009
- [4] K. Holstein, B. M. McLaren, V. Aleven, "Co-Designing a Real-Time Classroom Orchestration Tool to Support Teacher-AI Complementarity", *Journal of Learning Analytics*, vol. 6(2), pp. 27–52, DOI: 10.18608/jla.2019.62.3
- [5] J. K. Knight, C. J. Brame, "Peer Instruction", *CBE life sciences education* 17(2), June 2018, DOI: 10.1187/cbe.18-02-0025
- [6] L. Porter, D. Bouvier, Q. Cutts, S. Grissom, C. Lee, R. McCartney, D. Zingaro, B. Simon, "A Multi-institutional Study of Peer Instruction in Introductory Computing", *Proceedings of the 47th ACM Technical Symposium on Computing Science Education*, February 2016, pp. 358–363, DOI: 10.1145/2839509.2844642
- [7] M. Maageng Jakobsen, M. Nyborg, A. Valente, "Towards a new tool for individualised content delivery in classrooms", *HCHI International* 2021, July 2021, in press