A Practice Enquiry Design to Investigate How Pair Programming Can Help with Constructing Automata

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Abstract

Finite state automata (FSA) are a fundamental concept in the theory of computation and the undergraduate computer science education. However often students encounter difficulties with the task of constructing them due their abstract, theoretical nature. We present a disciplinary enquiry design investigating to what extent Pair Programming (PP) as a collaborative learning activity impacts on Software Engineering (SE) undergraduate students' perceived and assessed performance when used for the task of constructing FSA.

1 Motivation

The ACM-IEEE Software Engineering curriculum guidelines [1] recommend *formal or mathematical approaches, modelling, representation, and abstraction* for developing a SE mindset. In this present enquiry, we focus on the task of constructing FSA as part of an year 2 course on algorithms for a SE undergraduate degree.

The FSA construction fulfills Preston [7] criteria for tasks for which collaborative learning is most appropriate. PP [2] has been successfully adopted in CS educational settings [6] as a form of collaborative learning. PP has been shown to be effective by helping improve individual programming skills [3]. FSA are models of computation, hence constructing one is akin to programming.

2 Methodology

Materials and class set up. Students are tasked with constructing a FSA that accepts a given language (a set of strings build over an alphabet). The lecturer models solutions for this task during lectures. In the tutorial session the instructor explains how PP works, the effective work conduct in pairs, and sets up the pairs.

Each student pair has 10-15 minutes to work out a solution for the task. During this time the instructor observes what the students are doing. After the time is up, model solutions are provided and solutions from students are reviewed. Consideration will be given to existing information about learners' computational thinking skills when setting up pairs, as well as to mitigating the risk of learners "free-riding" on the partner's work.

Data collection methods. Data is collected using a mixed-methods approach [5] combining: a short in-class questionnaire (open questions), the University's course standard evaluation, classroom observations, and comparison of assessment scores before and after the intervention. The answers to open-ended questions is coded to identify common themes. For the observational data and students' comments in the course evaluation, we use critical reflection to identify and check the accuracy and validity of our assumptions regarding PP-based teaching activities. The educational intervention data is analysed using descriptive statistics.

Ethical considerations. This enquiry is designed to adhere to the best practices on ethical considerations for education research [4].

3 Early Insight and Future Work

We tested the materials and class set up during one tutorial session. We observed that students enjoyed working in pairs for this task and they commented positively on this experience. The course evaluation included a comment noting that working in pairs for the FSA construction task *"was nice to work with others to help build each others understanding and this approach would help more with some of the tricky sections"*. We will ran this enquiry fully during the next teaching block and for other abstract state machines.

This poster seeks to generate a discussion within the UKICER community around the use of collaborative learning activities, such as PP, in theory-heavy computer science undergraduate courses.

References

[1] M. Ardis, D. Budgen, G. W. Hislop, J. Offutt, M. Sebern, and W. Visser. SE 2014: Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering. *Computer*, 48(11):106–109, 2015.

[2] K. Beck and C. Andres. *Extreme Programming Explained: Embrace Change.* Addison-Wesley Professional, 2nd edition, 2004.

[3] G. Braught, L. M. Eby, and T. Wahls. The effects of pair-programming on individual programming skill. In J. D. Dougherty, S. H. Rodger, S. Fitzgerald, and M. Guzdial, editors, *Procs. of the 39th SIGCSE TS'08*, pages 200–204. ACM, 2008.

[4] British Educational Research Association (BERA). *Ethical Guidelines for Educational Research*, 2018.

[5] E. Cleaver, M. Lintern, and M. McLinden. *Teaching and Learning in Higher Education: Disciplinary Approaches to Educational Enquiry.* SAGE Publications Ltd, 2nd Edition edition, 2018.

[6] B. Hanks, S. Fitzgerald, R. McCauley, L. Murphy, and C. Zander. Pair programming in education: a literature review. *Computer Science Education*, 21(2):135–173, 2011.

[7] D. Preston. Pair programming as a model of collaborative learning: A review of the research. *J. Comput. Sci. Coll.*, 20(4):39–45, 2005.