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► To cite this version:

Michele Tessier-Baillargeon, Nicolas Leduc, Ludovic Font, Philippe R. Richard, Michel Gagnon. QED-Tutrix: Creating and expanding a problem database towards personalized problem itineraries for proof learning. CERME, Feb 2017, Dublin, Ireland. hal-01925485

HAL Id: hal-01925485

<https://hal.science/hal-01925485>

Submitted on 16 Nov 2018

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QED-Tutrix: Creating and expanding a problem database towards personalized problem itineraries for proof learning

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Keywords: Intelligent tutoring system, automated theorem proving, didactical contract, Design in use.

QED-Tutrix (QEDX) is an intelligent tutoring system which assists students in proof problem solving by providing hints while taking into account the student's cognitive state. QEDX stands out by the fact that it adapts to each user and class reality, not the opposite. However, this model implies recognizing, like a teacher would, proofs that do not necessarily conform to a formal logic. Hence, QEDX can't rely on an automated proof engine (Tessier-Baillargeon, 2016), raising the question of how to expand QEDX's problem database without manually implementing each valid proof. Therefore, our poster at CERME10 doesn't present a traditional research project with its research questions, its methodology and conclusions. It rather aims at presenting the new research questions that stem from the challenges that arise with trying to broaden QEDX's problem bank while staying true to our main goal, which is to create a geometrical workspace (Kuzniak, 2006) according to witnessed student/teacher interactions through a design in use approach (Rabardel, 1995). Here we will focus our attention on the process of problem implementation, starting with how we currently generate a proof problem's solution graph.

Generating a proof problem's solution graph.

QEDX's **HPDIC** graph (Figure 1) is used to record all the valid proofs to a given problem. It includes **H**ypotheses, **P**roperties, **D**efinitions, **I**ntermediary results and a **C**onclusion. This graph is unique to each problem and is built from the inferences individually identified as true according to the problem to solve and the class context. The HPDIC graph for the *rectangle* problem in Figure 1 is fairly simple since it counts only 13 inferences. However, in the five problems implemented in the current QEDX version, one counts 214 inferences creating a much more complex HPDIC graph.

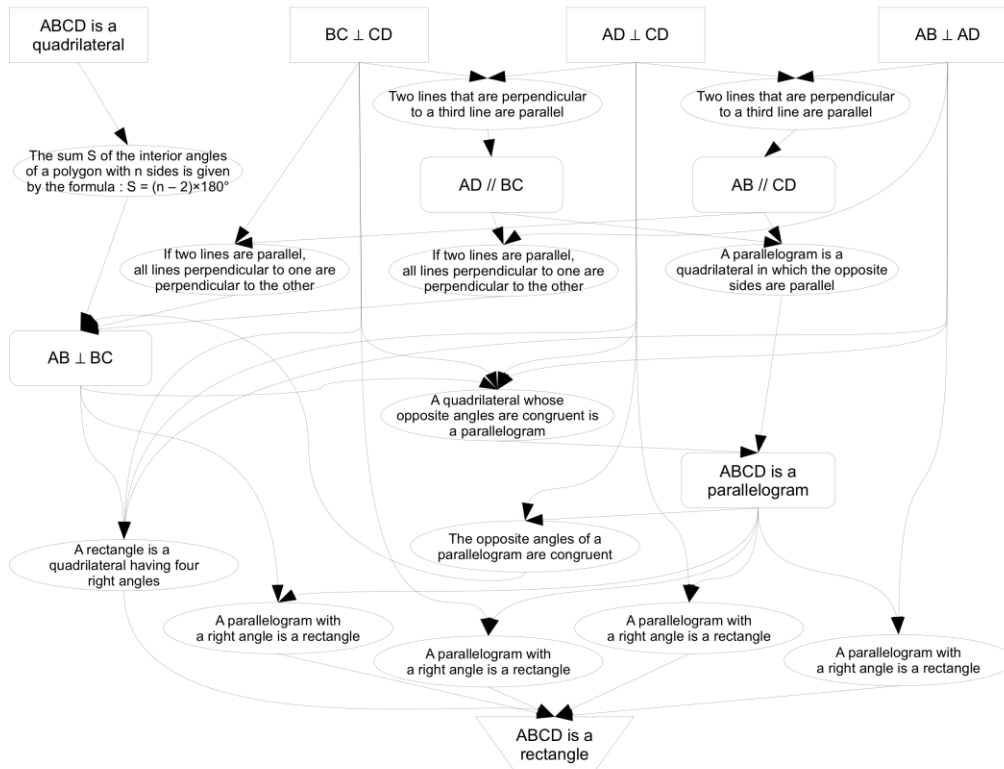


Figure 1: HPDIC graph, *rectangle* problem that asks to prove that a quadrilateral with three right angle is a rectangle

Needless to say, there is a great amount of prerequisite work to be done before a problem can be added to the system. Therefore, in order to expand QEDX's problem database, we need to, at least partially, automatically generate each problem's solution space. A rich problem database will allow the student to navigate a geometrical workspace made up of a sample of problems put together to help him or her overcome difficulties as well as exercise proving skills through personalized problem itineraries. However, since QEDX aims at adapting to every didactical contract (Brousseau, 1998) by expecting and recognizing proofs according to what the teacher of any given classroom would require, manually generating every valid solution becomes almost impossible. How can we take into account teaching traditions while maximizing our proof problem pool? This challenge will define the next steps in QEDX's design and development.

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